Environmental Assessment
Brunswick County
Interbasin Transfer

Prepared for

Prepared by

TETRA TECH

One Park Drive, Suite 200 • P.O. Box 14409
Research Triangle Park, NC 27709

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Lead Agency
North Carolina Division of Water Resources
Ms. Toya Ogallo
1611 Mail Service Center
Raleigh, NC 27699-1611
(919) 707-9023

Applicant
Brunswick County Public Utilities
Jerry Pierce, PE, Director
250 Grey Water Road NE
Supply, NC 28462
P.O. Box 249
Bolivia, NC 28422
(910) 253-2657

Consultant Contact
Tetra Tech
J. Todd Kennedy, PH, QEP
One Park Drive, Suite 200
P.O. Box 14409
Research Triangle Park, NC 27709
(919) 485-8278

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Executive Summary

Brunswick County (County), through Brunswick County Public Utilities, provides water to more than 34,000 retail customers and 11 wholesale customers through its two water treatment plants (WTP). The Northwest WTP is located near the City of Northwest and supplied by water from the Cape Fear River via the Lower Cape Fear Water and Sewer Authority. The 211 WTP, near the Town of St. James, is supplied by groundwater wells into the Castle Hayne Aquifer. The Northwest WTP and 211 WTP have permitted capacities of 24 and 6 MGD, respectively. Wastewater within the County is handled through a variety of system types including individual onsite septic systems, clustered and centralized land application, reuse, and discharging systems.

To meet future demand for water, the County is considering expansion of the Northwest WTP. The expansion is expected to trigger the need for an interbasin transfer (IBT) certificate from the North Carolina Environmental Management Commission under the Regulation of Surface Water Transfers Act. A portion of the surface water treated at the Northwest WTP in the Cape Fear IBT River Basin is distributed to customers in the Shallotte IBT River Basin (an *isolated river basin* according to Session Law 2010-155) and the Waccamaw IBT River Basin, both of which are in the Lumber Major River Basin.

Under the grandfather provision of the Regulation of Surface Water Transfers Act, the County may transfer up to 10.5 MGD from one designated river basin to another without an IBT certificate. The County is requesting an IBT certificate from the EMC for an increase of 7.8 MGD over the grandfathered transfer, with all the increase going to the Shallotte IBT River Basin and resulting in a maximum transfer from the Cape Fear IBT River Basin of 18.3 MGD. This increase is based on water demand projections and need through approximately 2042, representing nearly a 30-year period for the IBT certificate. No increase in IBT is being requested for the Waccamaw IBT River Basin: minor growth is expected in this area and future water will be supplied by the Little River Water and Sewerage Company in South Carolina via an agreement with the County.

The County has prepared this Environmental Assessment (EA) pursuant to the procedures and standards set out in G.S.§143-215.22I effective July 1, 2007, as specified in Session Law 2010-155 passed by the North Carolina General Assembly in summer 2010. The North Carolina Division of Water Resources is the lead agency in overseeing the preparation of the EA. This EA has been prepared to support the request for an IBT certificate only and does not involve any construction activities. Any potential impacts associated with construction of WTP improvements in the source basin, and transmission line upgrades in the source and receiving basin would be reviewed under environmental documents prepared under the State Environmental Policy Act (SEPA) specifically for these projects as required by statute and regulation. An EA for the plant expansion and associated improvements as described would be prepared and be reviewed as required by SEPA only if an IBT certificate is approved.

The EA includes detailed descriptions of environmental characteristics in the source and receiving basins, an analysis of alternatives considered to IBT, analyses of the potential impacts, and mitigation to reduce the potential impacts to an insignificant level. The full list of alternatives includes:

1) No Additional IBT
2) Additional IBT - Expand Northwest WTP
3) Waccamaw Surface WTP
4) Expand 211 WTP
5) New Groundwater WTP
6) Seawater Desalination Plant
7) Return of Additional Wastewater to Source Basin
8) Water Conservation and Reuse

9) Surface Water Storage

Factors considered during alternatives analyses included the technical viability of the option, the constructability of the alternative, potential environmental impacts, technical difficulty, permitting issues, and estimates of probable costs, both construction costs and O&M.

The No Additional IBT alternative (#1) was not recommended because the County has demonstrated the need for an expansion of its water treatment system, and not doing so would compromise its ability to provide reliable, high-quality potable water to its customers in the future, especially those located in the Shallotte IBT River Basin. Compared to alternatives #3 through #6 in the list above, additional IBT associated with an expansion of the Northwest WTP (#2, qualified below) is recommended as the preferred alternative because of a lower cost (capital, O&M), low technical difficulty, an equivalent or lower level of permitting difficulty, a low level of direct impacts (e.g., new WTP alternatives would have additional construction impacts for a new site), and an equivalent level of secondary and cumulative impacts in the Shallotte IBT River Basin. Return of additional wastewater to the source basin through land application (alternative #7 above) would add more than 40 percent to the cost of the preferred alternative without significant benefit to the resource.

Combined with additional IBT associated with the expansion of the Northwest WTP (alternative #2), the County proposes to use a combination of alternatives #8 and #9 to limit transfer of water. Water conservation and reuse are key elements of the County's current water management plan, and they already reduce water demand and any associated IBT of water. In addition, the County has reduced the need to transfer additional water by developing an interconnection and agreement to purchase water from the Little River Water and Sewerage Company for future potable water service in the Waccamaw River subbasin. Finally, the County is planning a study of aquifer storage and recovery at the 211 WTP to reduce withdrawal of surface water during peak demand periods. The technical viability of this option is unknown at the present time.

Direct impacts associated with the Additional IBT – Expand Northwest WTP alternative include those related to withdrawal of water from the Cape Fear River above and below Lock and Dam #1. An analysis using NCDWR's existing hydrology model for the Cape Fear was conducted to determine the County's impact on water availability and whether water demands are met for all users in the future. The results did not change NCDWR's (2008) previous conclusion that full demand for all withdrawals at Lock and Dam #1 are met through 2050. In addition, the increase from the Brunswick withdrawal is small and, predicted flows passing over the dam at the 95th percentile flow exceedence (i.e., a relatively low flow) in 2050 would remain substantial. Similarly, the impacts of the withdrawal on water quality are predicted to be minimal and insignificant based on a statistical analysis of observed data and as demonstrated by the North Carolina Division of Water Quality's model of the Lower Cape Fear River Estuary.

Secondary and cumulative impacts for the project are those that could be derived from potential growth inducement in the Shallotte IBT River Basin. The additional water supply is considered a factor in facilitating growth. Future growth in the County is expected to primarily occur as low- and medium-density residential uses. If not managed properly, additional urbanization of the service area has the potential to cause significant impacts that degrade water resources, aquatic and wildlife habitat and resources, and other environmental features due to increased stormwater runoff, erosion and sedimentation, and other consequences of land development. However, there are a robust set of government policies applicable to the service area (including a strong stormwater management program) that provide considerable and sufficient mitigation for potential secondary and cumulative impacts.

In summary, the request for an IBT certificate to increase water transfer of 7.8 MGD over the grandfathered amount (10.5 MGD) from the Cape Fear IBT River Basin to the Shallotte IBT River Basin would not be expected to result in any significant environmental impacts. Therefore, the long-term productivity and sustainability of the source and receiving basin are not compromised. Further, there would be no significant environmental changes that are irreversible or irretrievable.

1 Project Purpose and Need

Brunswick County (County), through Brunswick County Public Utilities (BCPU), provides water to more than 34,000 retail customers and 11 wholesale customers. To meet future demand for water, the County is considering expansion of its Northwest Water Treatment Plant (WTP). The expansion of the Northwest WTP is expected to trigger the need for an interbasin transfer (IBT) certificate from the North Carolina Environmental Management Commission (EMC) under the Regulation of Surface Water Transfers Act. A portion of the surface water treated at the Northwest WTP in the Cape Fear IBT River Basin, as defined by General Statute (G.S.) §143-215.22G, is distributed to customers in the Shallotte IBT River Basin (an *isolated river basin* according to Session Law 2010-155) and the Waccamaw IBT River Basin, both of which are in the Lumber Major River Basin (Figure 1).

The County has prepared this Environmental Assessment (EA) pursuant to the procedures and standards set out in G.S.§143-215.22I effective July 1, 2007, as specified in Session Law 2010-155 passed by the North Carolina General Assembly in summer 2010. The North Carolina Division of Water Resources (NCDWR) is the lead agency in overseeing the preparation of the EA.

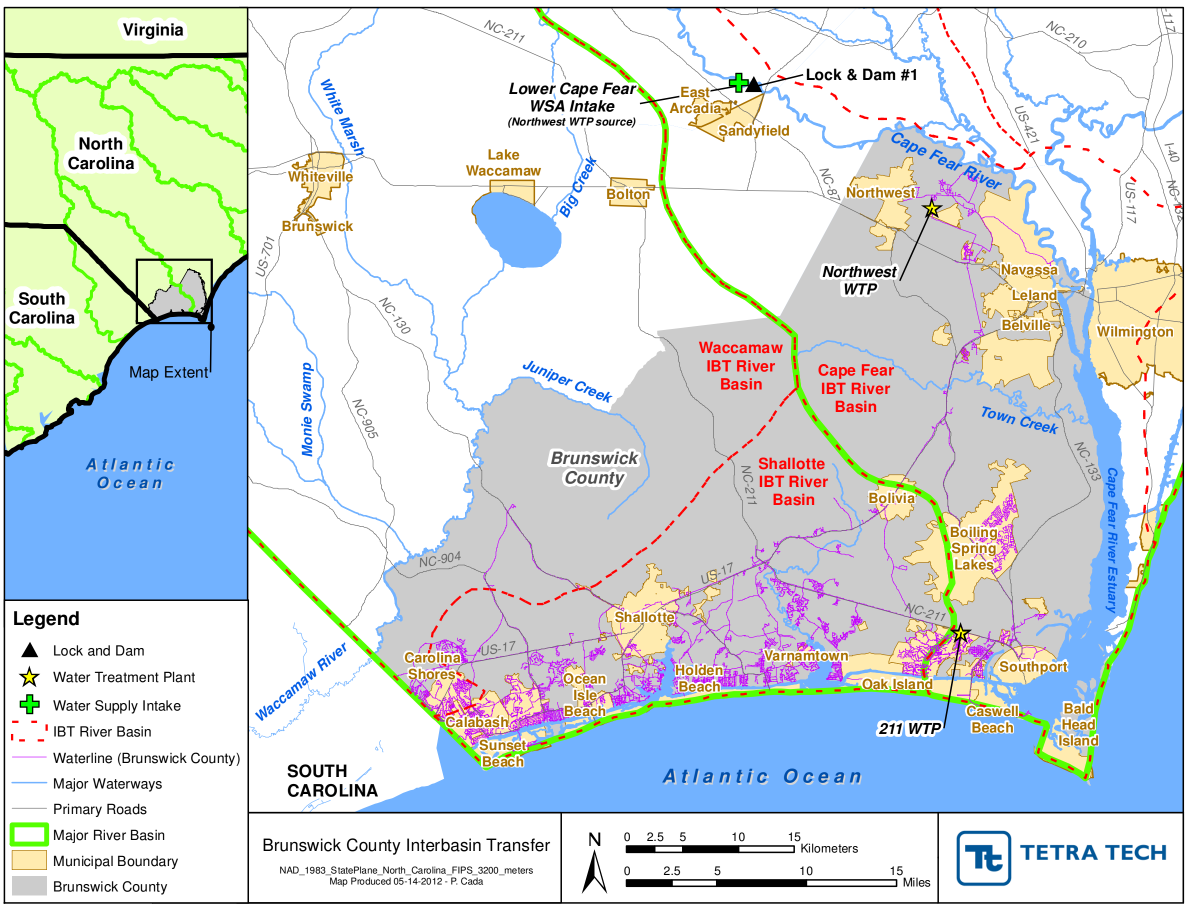

Figure 1. Location Map for Brunswick County IBT

This EA is organized into eight sections: (1) *Project Purpose and Need* discussing the existing water and wastewater systems and programs, water demand, and the IBT request; (2 through 4) *Existing Environmental Characteristics* of the source and receiving basins; (5) *Alternatives Analysis* comparing alternatives to IBT; (6) *Predicted Environmental Effects*, a detailed analysis of potential effects of the IBT; (7) *Mitigation Measures* that address secondary and cumulative impacts; and (8) a *Summary*.

This EA has been prepared to support the request for an IBT certificate only and does not involve any construction activities. Any potential impacts associated with construction of WTP improvements in the source basin, and transmission line upgrades in the source and receiving basin would be reviewed under environmental documents prepared under the State Environmental Policy Act (SEPA) specifically for these projects as required by statute and regulation. An EA for the plant expansion and associated improvements as described would be prepared and be reviewed as required by SEPA only if an IBT certificate is approved.

1.1 BACKGROUND

In 1993 (effective 1994), the North Carolina Legislature adopted the Regulation of Surface Water Transfers Act. The statute was subsequently modified in 1998, 2002, 2007, and most recently in 2010. It requires that large transfers of water across designated hydrologic basins, referred to as an IBT, be subject to environmental review and approval by the EMC. Certification by the EMC is required for (1) new transfers of 2 million gallons per day (MGD) or greater and (2) increases in existing transfers of 25 percent or more above average daily amount transferred during the year ending July 1, 1993, if the total transfer including the increase is 2.0 MGD or more.

A related statute, G.S.§143-215.22G, provides a subbasin map and definitions of the river basins and major subbasins under the law. In the more recent legislation, *subbasin* is synonymous with IBT river basin. The term *river basin* here is contrasted with the more commonly known *major* river basins in North Carolina.

The proposed expansion of the Northwest WTP plant is expected to trigger the need for an IBT certificate because a portion of the surface water treated at the Northwest WTP distributed to customers across the basin divide into the Shallotte IBT River Basin and the Waccamaw IBT River Basin, both of which are in the Lumber Major River Basin. Waters in the Lumber Major River Basin (except for the Lockwoods Folly and Shallotte rivers), including the Waccamaw River, are tributaries of the Pee Dee River, which flows to Winyah Bay in South Carolina. The Shallotte River and Lockwoods Folly River are also considered part of the Lumber Major River Basin but flow directly into the Atlantic Ocean (hence the recent classification as an isolated basin).

Under the grandfather provision of the Regulation of Surface Water Transfers Act, the County may transfer up to 10.5 MGD from one designated river basin to another without an IBT certificate (Table 1). The County is requesting an IBT certificate from EMC for an increase over the grandfathered transfer, with all of the increase going to the Shallotte IBT River Basin (i.e., no increase in the Waccamaw IBT River Basin). This increase is based on water demand projections and need through approximately 2042, representing nearly a 30-year period for the IBT certificate. Additional detail on the IBT request is provided later in this section.

Table 1. Brunswick County Transfer Capacity as of July 1, 1993

Water Transfer Elements	Capacity (MGD)
Surface WTP	24
Transmission/Distribution System	18
Discharge Capacity[1]	10.5
Transfer Capacity[2]	10.5

Notes:
[1] Includes max day WWTP permitted capacity, max day consumptive loses (i.e., septic tanks), and other system losses (i.e., a reasonable estimate of unaccounted losses such as leaking pipes).
[2] Approval via letter from NCDWR on April 25, 2008 (Appendix A).

The certification process was initiated in February 2009 by filing a Notice of Intent (NOI) to File a Petition to the EMC as described in G.S.§143-215.22L(c). A NOI letter described the County's plan to petition for an IBT. A copy is provided in Appendix B. As required by the IBT provisions in effect during that time, public notice was given, and four public meetings were held within 90 days of the NOI letter. In addition, a scoping document was circulated through the State Environmental Review Clearinghouse (Clearinghouse). Results of the public meetings and scoping are provided in Appendix C. The information obtained from these efforts was used to help define the content for this EA.

Following these initial steps required by G.S.§143-215.22L, the North Carolina General Assembly passed Session Law 2010-155 in the summer of 2010. This change in the statute directed the County to proceed with the certification process using the procedures and standards set out in G.S.§143-215.22I effective July 1, 2007.

The EA was provided for review to NCDWR, other agencies within the NC Department of Environment and Natural Resources (NCDENR), US Fish and Wildlife Service, NC Wildlife Resources Commission, and through the Clearinghouse. Correspondence from these reviews and NCDWR's Finding of No Significant Impact (FONSI) are provided in Appendix K and Appendix L.

1.2 EXISTING WATER SUPPLY

The County has two WTPs: the Northwest WTP, near the City of Northwest and supplied by water from the Cape Fear River, and the 211 WTP, near the Town of St. James and supplied by 15 wells that draw groundwater from the Castle Hayne Aquifer (Figure 1). The Lower Cape Fear Water and Sewer Authority (LCFWSA) supplies raw water to the Northwest WTP from an intake on the Cape Fear River above Lock and Dam 1. The Northwest WTP and 211 WTP have permitted capacities of 24 and 6 MGD, respectively. Water from the two plants is routinely mixed within the distribution system in the southeastern portion of the County.

The County's water system serves the majority of the County and does not serve customers outside the County. The southwest portion of the County uses the most water relative to the northeast and southeast. Current customers include the following wholesale entities: Bald Head Island, Leland, Caswell Beach, Holden Beach, Brunswick Regional Water and Sewer (H2GO), Northwest, Oak Island, Ocean Isle Beach, Shallotte, Navassa, and Southport. The system also serves retail and industrial customers in the County's jurisdiction as well as customers residing in the towns of Sunset Beach, Carolina Shores, Bolivia, Calabash, and Varnamtown. The County owns and operates the water systems in these small municipalities.

Recently, the County entered into an agreement with the Little River Water and Sewerage Company in South Carolina for an emergency water connection and to supply a small amount of water to meet future demand in Carolina Shores.

1.3 WATER DEMAND

1.3.1 Recent Water Demand Synopsis

Previous water demand projections prepared for the County's recent Water Master Plan suggested that *peak day* demand was estimated to reach 80 percent of the water treatment capacity for the Northwest and 211 plants *combined*, in about 2007 (Hazen and Sawyer, 2006). Additionally, data from 2005 through 2007 suggested that the Northwest WTP was approaching capacity on peak days which typically occur mid-summer (Hazen and Sawyer, 2008).

Since these earlier projections, finished water demand increased in 2008, but then declined in 2009 and 2010 before increasing to pre-2009 levels again in 2011 (Figure 2). The number of customers served increased modestly over this 4-year period (approximately 15% between 2008 and 2011), but slower than had been projected because of the economic downturn that became more pronounced in 2008.

It is believed that there are several reasons that average and peak water demands have not clearly increased despite an increase in the number of customers served including:

- Weather related effects (discussed below)
- Increased water efficiency, conservation and reuse (see Figure 4 and discussion of *per capita* water demand in Section 1.3.3)
- Decreased industrial demand (see Figure 5 and discussion of *industrial* water demand in Section 1.3.3)

It is likely that weather played a significant role in observed water demand (annual average and peaks) over the 2008-2011 period. Monthly precipitation data superimposed on Figure 2 appear to show some correlation between rainfall and water use (an inverse relationship as expected in a system with seasonal increases in water use associated with landscape irrigation). However, the simplified presentation of precipitation data in Figure 2 doesn't tell the complete story. For example, drought conditions leading up to the summer of 2008 resulted in a precipitation deficit of over 23 inches for calendar year 2007 at the National Weather Service's Wilmington, NC monitoring station. On the other hand, measured precipitation for calendar years 2008 and 2009 tracked closely with historical averages (+3.76 inches and +2.68 inches, respectively). However, 2010, which like 2008 saw a spike in water demand, finished with a 13.65 inch annual precipitation deficit.

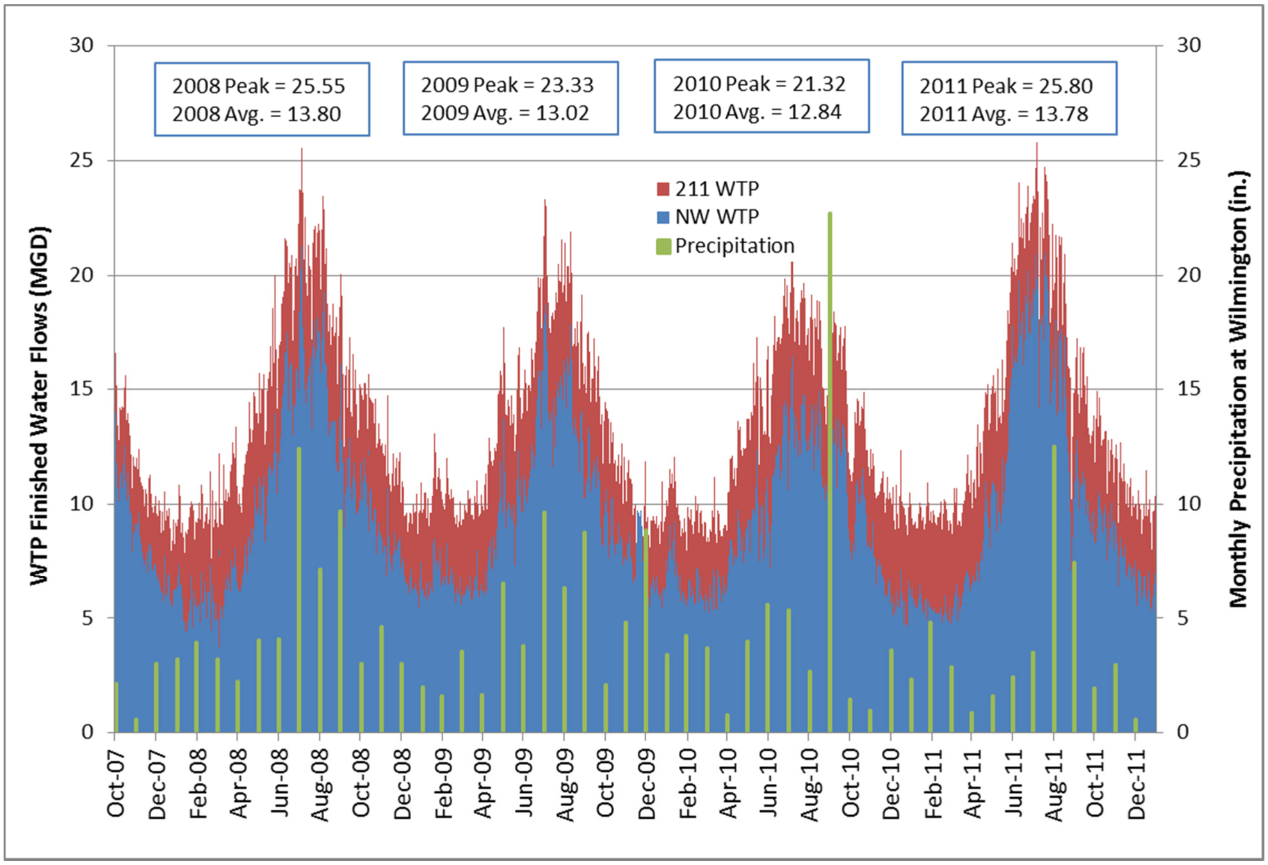

Figure 2. Brunswick County - Actual Finished Water Flows for October 2007 through 2011

Additional historical water demand trend analyses in support of future projections are provided in Section 1.3.3.

1.3.2 Current (2011) Water Demand Analysis

An analysis of water use for the most recent full calendar year (2011) was developed using data from the following sources:

- Daily finished water pumping data from Brunswick County Drought Report to NCDENR (2011)
- BCPU Monthly Reports for FY 2011 and FY 2012
- BCPU Monthly Total, Industrial and Wholesale Customer summary (2011)
- U.S. Census Data (2010)

The County meters the following water demand elements: total water pumped, retail pumped, large industrial pumped, wholesale pumped and operational (unbilled) uses pumped.

Unaccounted water is calculated as the difference between total water pumped and the sum of the other metered sectors. Unaccounted water losses averaged 0.56 MGD in 2010 and 1.01 MGD in 2011, with significant monthly variability. Operational (unbilled) uses averaged 0.31 MGD and 0.33 MGD for 2010 and 2011 respectively, but also varied widely from month to month.

Figure 3 provides a graphical summary of monthly water demand by sector for calendar year 2011. In 2011, total daily demand averaged 13.78 MGD (tabular data is provided in Appendix D). The peak day flow reported for 2011 was 25.80 MGD (approximately 86 percent of permitted water treatment capacity of 30 MGD), occurring in July, resulting in a peak day peaking factor of 1.87. Monthly average daily water demand ranged from about 68 percent (January, February, December) to 160 percent (July) of the annual average. In 2011, the average daily water demand for July was approximately 2.35 times the February water demand because of a combination of seasonal outdoor water uses and seasonal population increases associated with beach communities in County's service area. In Figure 3, the gray hatched segment at the top of each column represents the increase above the average demand associated with the peak day for that month.

Additional water sector demand analyses in support of future projections are provided in Section 1.3.3.

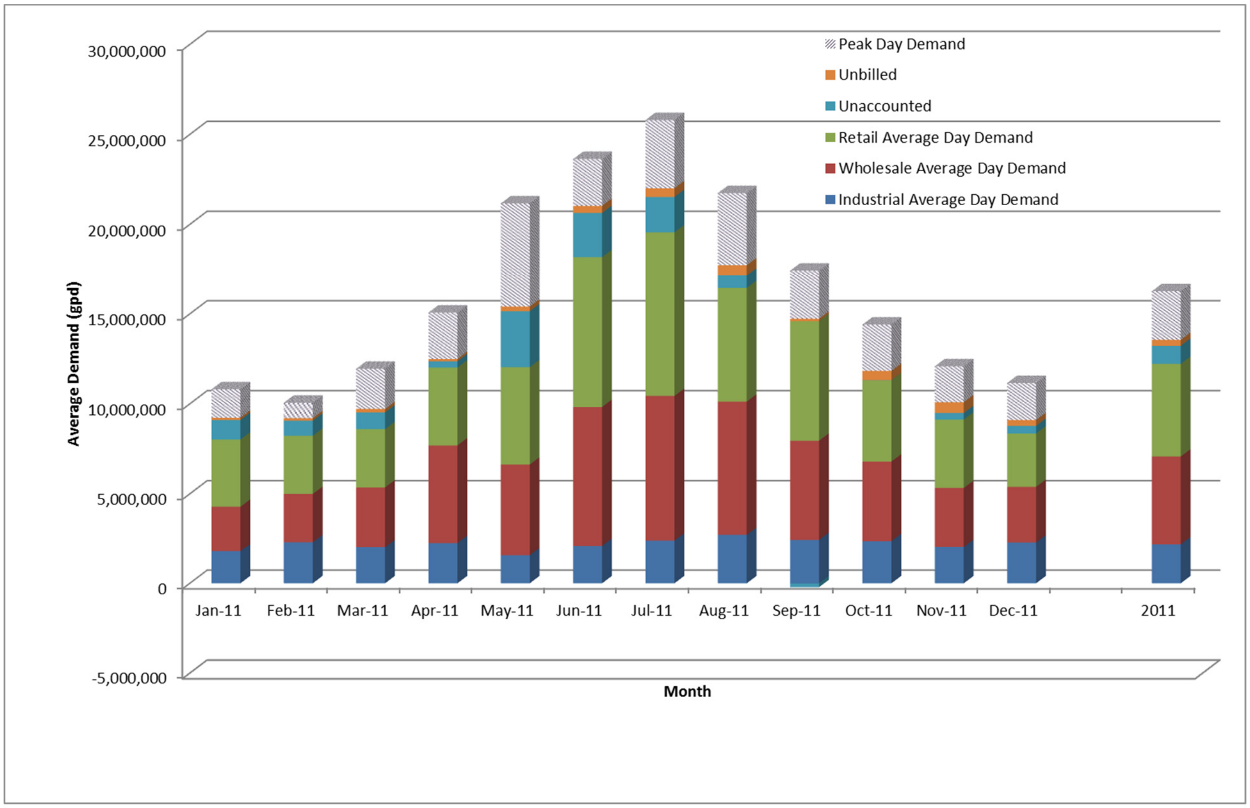

Figure 3. Brunswick County 2011 Water Sector Demands

1.3.3 Projected Water Demand based on Historical Demand Trends

The sectoral breakdowns summarized in Figure 3 were used along with population data and associated projections from various sources to estimate future water demand.

Water demand projections were based on the following main assumptions:

- A constant *per capita* water demand was used to estimate future *retail water demand* based on population growth projections
- *Wholesale water demand* was assumed to increase at a rate proportional to population growth projections
- *Industrial water demand* was assumed to be constant over the planning horizon
- *Non-revenue water demand* was assumed to increase at a rate proportional to population growth projections
- *Peak month and peak day peaking factors* were assumed to be constant over the planning horizon

Note that *per capita* and wholesale water demands as well as peaking factors associated with the County water systems are most likely influenced by the seasonal nature of some of its customer base. This seasonal effect likely results in somewhat lower than typical *per capita* demand (because a portion of the water user base is only present during tourist seasons and times) and higher than typical peaking factors, (since, in addition to seasonal water uses such as irrigation during summer months, more water users may also be present during these times).

Additional discussion on these water demand elements is provided below.

1.3.3.1 Retail Water Demand

The average *per capita* water demand for 2011 of 71.94 gallons per day (gpd) was used to estimate future retail demands. *Per capita* water demand was calculated by dividing the annual average daily retail demand by the average number of customers served in 2011. The average number of customers was calculated by multiplying the average number of connections (tracked monthly by BCPU) by 2.21, which is the average number of persons per household derived from 2010 U.S. Census for the County (U.S. Census, 2010). On a per connection basis, retail water demand for the County system was 158.99 gpd/connection for calendar year 2011 (note: because calculated *per capita* demand is directly proportional to per connection demand, the choice of which to use has no bearing on the following water demand projections).

For this projection, a constant *per capita* retail demand was applied throughout the planning horizon. Annual average *per capita* retail water use data for the period of 2006 to 2011 are presented in Figure 4. Although the figure appears to show a slight declining trend in *per capita* demand, the correlation is weak and it is likely that external factors account for annual variations. For example, as previously described, the drought of 2007 is likely to have resulted in a higher *per capita* water use for irrigation for that year which influences the apparent declining trend in demand.

Nevertheless, it is possible that the assumption of a constant *per capita* retail demand will somewhat overestimate actual future flows for this sector since no allowances have been made for potential demand reduction measures (e.g., water conservation, reuse) that might occur over the planning period. However, it should be noted that, in general, predicting future *per capita* water demand has proven to be difficult, as water use efficiencies in some areas can be offset by increases in others.

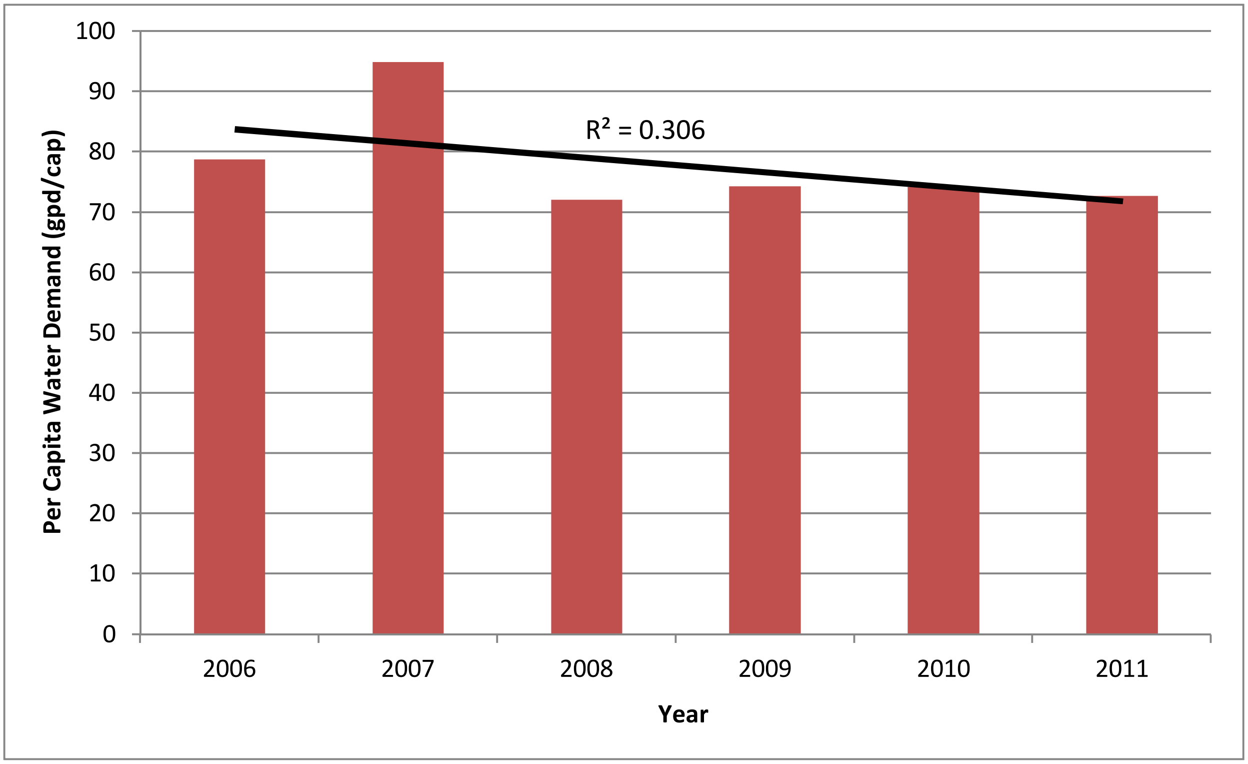

Figure 4. Historical *Per Capita* Retail Water Demand

1.3.3.2 Wholesale Water Demand

Although wholesale water demand remained relatively constant (and likewise the proportion of wholesale demand relative to retail demand declined) between 2006 and 2011, a constant wholesale-to-retail demand ratio (based on year 2011 data) was used to project future wholesale water demand. In other words, it was assumed that wholesale water demand will grow at the same rate as will retail demand (i.e., both are assumed to be proportional to projected County population growth). For this assumption to hold true, increases in wholesale water demand will need to come from customer growth for existing wholesale water users, the addition of new wholesale customers to County's water system or some combination of the two.

Despite uncertainties regarding the magnitude of wholesale water demand in the future, it is important to note that the apportioning of demand between retail and wholesale customer sectors should have no impact on total water demand over the planning horizon. The assumption that total non-industrial water demand (retail + wholesale) will increase in proportion to population growth is logical. It may however be that this total non-industrial demand turns out to be apportioned differently between the retail and wholesale sectors than projected.

1.3.3.3 Industrial Water Demand

Large industrial water usage was assumed to be constant over the planning period at the average 2011 demand of 2,192,911 gpd. As illustrated in Figure 5, linear regression of historical annual data shows a relatively strong declining trend in industrial water demand over the past decade, believed to be due to multiple factors, including greater water use efficiency and recycling at industrial facilities and a decreasing number of industrial facilities in the service area. Therefore, it is likely that the assumption of constant industrial water demand over the planning period is conservative (i.e., it may overestimate industrial demand). However, the addition of one or two large industrial facilities is possible and could have an effect on future industrial sector water demands, so this conservatism may be warranted.

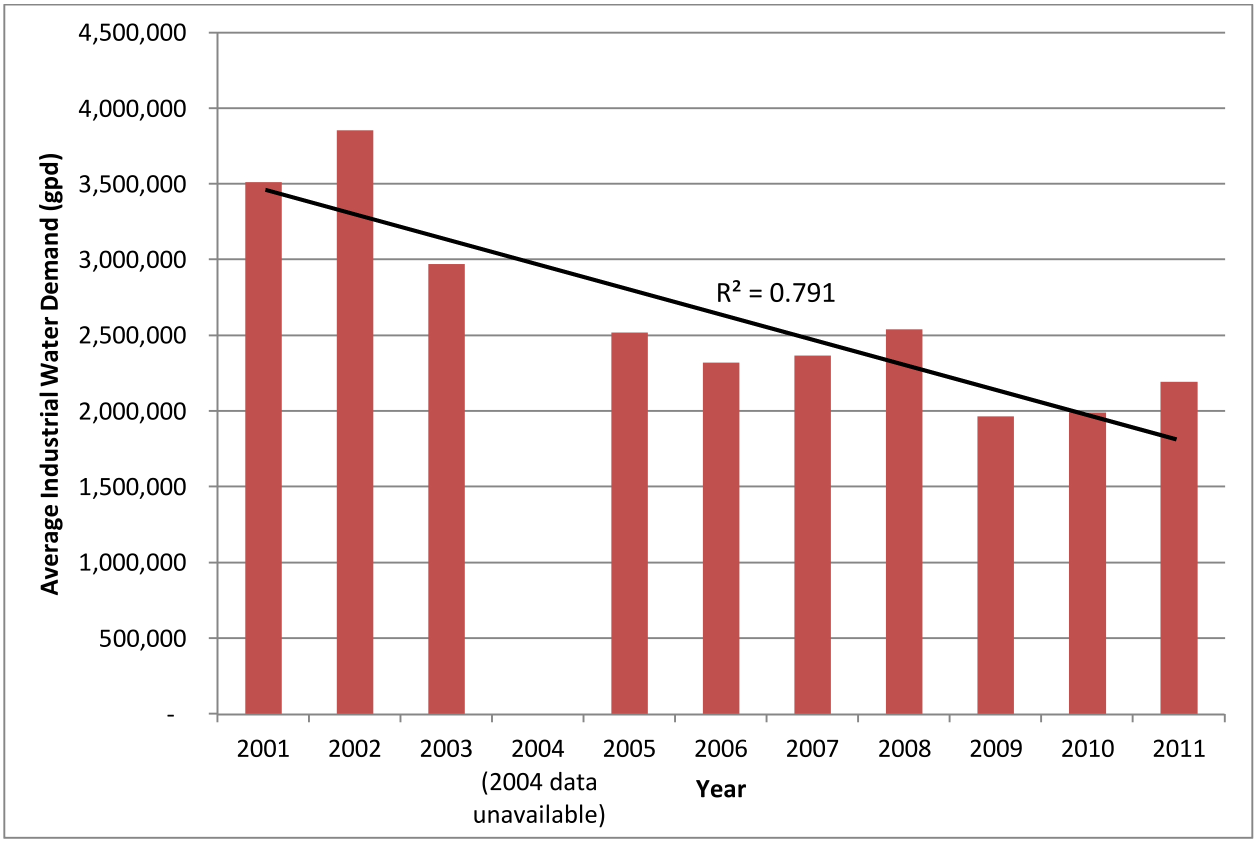

Figure 5. Historical Industrial Water Demand (2001-2011)

1.3.3.4 Non-Revenue Water Demand

Non-revenue water demands including unbilled (operational) uses and unaccounted water were assumed to grow in proportion to population served, using as a basis the latest data from 2011 which shows an average non-revenue demand of approximately 1.33 MGD (approximately 10 percent of the total demand for 2011).

Although it is logical to assume that operational water demands would increase with an increasing population and that unaccounted water demand would increase with additional service connections, pipeline and other infrastructure that could potentially leak, non-revenue water demand for 2006 through 2011 appears to show a declining trend (Figure 6). Additionally, a plot of non-revenue demand versus total billed water demand (which is related to the number of service connections and other infrastructure) shows no clear correlation (Figure 7). Possible explanations for the decreasing trend in unbilled demand with time could include effective programs for reducing leaks and for metering and billing all water users. Conservation efforts undertaken by unbilled (operational) users could also be contributing to the decreasing trend.

Nevertheless, because these apparent trends are somewhat uncertain and because the 2011 non-revenue demand of approximately 10 percent of total demand is in line with typical water system allowances, water demand projection calculations were based on the 2011 non-revenue data, assumed to grow in proportion to population served.

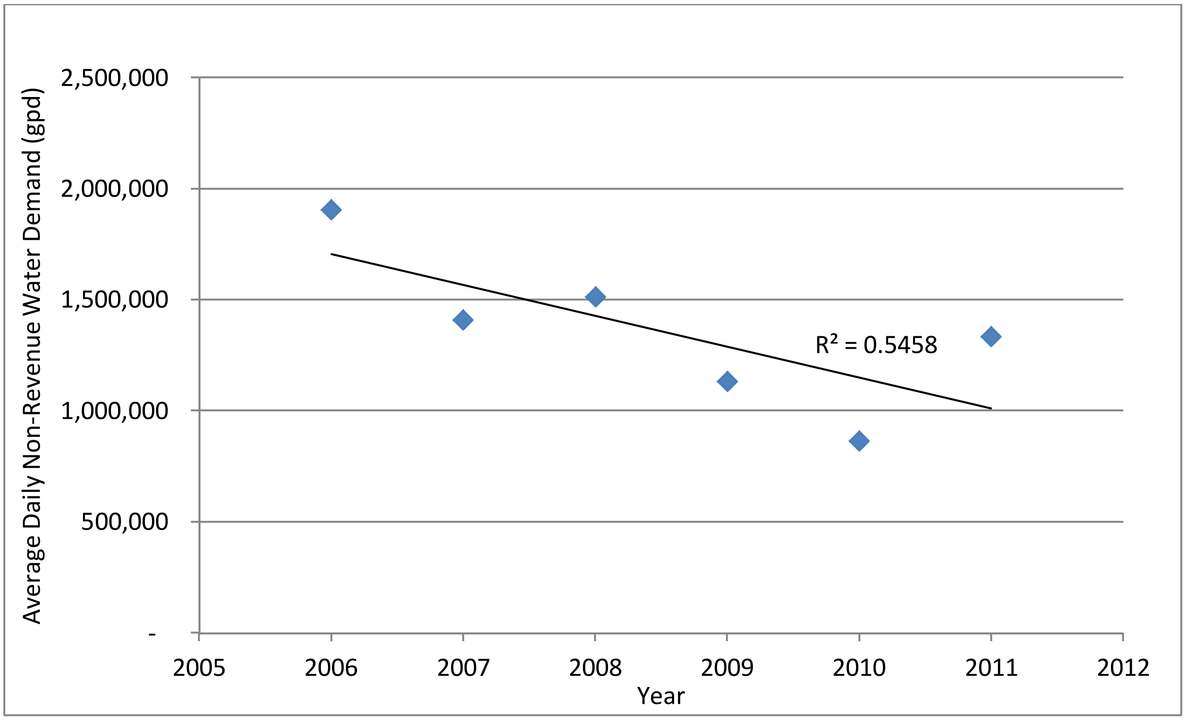

Figure 6. Non-Revenue Water Demand Trend

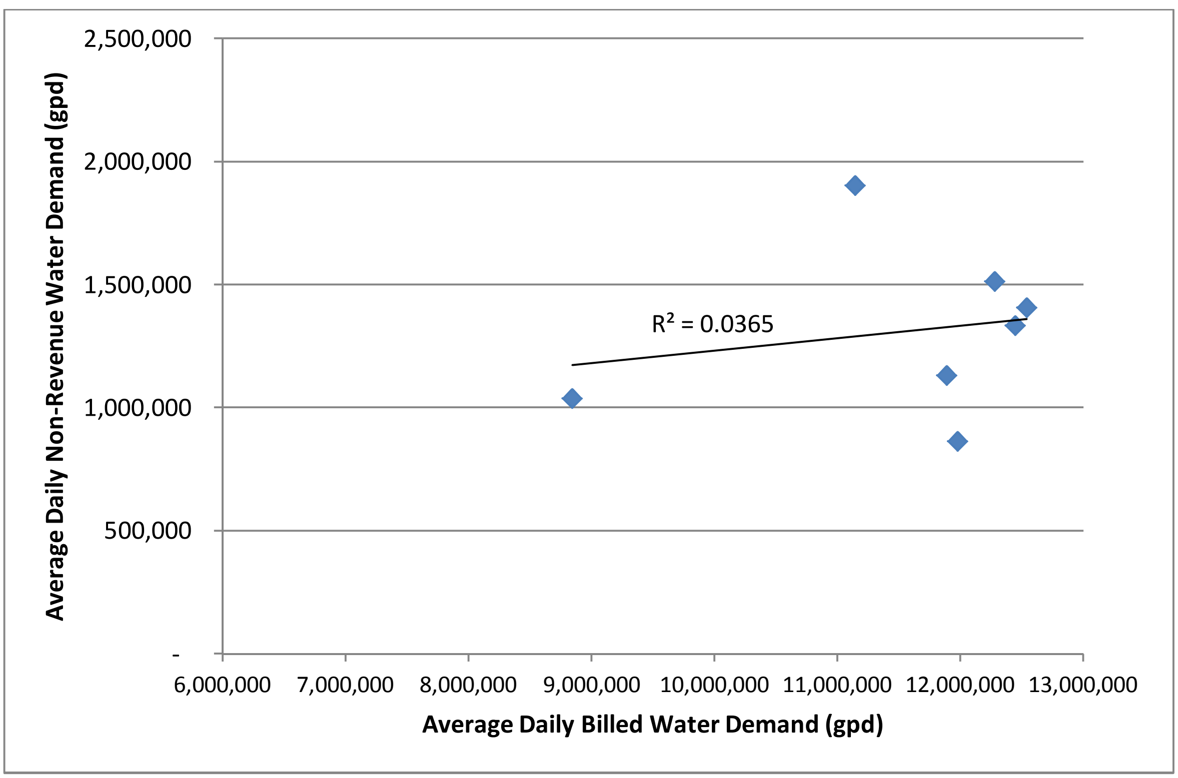

Figure 7. Non-Revenue Water Demand as a Function of Billed Water Demand

1.3.3.5 Peaking Factors

To project future peak day demands, the average annual peak day peaking factor (1.72) from the past 12 years was used. An analysis of annual average, peak month average day and peak day flows for 2000 through 2011 showed modest annual variability (standard deviation of 0.09 or 5.4%) and little correlation between peak day peaking factors and year (Figure 8). By contrast, there is a relatively strong correlation for peak month peaking factor as a function of time (R^2 = 0.74, relative standard deviation of 10.8%). However, there is no reason to believe that peak month peaking factors will continue to increase and visual observation of Figure 8 appears to show the peak month peaking factor plateauing between 2006 and 2011.

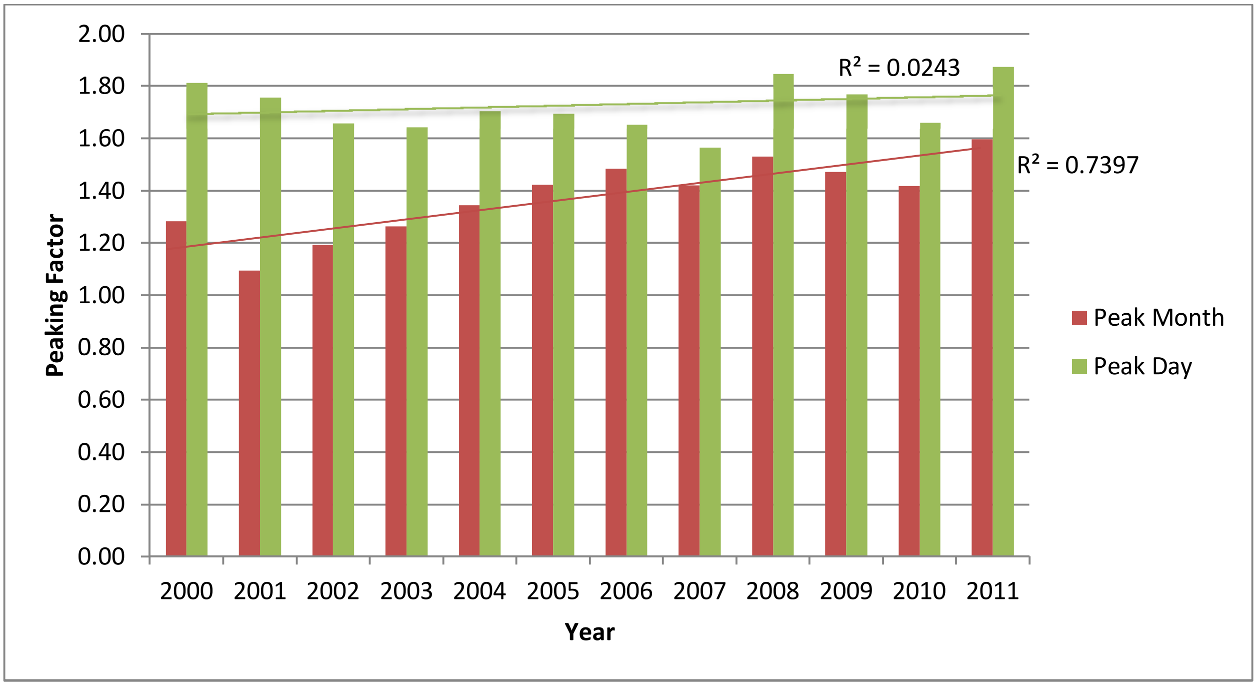

Figure 8. Analysis of Historical Water Demand Peaking Factors

The bottom line for the purposes of projecting water demand is that maximum day peaking factors appear to be historically stable and that there is no compelling reason to believe that the peaking factor will change significantly in the future. For example, although we could speculate that improved irrigation system efficiency should decrease peak water demand at the site scale, more widespread use of irrigation systems (new development and retrofits) could offset individual irrigation unit efficiencies from a system-wide perspective.

1.3.3.6 Future Demand Projection

As indicated, water demand projections are dependent in large part on projected growth in population, as retail, wholesale and non-revenue water demands were assumed to grow at the same rate as population. For example, to project non-revenue water demand in 2020, the non-revenue demand for the most recent calendar year of 2011 was multiplied by the ratio of County population projected for 2020 to the 2011 population (estimated by interpolation between the 2010 and 2020 population numbers). Table 2 provides a summary of the population projections used for this analysis.

Based on the analysis and assumptions described above, Table 3 summarizes water demand projections through 2050 and Figure 9 provides a graphical representation of average and peak day demand for 2000 through 2050.

Table 2. Population Projections for Brunswick County

Year	Population	Percent Change
2000	73,143 [1]	--
2010	108,176 [1]	47.9%
2020	137,677 [2]	27.3%
2030	167,178 [2]	21.4%
2040	199,323 [3]	19.2%
2050	230,483 [3]	15.6%

Notes:
[1] Actual population numbers (U.S. Census for 2000 and 2010)
[2] North Carolina State Data Center, http://linc.state.nc.us/
[3] Based on linear regression of values from 2000-2030.

Table 3. Brunswick County Water Demand Projections (MGD)

Year	2000[1]	2010[1]	2011[1]	2020	2030	2040	2050
Retail Demand	1.903	5.088	5.370	6.653	8.078	9.631	11.137
Industrial Demand	3.934	1.993	2.193	2.193	2.193	2.193	2.193
Wholesale Demand	3.005	4.895	4.885	6.052	7.348	8.761	10.131
Non-Revenue Demand	1.039	0.865	1.334	1.652	2.006	2.392	2.766
Average Demand	9.880	12.841	13.781	16.549	19.626	22.978	26.227
Peak Month Demand[2]	12.680	18.192	22.009	26.479	31.401	36.764	41.963
Peak Day Demand[3]	17.900	21.319	25.798	28.465	33.756	39.522	45.111
Peak Day Capacity (%)[4]	60%	71%	86%	95%	113%	132%	150%

Notes:
[1] All entries for 2000, 2010 and 2011, including Peak Month and Peak Day, are from actual water demand data
[2] For 2020-2060, Peak Month Demand = Average Demand x 2011 Monthly PF (1.60)
[3] For 2020-2060, Peak Day Demand = Average Demand x 1.72 (average Maximum Day Peaking Factor for the combined output from the plants over the past 12 years)
[4] Peak Day Capacity = Peak Day Demand / 30 MGD (existing treatment capacity)

An examination of Figure 9 shows that the slight decreases in demand between 2008 and 2011 are likely temporary and that the overall trend is increasing in good agreement with projections. Demand for water is expected to accelerate as economic conditions improve and new customers are brought online. To meet this future demand, the County has proposed to expand the existing Northwest WTP from 24 to 36 MGD.

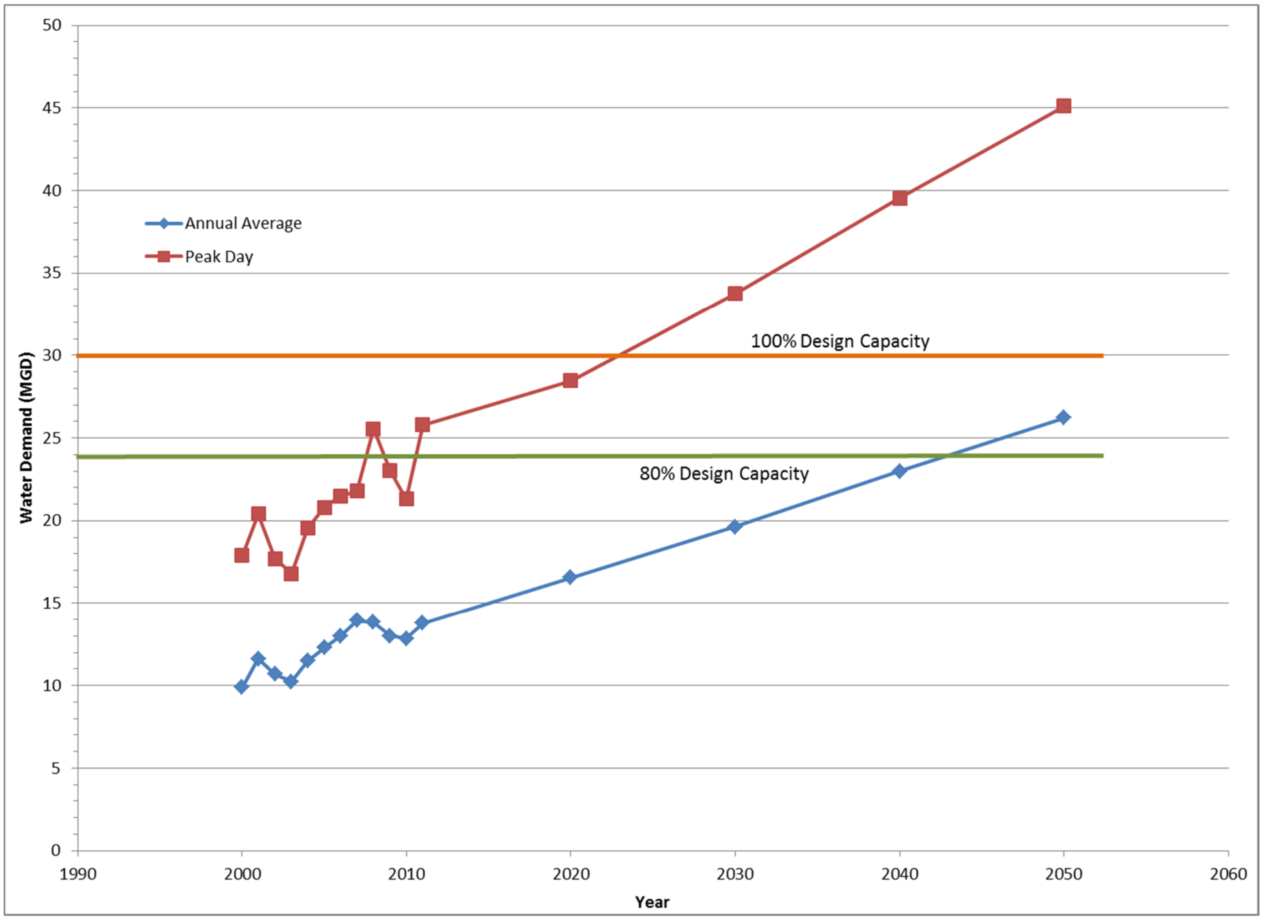

Figure 9. Water Demand (2000-2011) and Projections through 2050

1.4 Water Demand Reduction

As indicated, the water demand projections assume a constant *per capita* retail usage throughout the planning period (which is also directly related to the wholesale demand estimates). However, increased water conservation and water reuse could result in lower *per capita* demands over time.

The County has a water conservation program that includes voluntary and mandatory water use restrictions, price signals (tiered water rates and separate irrigation metering), customer education, and water reuse.

1.4.1 Water Use Restrictions

The County has the authority to impose water restrictions if a public water supply shortage occurs. All water customers, including the municipalities in the Shallotte IBT River Basin, are subject to the water use restrictions. The water use restrictions are organized in stages, with Stage 1 being voluntary and Stages 2 and 3 being mandatory. The stages are defined as follows (Chapter 1-13, Article V of County ordinances, http://library.municode.com/index.aspx?clientId=19946):

1) Stage 1—Water conservation alert. A Stage 1 water shortage emergency may be declared in the event of an immediate water shortage, as so declared by state and/or local officials, or when there are three (3) consecutive days when water demand exceeds eighty (80) percent of the water production capacity.

2) Stage 2—Water shortage warning. A Stage 2 water shortage emergency may be declared in the event of an immediate water shortage, as so declared by state and/or local officials, or when there are two (2) consecutive days when water demand exceeds ninety (90) percent of the water production capacity.
3) Stage 3—Water shortage danger. A Stage 3 water shortage emergency may be declared in the event of an immediate water shortage, as so declared by state and/or local officials, or when there is one (1) day when water demand exceeds one-hundred (100) percent of the water production capacity.

Additional details regarding the three stages are provided in Section 7.

1.4.2 Pricing Signals

The main elements of the County's water service pricing that affect water demand are tiered rates and separate metering for outdoor (irrigation) uses.

The rates for retail meters include a base charge that increases with larger service meter sizes from $11/month (for ¾-inch retail meters) to $27/month (for 4-inch retail meters). In addition to this base charge, retail water rates include three usage tiers, charged at $3.05, $3.10 and $3.15 per 1,000 gallons, as monthly usage increases. For ¾ to 1-1/2 inch service connections, the three tiers are 0–6,000 gallons, 6,001–20,000 gallons and > 20,000 gallons. For 2-inch service connections, the three tiers are 0–20,000 gallons, 20,001–100,000 gallons and > 100,000 gallons. For 3- and 4-inch service connections, the tiers are 0–50,000 gallons, 50,001–250,000 gallons and > 250,000 gallons. Industrial and wholesale water rates are based on a service charge depending on the size of the meter and a constant rate of $2.76 per 1,000 gallons (there is also a minimum usage charge).

Irrigation meter rates have five tiers, ranging from $3.05 per 1,000 gallons to $4.00 per 1,000 gallons. The five residential irrigation meter tiers have usage cutoffs of 6,000, 12,000, 20,000 and 50,000 gallons. Commercial and multifamily irrigation meter cutoffs are at 20,000, 50,000, 100,000 and 200,000 gallons. The monthly base service charge is the same as that for retail meters but is waived for irrigation meters where the facility has another retail meter.

Although the use of irrigation meters is not mandatory, there is a strong incentive to use them because irrigation water is not included in the user's sewer bill, and all residential wastewater flows over 3,000 gallons per month are billed at the relatively high rate of $6.50 per 1,000 gallons (note that all commercial wastewater flows are billed at a constant rate of $6.50/1,000 gallons and that industrial wastewater flows are billed using a declining block rate structure).

The County is also in the process of retrofitting meters with Automated Meter Reading, or Advanced Metering Infrastructure systems that will allow meters to be read quickly and remotely, enhancing the County's ability to both analyze water use to improvement management and identify abnormal water usage and notify customers as appropriate. The County is about one-third of the way through retrofitting its 38,000+ retail customers' meters.

Detailed rate and fee information for water and wastewater services are at http://www.brunsco.net/Departments/LandDevelopment/Utilities/WaterSewerRates.aspx.

The County's wholesale customers are required to adopt the County's conservation measures at a minimum. In some cases, the wholesale customer has enacted more stringent measures than the County.

1.4.3 Customer Education

The County provides water conservation information to its customers through various means including their website, in water bill mailers and at public events. For example, the County has developed a water conservation brochure which is available in hard copy and on their website at http://www.brunsco.net/Departments/LandDevelopment/Utilities/BrochuresUtilities.aspx. The County also maintains a Frequently Asked Questions list (http://www.brunsco.net/Portals/0/bcfiles/finance/fin_faqs.pdf) and produces annual water quality and wastewater performance reports, available at http://www.brunsco.net/Departments/LandDevelopment/Utilities/AnnualReports.aspx.

The County also works with the Cooperative Extension Agency on water conservation and sustainable landscaping practices, and with property owners associations in a number of large subdivisions to promote water conservation.

1.4.4 Water Reuse

The County has four wastewater treatment plants (WWTPs) that are permitted for reuse: Ocean Ridge Plantation, Sea Trail, West Brunswick Regional and Northeast Brunswick Regional. Two additional facilities recharge the surficial groundwater aquifer via spray irrigation: Shallotte and Carolina Shores. Several other small reuse systems and a number of other land application (surface or subsurface) systems are located in the County but not owned or operated by them; these systems are discussed in Section 1.5 below.

The largest water reclamation plant in the County is the West Regional plant, with a permitted capacity of 6.0 MGD. This plant includes a reclaimed water line that extends to four golf courses, in addition to three dedicated land application sites. The Northeast Regional plant produces reuse quality water and is permitted for reuse, but it is not currently reusing water except within the boundaries of the plant.

The County is conducting a study to assess the feasibility of residential water reuse (costs, demand and public acceptance issues) at the Saint James Plantation and Winding River developments. The County estimates that these developments might have a seasonal reclaimed water demand of up to 1.3 MGD.

1.5 Wastewater Management

Wastewater in Brunswick County is managed using a combination of individual onsite systems and clustered and centralized land application, reuse, and discharging systems. Table 4 and Table 5 summarize the numbers of systems and permitted flows for the various permit types and service types, respectively, based on data compiled from the following sources:

- BCPU
- Division of Water Quality (DWQ), Surface Water Section, National Pollutant Discharge Elimination System (NPDES) Wastewater Permitting and Compliance Program
- DWQ, Aquifer Protection Section, Land Application Unit
- Brunswick County Health Department, Environmental Health

Table 4. Number of Wastewater Systems and Permitted Flow Rates by Permit Type

Permit Type	Permitting Authority	# Systems	Total Permitted Flow (MGD)
Large Subsurface[1]	Brunswick Co. Env. Health	23	0.35
Surface Irrigation	DWQ-Non-Discharge Unit	24	11.05
Discharging	NPDES	15	10.30
		TOTAL	21.70

Notes:
[1] Large subsurface systems are defined as >3,000 gpd. The number and permitted flow rate associated with small subsurface systems is unknown, but discussed in more detail below.

Table 5. Number of Wastewater Systems and Permitted Flow Rates by Service Type

Service Type	# Systems	Total Permitted Flow (MGD)
Commercial	10	0.04
Domestic	14	1.43
Industrial	8	> 7.04
Institutional	7	0.39
Municipal	12	12.81
	TOTAL	21.70

For smaller onsite, subsurface-discharging wastewater systems (conventional and advanced septic systems), Brunswick County Environmental Health's permit database lists about 70,000 Improvement Permits with a total permitted flow of over 17 MGD and approximately 32,000 Operation Permits; however, these numbers do not account for all of the onsite systems that have been retired and connected to public sewer. It is estimated that between 10,000 and 20,000 individual, residential onsite systems remain in Brunswick County. Assuming 15,000 onsite systems with an average permitted design flow of 360 gpd (as required for a three-bedroom house), the total permitted wastewater flow for small onsite systems in Brunswick County is estimated to be approximately 5.40 MGD.

As summarized in Table 6, the majority of the wastewater treated in the County (note that this table does not include onsite systems less than 3,000 gpd, because location data was not readily available for these systems) is dispersed or discharged in the Cape Fear IBT River Basin, which includes 11 of the 14 permitted surface discharging (NPDES) systems in the County. The Shallotte IBT River Basin includes a number of *large* (> 3,000 gpd) subsurface wastewater systems because this area is largely unsewered and has some resort and other higher-density developed areas. It is also the location of the County's largest plant, the West Regional WWTP. There appears to be only three significant wastewater systems in the Waccamaw IBT River Basin, and the combined permitted flow is relatively small.

Table 6. Number of Wastewater Systems and Flow by IBT River Basin

Subbasin	# Subsurface[1]	# Surface[2]	# Discharge	Total Permitted Flow (MGD)
03-07-57 (Waccamaw)	1	1	1	0.54
03-07-59 (Shallotte)	13	8	2	8.89
03-06-17 (Cape Fear)	8	9	11	12.28
TOTAL	22	18	14	21.71

Notes:
[1] Includes only large subsurface, defined as > 3,000 gpd
[2] Includes only surface dispersal of treated effluent, not residuals

Locations of the Non-Discharge (i.e., surface irrigation) and NPDES permitted systems are shown on the map in Figure 10 (a tabular summary is provided in Appendix E). Subsurface systems permitted by Brunswick County Environmental Health are not shown on Figure 10 because spatial data for the locations of these systems are not readily available. Figure 10 clearly identifies those systems owned and operated by the County. This subset of County-operated systems is summarized in Table 7.

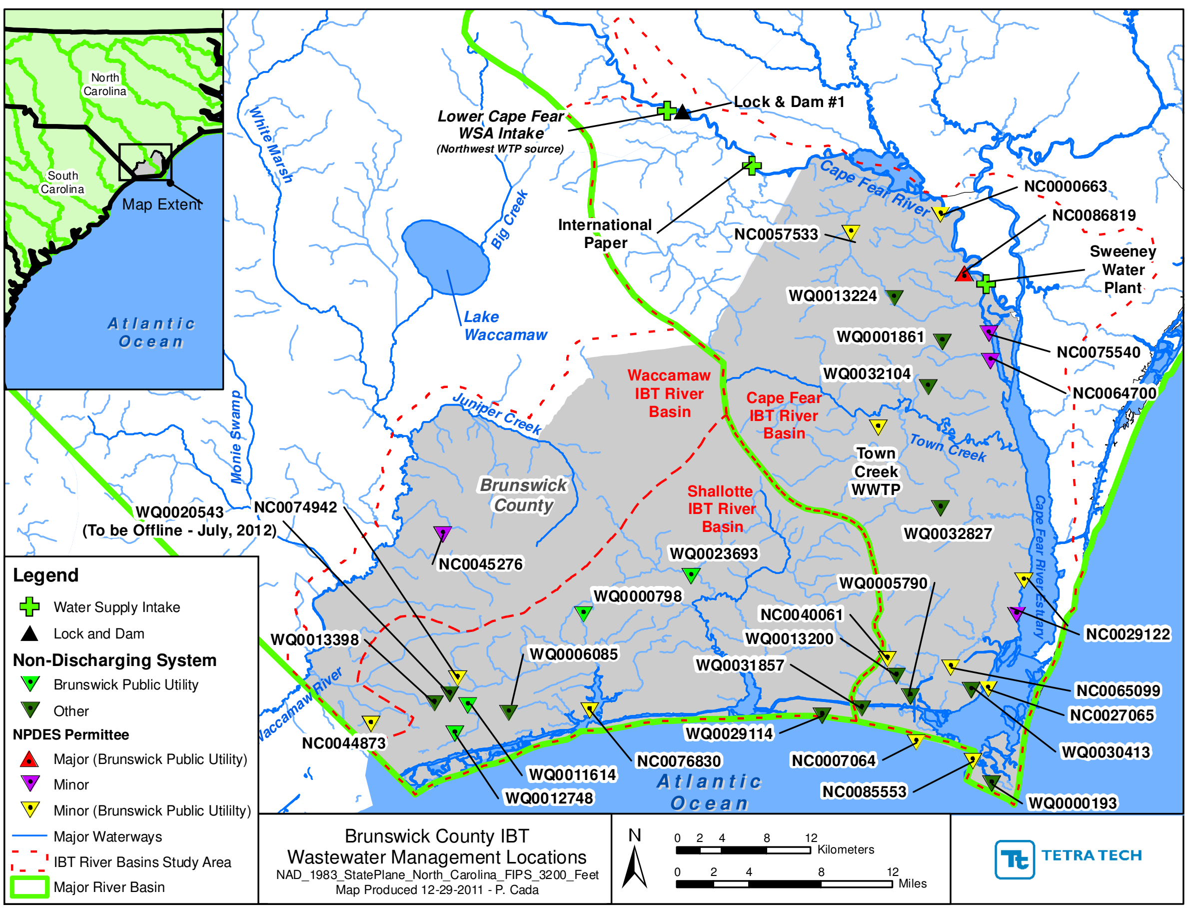

Figure 10. Permitted NPDES and Non-Discharge Wastewater Facilities in Brunswick County

Table 7. Permit Summary for BCPU Wastewater Systems

System	Permit Type	Permit Number	Type	Effluent Dispersal Method	Permitted Flow (MGD)
Town Creek Township Park WWTP	NPDES	unknown	Institutional	Discharge	0.001
Carolina Shores WWTP	NPDES	NC0044873	Municipal	Discharge/Spray Irrigation	0.53
Ocean Ridge Plantation WWTF	Non-Discharge	WQ0011614	Municipal	Reuse	0.100
Sea Trail WWTP	Non-Discharge	WQ0012748	Municipal	Spray Irrigation/Reuse	0.500
Shallotte WWTP	Non-Discharge	WQ0000798	Municipal	Spray irrigation	0.500
Northeast Brunswick Regional WRF	Conjunctive NPDES	NC0086819	Municipal	Discharge/Reuse	1.650
West Brunswick Regional WRF	Non-Discharge	WQ0023693	Municipal	Spray Irrigation/Infiltration/ Reuse	6.000
Class A Residuals Distribution Program	Non-Discharge	WQ0034468	Residuals	Residuals-Land Application	na
Northwest WTP Residuals Disposal Program	Non-Discharge	WQ0018351	Residuals	Residuals-Land Application	na
Class B Residuals Application Program	Non-Discharge	WQ0034513	Residuals	Residuals-Land Application	na
Beaverdam Creek WTP	NPDES	NC0040061	WTP	Discharge	no limit
Hood Creek NW WTP	NPDES	NC0057533	WTP	Discharge	no limit

Average and maximum month average daily flows from July 2009 through June 2011 for County-operated wastewater treatment systems are summarized in Table 8. Actual average flows over this period were approximately 31 percent of the permitted capacity, while maximum month average flows were about 42 percent of permitted capacities for this subset of wastewater facilities.

Note that this permitted wastewater treatment capacity will increase after January 7, 2012 with the County's acquisition of the 1.032 MGD Ocean Isle Beach wastewater treatment facility. Additionally, an expansion of the Northeast Brunswick water reclamation facility (discussed in Section 1.5.1 below) is expected to be completed by July 1st, after which the County estimates that their total wastewater treatment capacity will be 10.98 MGD.

Table 8. Average Daily Wastewater Flow (MGD) for County-Operated systems for July 2009 through June 2011

Facility	Permitted Flow	Average Month	Maximum Month
Northeast Brunswick	1.65	1.197	1.533
Sea Trail	0.5	0.150	0.181
Carolina Shores	0.53	0.476	0.622
West Brunswick	6	0.956	1.628
Ocean Ridge	0.1	0.039	0.055
Shallotte - 1	0.5	0.016	0.073
Shallotte - 2		0.066	0.178
Average Day	*9.28*	*2.900*	*3.926*

1.5.1 Planned Expansions and Future Trends

In June 2011, a revised EA and Finding of No Significant Impact (FONSI) were issued for a proposed expansion to the Northeast Brunswick Regional Wastewater System to an ultimate capacity of 3.8 MGD over a 20-year planning period (McKim and Creed, 2008). The plan calls for a Phase 1 expansion of the plant from 1.65 to 2.475 MGD and a Phase 2 expansion per the construction of a new treatment plant to 3.8 MGD when the 2.475 MGD capacity approaches 70 percent utilization. With the existing 0.4 MGD Belville WWTP (operated by H2GO) in the area, the total treatment capacity in the northeastern service area would be 4.2 MGD. Brunswick Regional Water and Sewer (H2GO) has indicated that it plans to replace its existing 0.4-MGD facility in Belville. Located south of Navassa, the H2GO service area encompasses approximately 21 mi^2 and includes portions of the towns of Leland, Belville, and unincorporated areas of the County.

Three relatively large land application systems (surface/subsurface) are scheduled to be retired and connected to the County's sewer systems before July 2012. Additional septic systems continue to be connected to centralized facilities as their service areas expand. An increasing proportion of new development is being connected to centralized sewers rather than onsite or small community systems. DWQ's Non-Discharge Unit database shows only one outstanding non-discharge permit application, for a reuse system for the Town of Oak Island.

1.5.2 Water Demand Implications on Wastewater Management

Water demand data (described in detail in Section 1.3) and existing and future wastewater management information (described in this section) were analyzed in order to determine the most likely implications of projected future water demands on wastewater management in Brunswick County. The analysis involved first estimating wastewater flows throughout the planning period (through 2050) and then comparing those flow estimates with existing wastewater system capacity. Future wastewater flows were estimated by determining an appropriate *per capita* daily wastewater flow rate and then multiplying the *per capita* flow rate by projected population. The *per capita* wastewater flow rate was estimated by re-analyzing the historical water demand data presented in Section 1.3.

1.5.2.1 Estimates of Recent Wastewater Flow Rates

A 10 percent reduction between indoor water demand and wastewater flow is typically assumed to account for consumptive water uses. However, to err on the conservative side for this analysis, average wastewater flows were assumed to be approximately equal to the sum of the average retail and wholesale water demands for the late fall and winter months (November, December, January, February and March), since unsewered, outdoor water uses would be at a minimum during these months. Although it could be argued that averaging only the cold-season months will result in artificially low wastewater flow rates by missing increased summertime flows associated with seasonal use facilities (vacation homes, resorts), the following factors suggest that this is not the case.

- Infiltration and inflow (I/I) into the sewer system will be highest during the wettest months with lowest evapotranspiration rates, which also coincide with the November-March time period. I/I additions to cold-month wastewater flows offset the decrease in seasonal use facilities.
- Although the Northeast Brunswick WWTP service area generally does not include classic seasonal resort areas, the EA prepared to support a plant expansion reports that wastewater flows were lower in the summer months than in the winter months (Marotti, 2011).
- Seasonal average daily wastewater flows for County-operated facilities show no clear trends with respect to month, individually or in aggregate (Figure 11).

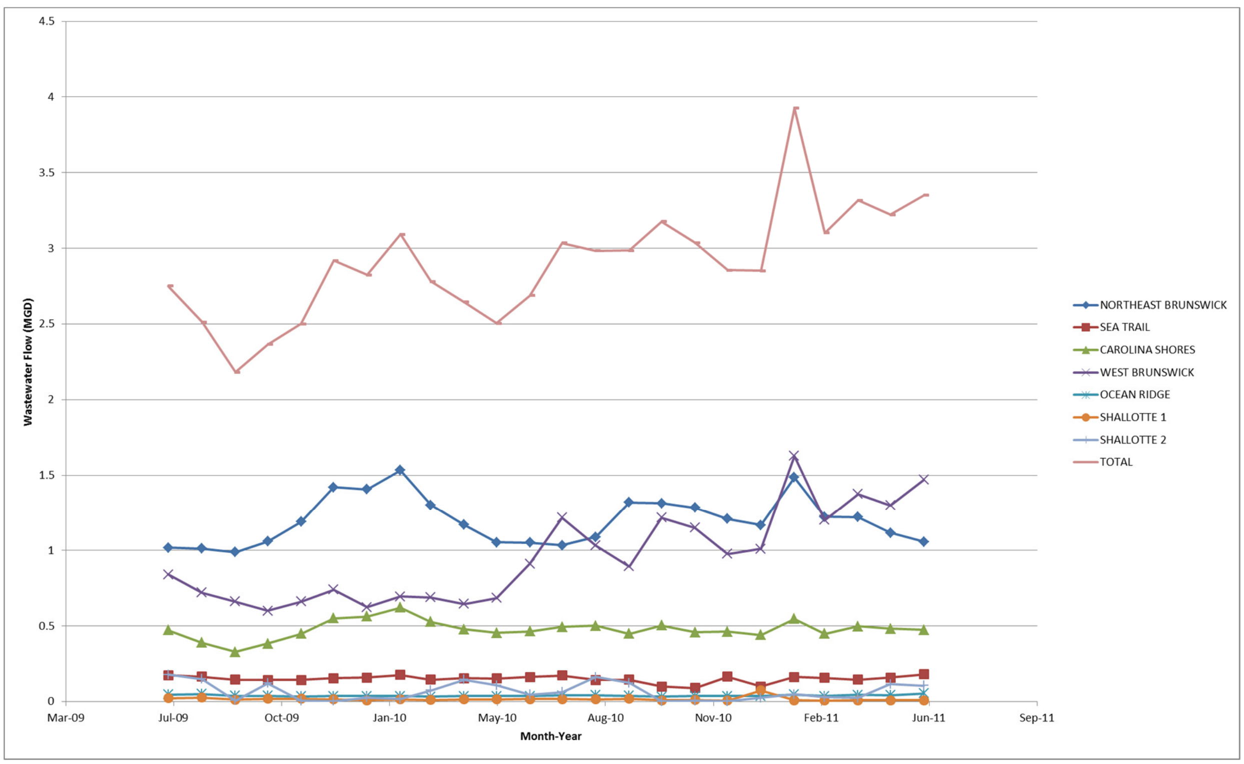

Figure 11. Monthly Average Daily Wastewater Flows for July 2009 through June 2011 for BCPU Permitted Facilities Only

Monthly water demand for the retail, wholesale and industrial sectors was plotted for calendar years 2010 (Figure 12) and 2011 (Figure 13). Wastewater flow rates associated with all potable water customers for 2010 and 2011 (i.e., estimated flow beyond the County's own wastewater facilities shown in Figure 11) were estimated to be 7.70 and 6.65 MGD, respectively. However, it is important to note that not all County water customers are also sewer customers (although we do expect that most of BCPU's sewer customers are also supplied water by BCPU). Because most of the large industrial water users have their own wastewater management systems and because industrial water demand is not expected to increase over the planning period, industrial water demand was not used in the determination of future wastewater flows. Since they are not broken out as separate water demand sectors, commercial and institutional water uses should already be properly represented in the retail and wholesale sector demand numbers.

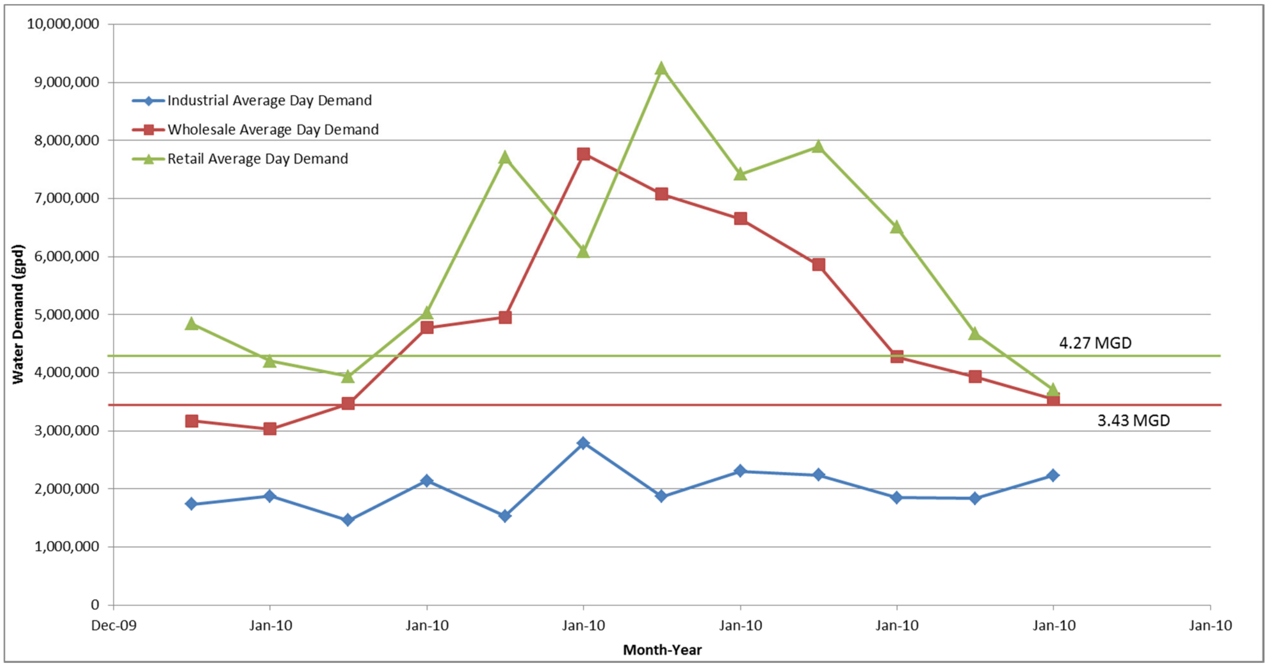

Figure 12. Monthly Water Demand by Sector for 2010 (horizontal lines indicate averages for November, December, January, February and March)

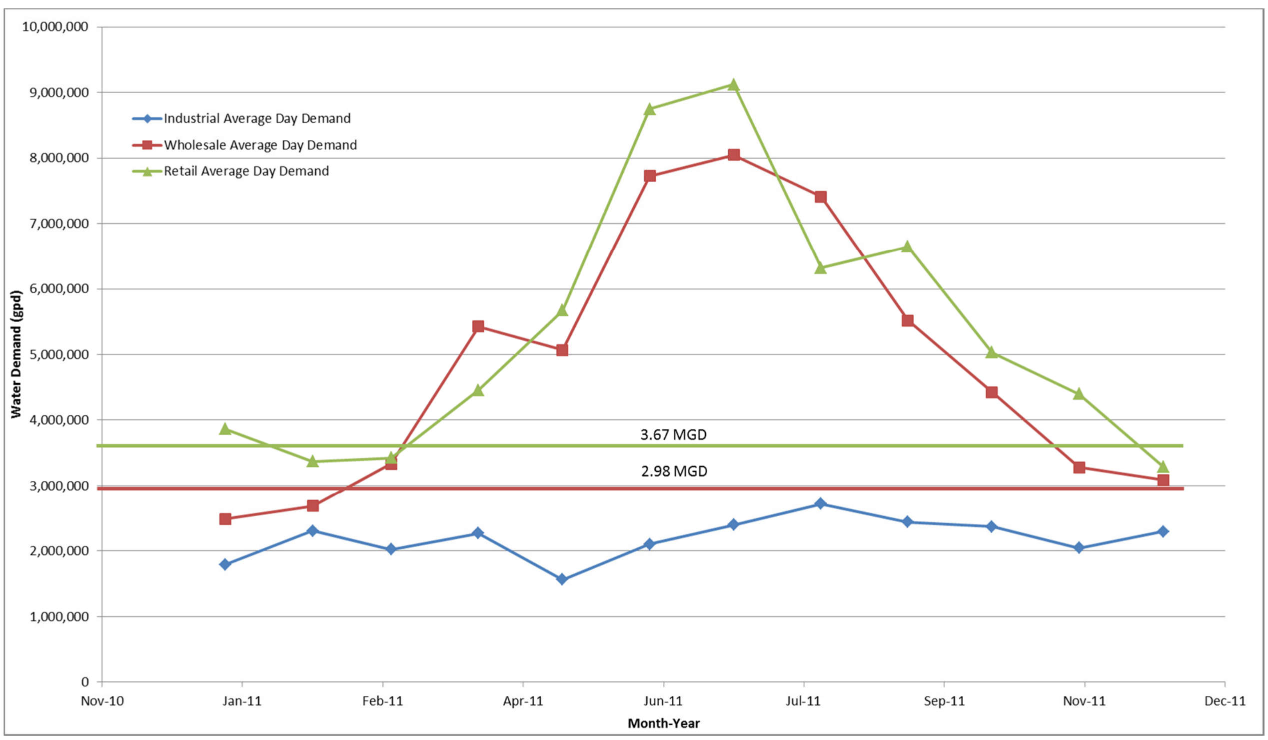

Figure 13. Monthly Water Demand by Sector for 2011 (horizontal lines indicate averages for November, December, January, February and March)

1.5.2.2 Determination of *Per Capita* Wastewater Flow Rates

To determine *per capita* wastewater flows, the average retail water demand for the late fall and winter months (November, December, January, February and March) was divided by the estimated population served (number of connections multiplied by 2.21 persons/household as described in Section 1.3), resulting in an average *per capita* wastewater flow of 59.4 gpd for 2010 and 49.7 gpd for 2011. Wholesale water demand was not used in the *per capita* wastewater flow calculation since BCPU does not track the number of people (or individual connections) served by each of their wholesale customers.

Based on these results, an average *per capita* wastewater flow rate of 60 gpd/capita was used for projecting future wastewater flows. This number is consistent with the assumed *per capita* flow rate used by the State of North Carolina for sizing wastewater systems.

1.5.2.3 Projection of Future Wastewater Flow Rates and Treatment Needs

Applying a 60 gpd *per capita* flow rate to the population projections in Table 2 results in the estimated countywide wastewater flow rates shown in Table 9.

Table 9. Projected Average Daily Wastewater Flow for Brunswick County

Year	Population	Wastewater Flow (gpd)
2000	73,143	4,388,580
2010	108,176	6,490,560
2020	137,677	8,260,620
2030	167,178	10,030,680
2040	199,323	11,959,380
2050	230,483	13,828,980

Based on the data provided in Appendix E, permitted wastewater capacity for publically-owned and operated municipal wastewater treatment systems in the County was determined to be approximately 12.7 MGD. With the aforementioned expansion planned for the Northeast Brunswick wastewater plant to 3.8 MGD, the currently anticipated municipal wastewater treatment capacity within the County should be approximately 14.0 MGD. Since wastewater treatment systems typically begin expansions when average flows approach 80% of design, the effective treatment capacity on a countywide basis is approximately 11.2 MGD (14.0 MGD x 80%). An additional 1.45 MGD of permitted domestic wastewater treatment capacity is currently provided by private system owners, while individual onsite systems currently provide over 5 MGD of estimated wastewater management capacity (although septic systems continue to be retired and connected to public sewer systems, so this estimated capacity is expected to decrease over time).

Although a detailed analysis of wastewater treatment system location versus water service and growth areas is beyond the scope of this study, Table 6 indicates that wastewater treatment capacity is distributed relatively evenly within the County with the 6 MGD West Brunswick plant sited in the Shallotte IBT River Basin and serving the southwestern part of the County and the Northeast plant and Belville plants located in the Cape Fear IBT River Basin serving the northeastern part of the County. This suggests that treatment facilities are sited in a way that should make it feasible to serve new connections in areas of the County projected to grow throughout the planning period.

Based on this comparison between wastewater flow rate projections and permitted and planned wastewater treatment capacity in Brunswick County, additional system expansions should not be required until after 2030.

1.6 INTERBASIN TRANSFER REQUEST

The proposed expansion of the Northwest WTP triggers a need for an IBT certificate because a substantial portion of the additional surface water withdrawn in the Cape Fear IBT River Basin and treated at the plant would be distributed to customers in the Shallotte IBT River Basin. The County is requesting an IBT certificate from the EMC for an increase of 7.8 MGD over the grandfathered transfer, resulting in a maximum transfer of 18.3 MGD on the basis of projections through approximately 2042 (Table 10; Figure 14). No increase in IBT is being requested for the Waccamaw River Basin: minor growth is expected in this area (2010 peak demand 0.45 mgd; 2050 demand of 0.57 mgd) and future water will be supplied by the Little River Water and Sewerage Company in South Carolina via an agreement with the County. Detailed IBT water balance tables are provided in Appendix F.

Table 10. Brunswick County Maximum Daily Surface Water Transfer (Actual 2010; Projected 2020 – 2050)

Year	Total Water Demand (MGD) – Max Day	Withdrawal from Surface Water Source (MGD) [1]	Total Return to Source Basin (MGD)	IBT – Shallotte (MGD)	IBT – Waccamaw (MGD)	Total IBT (MGD)
2010	21.32	16.83	8.31	7.71	0.81	8.52
2020	28.47	22.47	11.09	10.57	0.81	11.38
2030	33.76	27.76	13.70	13.25	0.81	14.06
2040	39.52	33.52	16.54	16.17	0.81	16.98
2050	45.11	39.11	19.30	19.00	0.81	19.81
IBT Request (~2042)		36 [2]	17.76	17.43	0.81	**18.3** [3]
IBT Exceeding Grandfathered Amount of 10.5 MGD				**7.8** [3]		

Notes:

[1] The flow amounts are surface water only for the Northwest WTP and do not include flows from the 211 WTP.
[2] Based on the proposed treatment capacity of 36 MGD finished water for the Northwest WTP. Additional raw water that is withdrawn from the river for backwash, clarifier blowdowns, and process water is not included. This water is discharged back to the Cape Fear source basin via NPDES permit.
[3] Values have been rounded up for the IBT request.

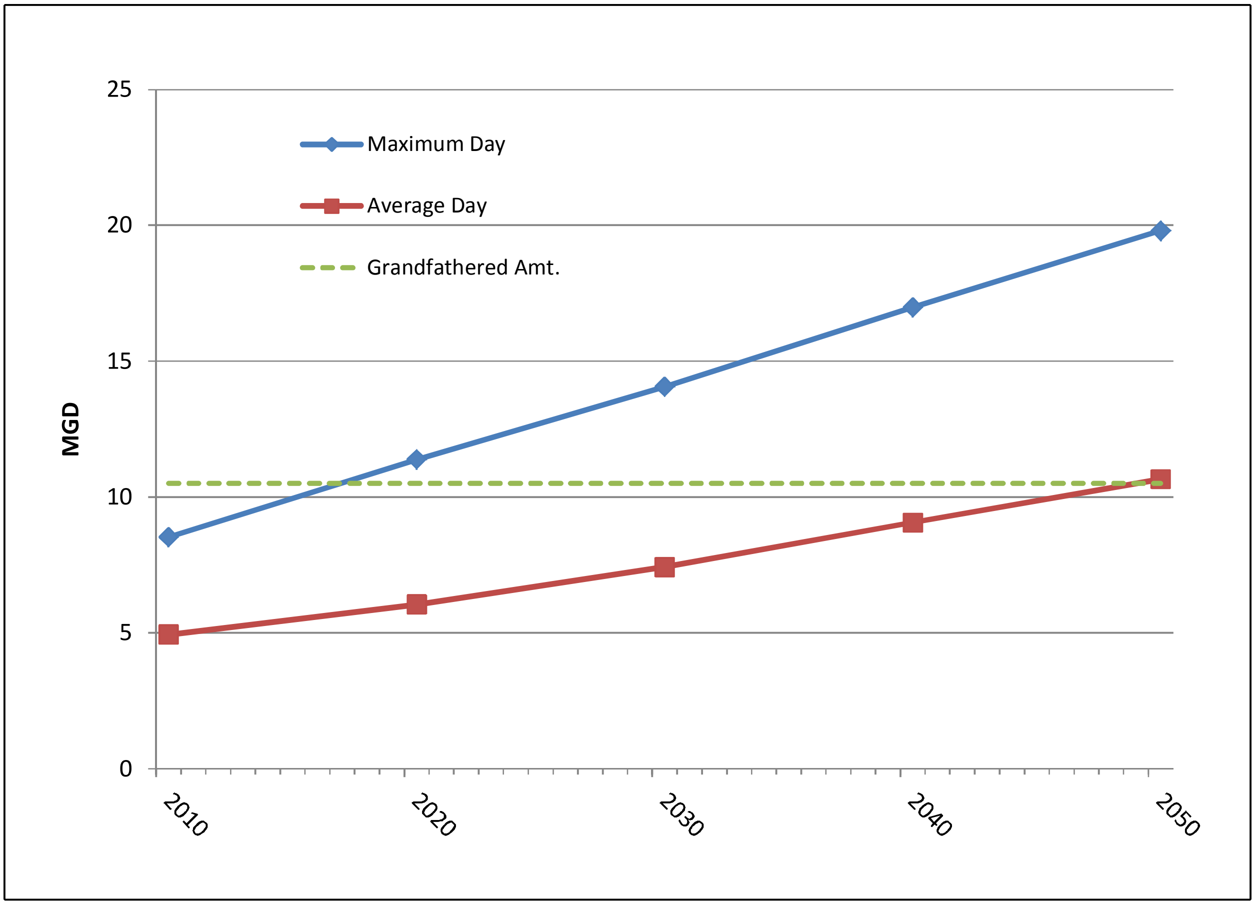

Figure 14. Brunswick County IBT Projections (Max Day and Average Day)

1.7 WATER SUPPLY ALTERNATIVES TO IBT

An analysis of water supply alternatives is a requirement of the IBT evaluation and environmental document and is important for determining the most viable alternative for the County. Options for an increase in IBT associated with an expansion of the Northwest WTP are weighed herein against alternatives that do not require additional IBT or combinations of alternatives that could limit the quantity of the IBT. Factors considered during alternatives analyses include the technical viability of the option, the constructability of the alternative, potential environmental impacts, technical difficulty, permitting issues, and estimates of probable costs, both construction costs and operation and maintenance (O&M).

The alternatives compared herein are:

1) No Additional IBT
2) Additional IBT - Expand Northwest WTP
3) Waccamaw Surface WTP
4) Expand 211 WTP
5) New Groundwater WTP
6) Seawater Desalination Plant
7) Return of Additional Wastewater to Source Basin
8) Water Conservation and Reuse
9) Surface Water Storage

The analysis of these alternatives is discussed in Section 5 after the detailed descriptions of environmental characteristics in the source and receiving basins.

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2 Existing Environmental Characteristics: Cape Fear IBT River Basin

This section describes the existing environmental characteristics in the source basin, the Cape Fear IBT River Basin. Sections 3 and 4 cover the two receiving basins.

The LCFWSA supplies water to the Northwest WTP from an intake on the Cape Fear River above Lock and Dam #1. For this assessment, the study area is composed of a portion of the Cape Fear IBT River Basin in the vicinity of Lock and Dam #1 extending downstream to include the remainder of the basin, hereafter referred to as the *Cape Fear Study Area* (Figure 15). The northern terminus of the study area begins 1 mile north (as Euclidean distance) of the intake above Lock and Dam #1. The inclusion of area above the intake is meant to capture portions of the source basin that might be affected by the withdrawal without including areas farther upstream (extending another 130 miles upstream) that would reasonably be expected to have no impact.

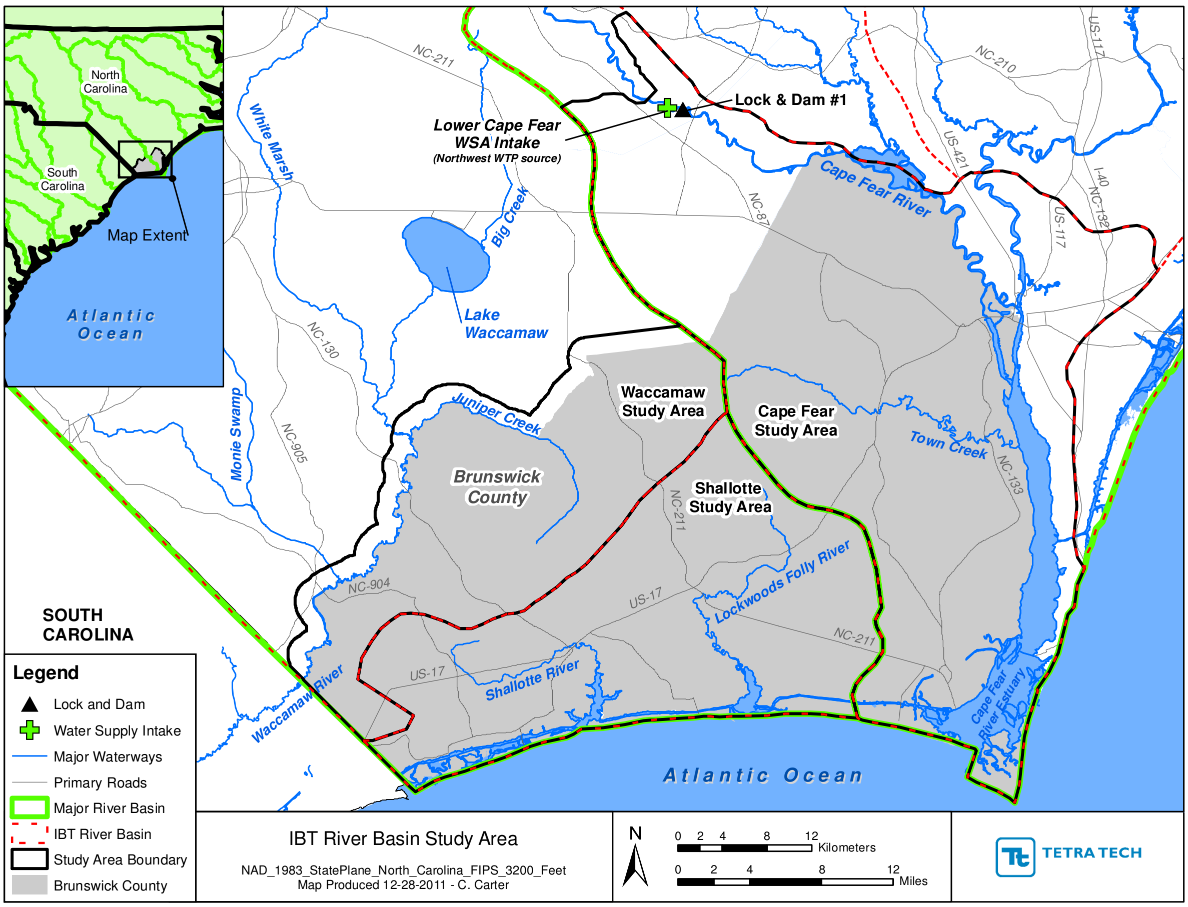

Figure 15. Overview Map of the IBT River Basins Study Area

2.1 Topography, Geology, and Floodplains

The Cape Fear Study Area is in the Inner and Outer Coastal Plain physiographic provinces, which are characterized by gently rolling hills and valleys at higher elevations and flat, poorly drained areas near the coast (NCGS, 2004). Elevations in the Cape Fear Study Area range from sea level throughout the lower Cape Fear River to 105 feet above mean sea level in the grounds of International Paper. The maximum elevation outside the International Paper grounds reaches 77 feet above mean sea level near the town of Northwest west of the Cape Fear River and near the center of the study area.

The underlying geology of the Cape Fear Study Area consists of formations from the Tertiary, Cretaceous, and Quaternary periods. These formations include the Comfort Member Formation and New Hanover Member Formation, undivided, and the Waccamaw Formation from the Tertiary period, the Peedee Formation from the Cretaceous period, and surficial deposits, undivided, from the Quaternary period. These formations are characterized by consolidated and loosely consolidated sedimentary rock composed of materials such as silt, sand, gravel, clay, limestone, and peat that were alluvial sediments brought down from the Piedmont or marine sediments deposited by the ocean.

Portions of the Cape Fear Study Area are within the FEMA 100- and 500-year floodplains. These areas are mainly associated with the Cape Fear River and its tributaries.

2.2 SOILS

2.2.1 Soil Series

County soil survey data for portions of Brunswick, Columbus, New Hanover, Pender, and Bladen counties in the Cape Fear Study Area were retrieved from the U.S. Department of Agriculture's (USDA's) Natural Resources Conservation Service (NRCS; NRCS, 2011a). All the soils in the Cape Fear Study Area formed in Coastal Plain sediment or in sediment deposited by streams. Whereas 83 soil series are in the study area, 50 percent of the Cape Fear Study Area is composed of only 10 major soil series: Baymeade, Leon, Murville, Goldsboro, Rains, Torhunta, Foreston, Kureb, Norfolk, and Dorovan soils (Table 11, Figure 16).

Table 11. Soil Series of the- Cape Fear Study Area

Series Name	Percent of Cape Fear Study Area
Baymeade	10.00%
Leon	7.58%
Murville	6.22%
Goldsboro	4.80%
Rains	4.61%
Torhunta	4.04%
Foreston	4.02%
Kureb	3.97%
Norfolk	3.80%
Dorovan	3.52%
All Other Soil Series	39.25%
Water	8.19%

The 10 major soil series in the Cape Fear Study Area are described below according to information obtained from the USDA's NRCS Official Soil Series Descriptions database (NRCS, 2011b).

Baymeade

The Baymeade series consists of deep, well-drained soils with moderately rapid permeability. They formed in loamy and sandy marine sediments of the lower Coastal Plain and occur on broad, gently sloping surfaces. Slopes range from 0 to 12 percent. Measured water table levels at two sites show that the water table is 45 to 60 inches below the surface in December to April and other wet periods.

Most Baymeade soils are in forest of mixed hardwood and pine. Native vegetation is turkey oak, long leaf pine, dwarfed huckleberry, small myrtle, wire grass, and aster. Large areas are in residential and urban uses in New Hanover County.

Leon

The Leon series consists of very deep, poorly and very poorly drained, moderately to moderately slowly permeable soils on upland flats, depressions, stream terraces and tidal areas. They formed in sandy marine sediments of the Atlantic and Gulf Coastal Plain. Slopes range from 0 to 5 percent.

Most areas of Leon soils are used for forestry, rangeland and pasture. Areas with adequate water control are used for cropland and vegetables. The natural vegetation consists of longleaf pine, slash pine, water oak, myrtle, with a thick undergrowth of saw palmetto, running oak, fetterbush and other lyonia, inkberry (gallberry), chalky bluestem, creeping bluestem and pineland threeawn (wiregrass). In depressions, the vegetation is dominated by bracken fern; smooth sumac and swamp cyrilla are common. Vegetation in the tidal marshes includes bushy sea oxeye, marsh hay cordgrass, seashore saltgrass, batis, and smooth cordgrass.

The water table is at depths of 6 to 18 inches for 1 to 4 months in most years. In low flats or sloughs it is at a depth of 0 to 6 inches for periods of more than 3 weeks in most years. It is between depths of 18 and 36 inches for 2 to 10 months in most years. It is below 60 inches in the dry periods of most years. Depressional areas are covered with standing water for periods of 6 months or more in most years.

Murville

The Murville series consists of very poorly drained soils that have rapid permeability in the A horizon and moderately rapid permeability in the Bh horizon. The soils formed from wet, sandy, marine and fluvial sediments. They are nearly level and are on flats or in slight depressions on broad interstream areas of uplands and stream terraces in the Coastal Plain. Slopes are less than 2 percent. The water table is at or near the surface most of the time except in summer months or where artificially drained. Depth to the seasonal high water table ranges from 0 to 1 foot from November to May.

Murville soils chiefly occur in cutover forests of pond pine, with a few scattered loblolly, longleaf pine, and red maple. Slash pine grow in the southern part of the range. Understory vegetation includes sweetbay, redbay, swamp cyrilla (red titi), zenobia, inkberry (bitter gallberry), large gallberry, greenbrier, switchcane, fetterbush lyonia, blueberry, loblollybay gordonia, southern bayberry (waxmyrtle), and a ground cover of sphagnum and club mosses, chain fern, broom sedge, and switch cane and maidencane in open areas. Where frequent burning has taken place, only the understory species are present.

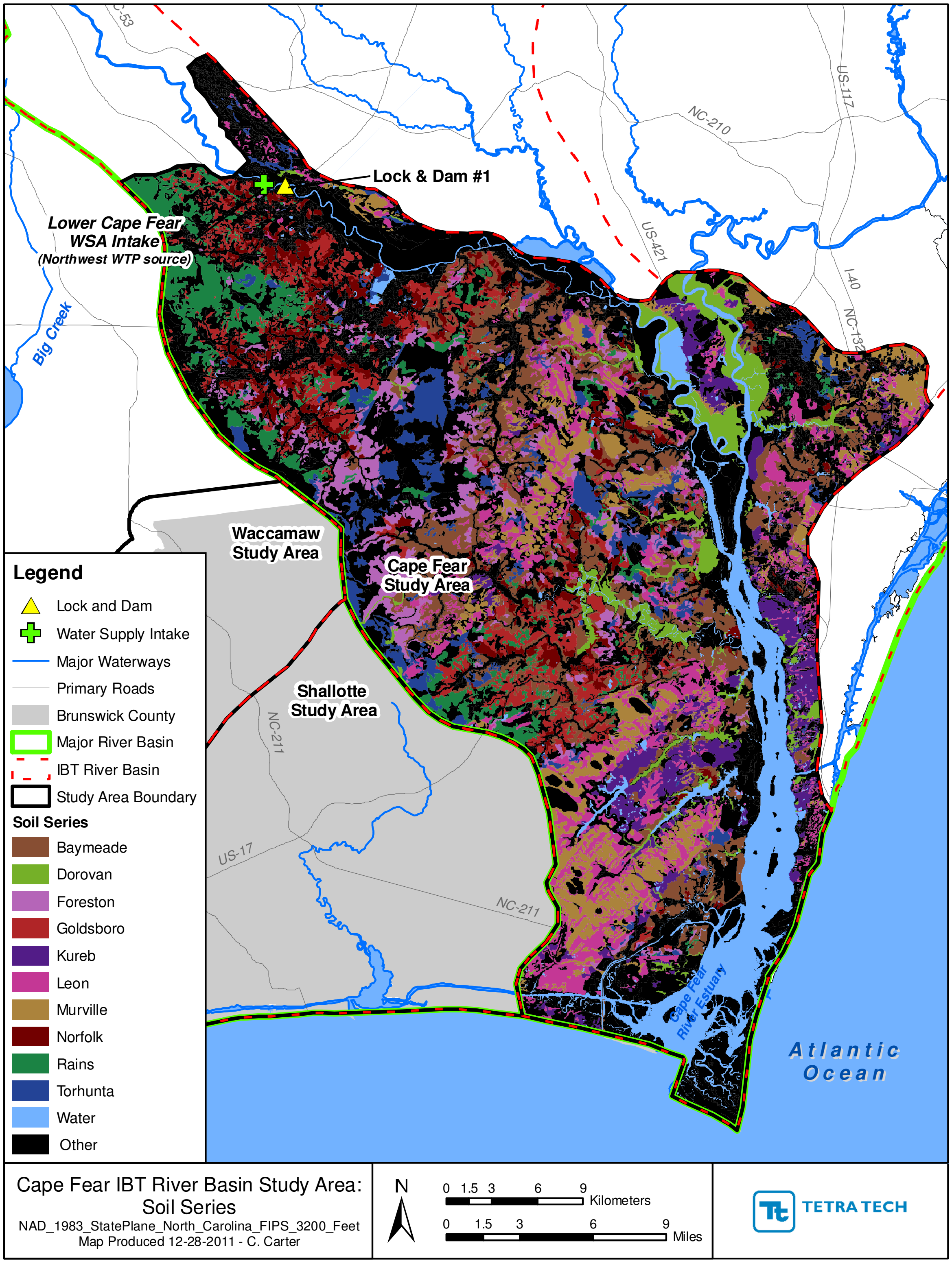

Figure 16. Soil Series of the Cape Fear Study Area

Goldsboro

The Goldsboro series consists of moderately well-drained soils that have moderate permeability. The soils formed from marine and fluviomarine deposits and are on marine terraces and uplands in the lower to upper Coastal Plain. Slopes range from 0 to 10 percent. The depth to the seasonal high water table ranges from 18 to 30 inches from December to April.

Goldsboro soils primarily occur on lands used for croplands; the dominant vegetation, where cultivated, is corn, peanuts, tobacco, soybeans, small grain, cotton, and pasture. Where wooded, the dominant vegetation is loblolly pine, longleaf pine, slash pine, sweetgum, southern red oak, white oak, water oak, and red maple, yellow poplar. Understory plants include American holly, blueberry, flowering dogwood, greenbrier, persimmon, redbay, southern bayberry (waxmyrtle), inkberry (bitter gallberry), honeysuckle, poison ivy, and summersweet clethra.

Rains

The Rains series consists of poorly drained soils that have moderate permeability. The soils formed from marine and fluviomarine deposits and are on flats, depressions, or the Carolina bays in the lower, middle, and upper Coastal Plain. Slopes range from 0 to 2 percent. The depth to the seasonal high water table ranges from 0 to 12 inches from December to April.

Rains soils occur in forested and cropland areas. Where cultivated, the dominant vegetation is corn, soybeans, and small grains. Where wooded, the dominant vegetation is pond pine, loblolly pine, and hardwoods.

Torhunta

The Torhunta series consist of very poorly drained soils with moderately rapid permeability and slow runoff in upland bays and on nearly level stream terraces in Coastal Plain. Slopes range from 0 to 2 percent. The soil formed in coarse to medium textured, marine or fluvial deposits. The water table is at or near the surface 2 to 6 months annually.

Approximately two-thirds of Torhunta soils are in pine forest with pond and loblolly being the principal species. About one-third of the soil area has been drained and is used for growing corn, soybeans, small grain, and pasture grasses.

Foreston

The Foreston series consists of moderately well-drained, moderately rapidly permeable soils with slow surface runoff that formed in loamy marine sediment. These soils are on high ridges and slight rises in broad flat interstream divides of the Coastal Plain. Slopes range from 0 to 2 percent.

Most areas of these soils have been cleared and are cropped to corn, cotton, tobacco, soybeans, and hay crops. Vegetation of forested areas includes various species of pine with mixed hardwoods.

Kureb

The Kureb series consists of very deep, excessively drained, gently sloping to moderately steep soils with rapid permeability and slow surface runoff on Coastal Plain uplands and on side slopes along streams and bays. They have formed in marine, aeolian, or fluvial sands. Slopes range from 3 to 10 percent and can range to 20 percent on side slopes along streams and edges of bays. Depth to seasonal high water table is more than 6 feet most of the year.

Kureb soils are mainly wooded. Native vegetation is turkey oak, bluejack and a few live oak with scattered longleaf pine. The understory consists mainly of huckleberry and pineland threeawn.

Norfolk

The Norfolk series consists of very deep, well-drained, moderately permeable soils formed from marine or fluviomarine deposits on uplands or marine terraces in the lower, middle, or upper Coastal Plain. Slopes range from 0 to 10 percent. Depth to the seasonal high water table ranges from 40 to 72 inches from January to March.

Most Norfolk soils have been cleared and are used for general farm crops such as corn, cotton, peanuts, tobacco, and soybeans. Where these soils are still wooded, the dominant vegetation is pines and mixed hardwoods.

Dorovan

The Dorovan series consists of very poorly drained, moderately permeable soils on densely forested flood plains, hardwood swamps, and depressions in the Atlantic Coast Flatwoods, Eastern Gulf Coast Flatwoods, and Southern Coastal Plain Major Land Resource Areas. The soil is saturated to the surface most of the time. Runoff is very slow and water is ponded on the surface in depressions. Dorovan soils formed in highly decomposed acid-organic materials. Slopes are less than 2 percent.

Nearly all the soils are used for woodland and wildlife habitat. The native vegetation is blackgum, baldcypress, sweetbay, swamp tupelo, titi, greenbrier, red maple and scattered pine. The ground cover is ferns, mosses, and other hydrophytic plants.

2.2.2 Hydrologic Soil Groups

Soil survey data retrieved from USDA NRCS (NRCS, 2011a) provides soil series assignments to specific hydrologic soil groups (HSGs). Soils grouped to specific HSGs have similar physical properties and runoff characteristics. Most of the groupings are based on the premise that soils in a climatic region that are similar in depth to a restrictive layer or water table, transmission rate of water, texture, structure, and degree of swelling when saturated will have similar runoff responses (NRCS, 2007).

Four HSG groups have been developed: Group A (low runoff potential and high infiltration rates when thoroughly wetted), Group B (moderate infiltration rate when thoroughly wetted), Group C (low infiltration rates when thoroughly wetted), and Group D (highest runoff potential and very low infiltration rates when thoroughly wetted). Some soils have been assigned dual HSGs (e.g., A/D, B/D, and C/D). In such cases, the first letter applies to the drained condition and the second to the undrained condition (NRCS, 2007).

Twenty-two percent of the Cape Fear Study Area is composed of HSG A soils, 19 percent is composed of B/D soils, and 17 percent is composed of HSG B soils (Table 12). This translates to over 50 percent of the total Cape Fear Study Area being composed of soils that have either low runoff potential with high infiltration rates (Group A) or moderate infiltration rates when thoroughly wetted (Group B) or in drained conditions (Group B/D). These HSGs consist chiefly of deep, well- to excessively drained sands or gravels and have a high rate of water transmission (Group A) or of moderately deep to deep, moderately well- to well-drained soils with moderately fine to moderately coarse textures (Group B).

Table 12. HSG for Cape Fear Study Area

HSG	Percent of Study Area
A	22%
B/D	19%
B	17%
D	14%
C	11%
Not Classified	9%
A/D	7%
C/D	1%

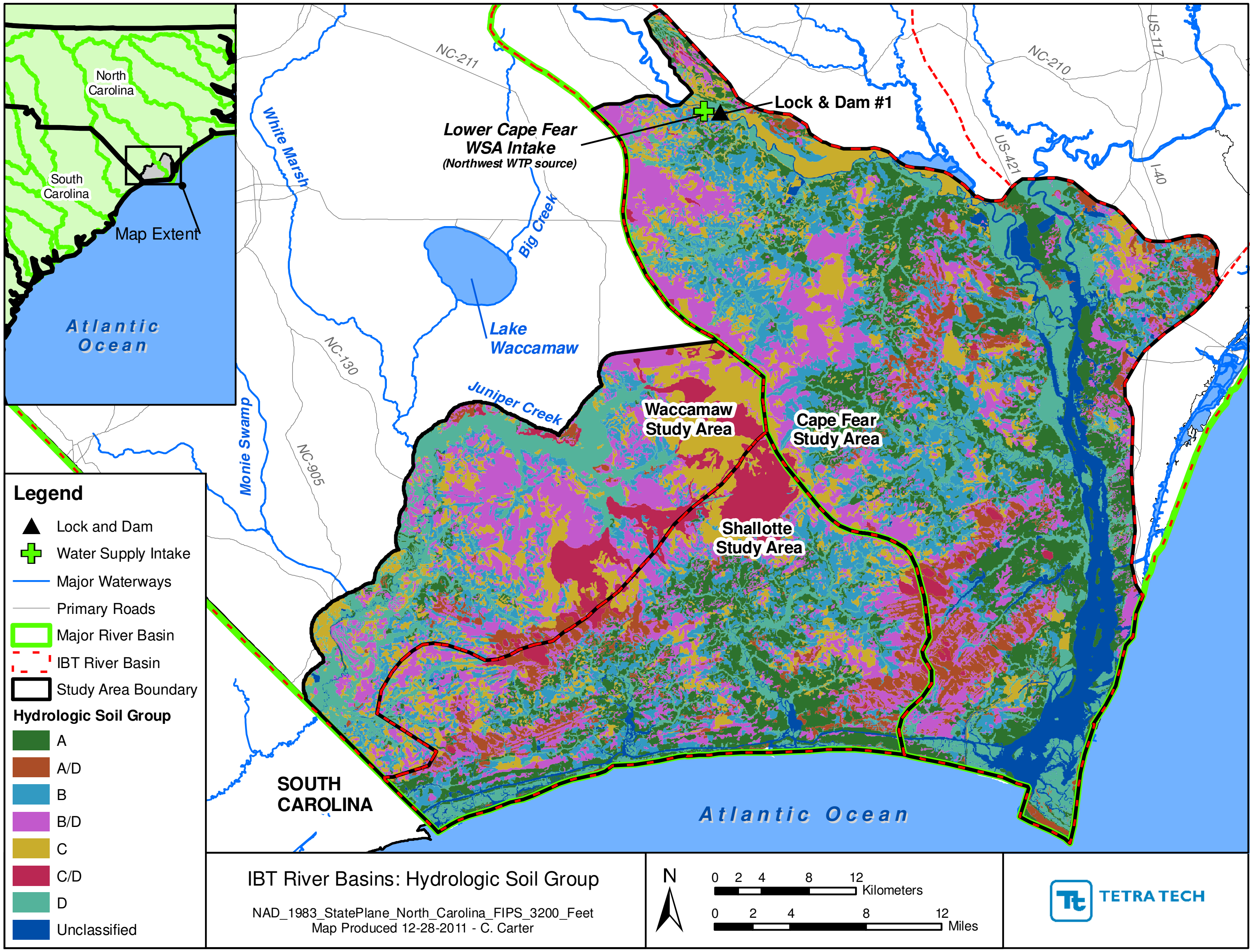

Figure 17. HSG for the IBT River Basins Study Area

2.3 LAND USE

2.3.1 Existing Land Use

Land use and land cover are summarized from two data sources: (1) existing land use data for the County developed by the County's Geographic Information System (GIS) Department, and (2) 2006 land cover data from the National Land Cover Dataset (Fry et al., 2011).

In the portion of the Cape Fear Study Area in the County (Table 13, Figure 18), land use consists of forested lands (63 percent), lands covered by water and wetlands (12 percent), lands developed for low, medium, and high-density residential purposes (totaling 11 percent), agricultural lands and open fields used for crops primarily consisting of corn, soybeans, and tobacco (4 percent), transportation (4 percent), military purposes (3 percent), lands developed for commercial, educational, institutional, and industrial purposes (2 percent), lands used for communications and utilities (1 percent), recreational uses (< 1 percent), and mining and extraction (< 1 percent). Outside the County, the Cape Fear Study Area primarily consists of water and wetlands (35 percent), forested lands (22 percent), developed areas (20 percent), and agricultural lands or open fields (12 percent) (Figure 18).

The land use category assignments used for Table 13 are provided in Appendix G.

Table 13. Land Use for the Cape Fear Study Area in Brunswick County

Land Use Group	Area (km^2)	Percent
Forest	623.12	63.00%
Water/Wetlands	114.77	11.60%
Low-Density Residential	109.59	11.08%
Agricultural Land/Open Field	38.08	3.85%
Transportation	35.61	3.60%
Military	32.15	3.25%
Developed Land	16.08	1.63%
Communications & Utilities	11.10	1.12%
Recreation	6.75	0.68%
High-Density Residential	0.72	0.07%
Medium-Density Residential	0.66	0.07%
Mining & Extraction	0.42	0.04%

Note:

km^2 = square kilometers

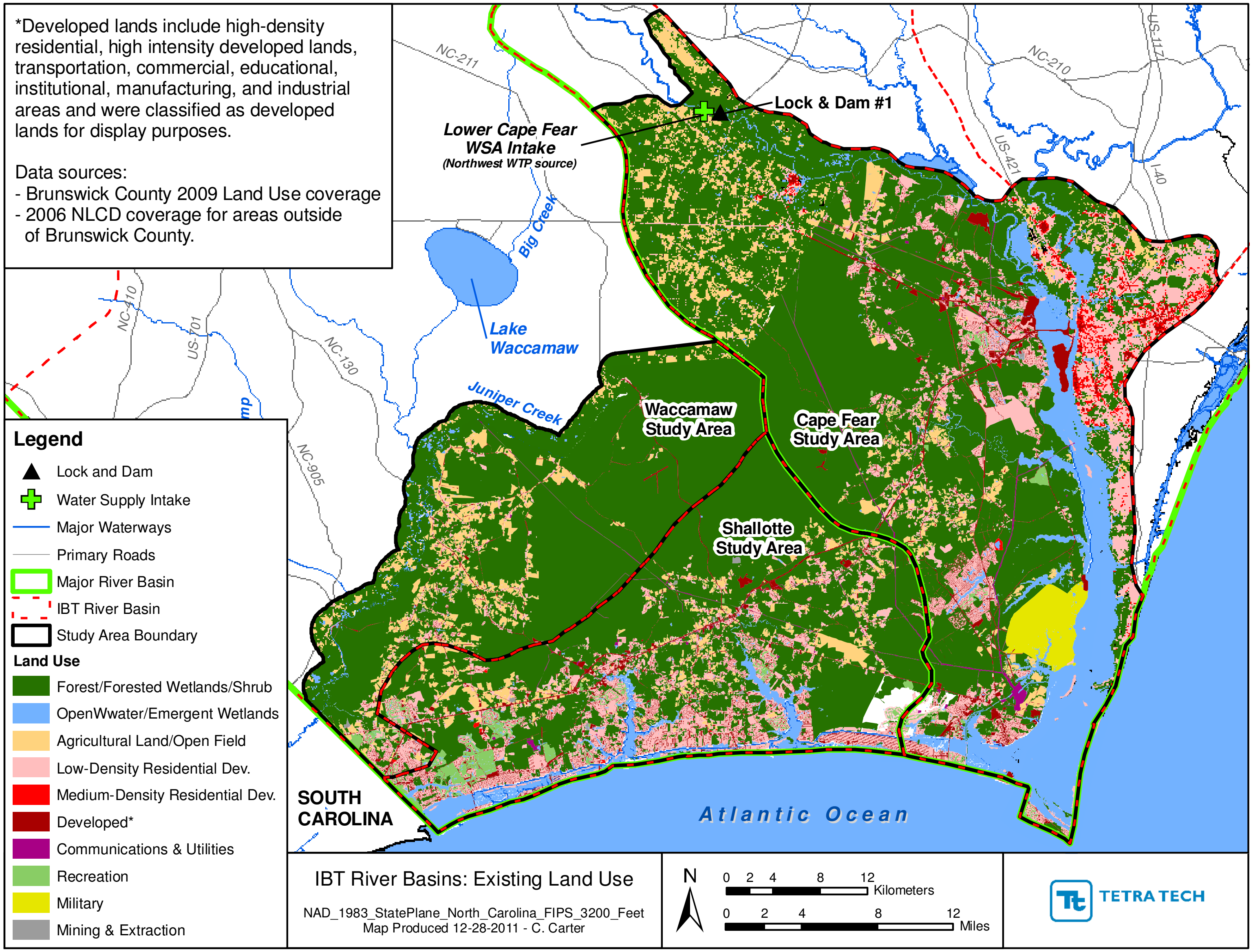

Figure 18. Existing Land Use for the IBT River Basins Study Area

2.3.2 Future Land Use

The CAMA Core Land Use Plan (Plan) was prepared in accordance with the requirements of the North Carolina Coastal Area Management Act (CAMA) for the County when it was undergoing tremendous fiscal and social change (Holland Consulting Planners, Inc., 2007a). The County Future Land Use developed for the Plan (supplied by the Brunswick County Planning Office) was forecast to 2025 but is thought to represent a scenario close to build-out and is summarized in Table 14 and shown in Figure 19. Some municipalities within Brunswick County were not included in the County's Future Land Use classification. Future land use data were retrieved from several of these non-participating municipalities and were added to the summary; these additions are included in area calculations presented in Table 14 (see table note). Note that only future land use within the boundaries of the County are shown.

Table 14. Future Land Use for Brunswick County in the Cape Fear Study Area

Future Land Use	Area (km^2)[1]	Percent of Study Area
Conservation	366.97	37.10%
Low Density Residential	319.87	32.34%
Industrial	87.99	8.90%
Medium Density Residential	40.27	4.07%
Military	37.02	3.74%
Commercial and Community Commercial	47.91	4.85%
Recreation	5.13	0.52%
Mixed Use	4.32	0.44%
Protected Lands	4.03	0.41%
Office & Institutional	3.00	0.30%
Government/Airport	2.16	0.22%
High Density Residential	0.86	0.09%

Note:

[1] Some Cape Fear Study Area municipalities were not included in the Brunswick County Future Land Use classification. Data for these areas were obtained from the following and were added: Bald Head Island (Holland Consulting Planners, Inc., 2008), Navassa (The Rhett Company, 2008), Oak Island (Town of Oak Island, 2009), and Southport (Holland Consulting Planners, Inc., 2007b). Future land use data is not currently available for Leland or Sandy Creek.

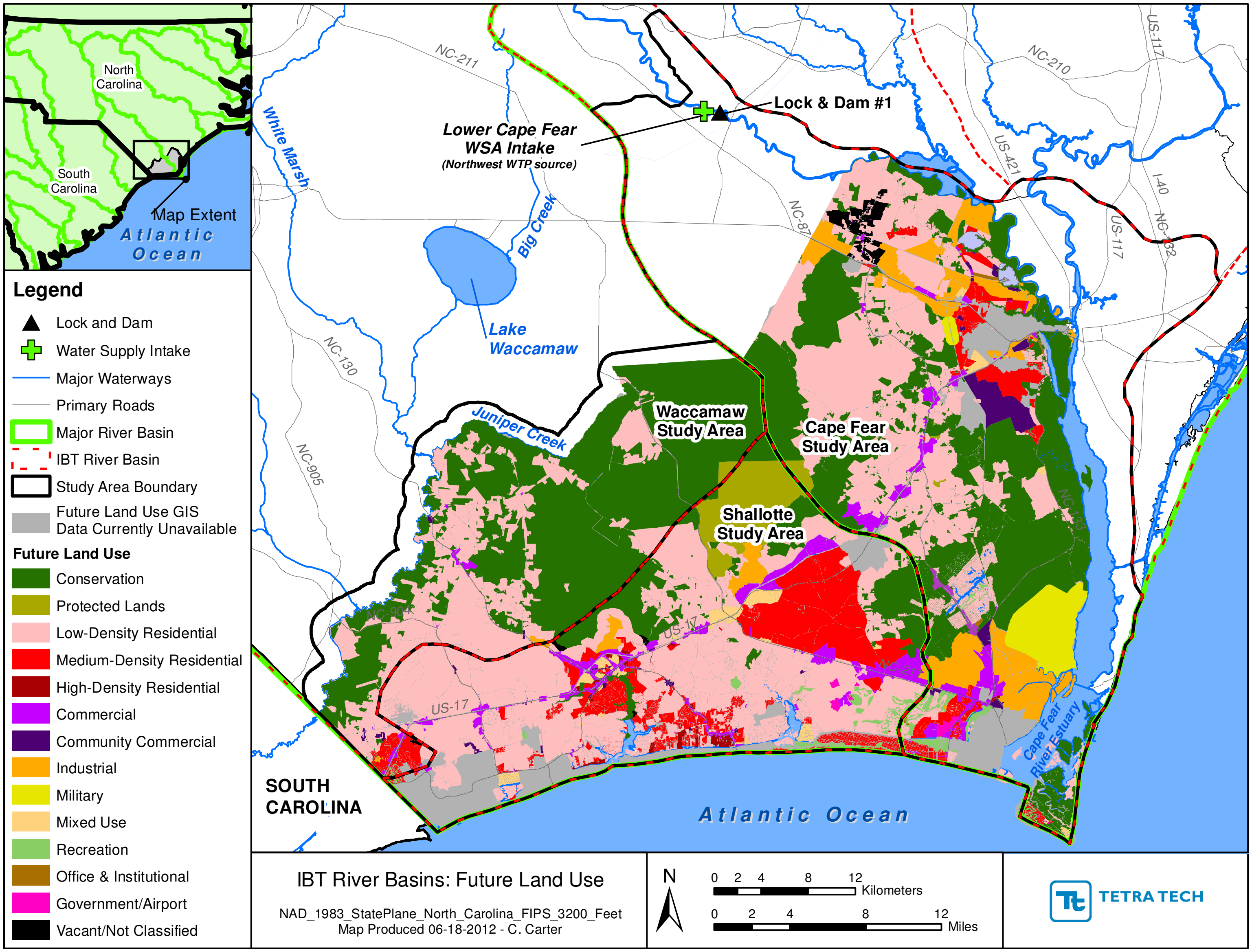

Figure 19. Future Land Use for the IBT River Basins Study Area

Table 14 provides a breakdown of future land use categories for the portion of the Cape Fear Study Area in the County. The two most prevalent categories are conservation (37 percent) and low-density residential (32 percent). The conservation designation is intended to be used for the permanent protection and preservation of environmentally sensitive lands, and areas with historical, cultural, and archeological significance (Holland Consulting Planners, Inc., 2007a). Low density residential areas are designated for agricultural uses, single family residences, multifamily residences in certain cases, single- and double-wide manufactured homes, emergency shelters, parks, and places of worship (Holland Consulting Planners, Inc., 2007a). The future land use projections are focused on land use rather than land cover, thus it is reasonable to expect that low density residential areas would contain natural land covers of forest, wetlands, and water.

2.3.3 Forest Resources

North Carolina's recently published *Forest Resources Assessment* (North Carolina Division of Forest Resources, 2010) is a statewide analysis of the past, current, and projected future conditions of North Carolina's forest resources. Because of the numerous and diverse forest types across the state, forest groupings were used to portray forest composition for the assessment. Data used throughout the assessment was obtained from the USDA Forest Service – Forest Inventory and Analysis (FIA) Program and Remote Sensing Applications Center (RSAC; USFS, 2008). This data set portrays 28 forest groups across the contiguous United States and was derived from MODIS composite images from the 2002 and 2003 growing seasons in combination with nearly 100 other geospatial data layers.

Forest groups from this data set cover approximately 81 percent of the total land area in the Cape Fear Study Area and are composed of five dominant forest groupings (Figure 20). The loblolly-shortleaf pine group is most prevalent, covering approximately 49 percent of the Cape Fear Study Area. These are forests in which loblolly pine (*Pinus taeda*), shortleaf pine (*P. echinata*), or other southern yellow pines, except longleaf (*P. palustris*) or slash (*P. elliottii*) pine, singly or in combination, constitute a plurality of the stocking and common associates include oak (*Quercus* spp.), hickory (*Carya* spp.), and gum. At lower elevations, near the coast, these forests are on moist and poorly drained soils. At higher elevations, they are on drier soils and often on abandoned farmland (USFS, 2008).

The next most prevalent forest group in the Cape Fear Study Area is the oak-gum-cypress group, covering approximately 12 percent of the Cape Fear Study Area. Forests in this group are bottomland forests in which tupelo (*Nyssa* spp.), blackgum (*N. sylvatica*), sweetgum (*Liquidambar styraciflua*), oaks, or southern cypress (*Taxodium distichum*), singly or in combination, constitute a plurality of the stocking, except where pines account for 25 to 50 percent, in which case the stand would be classified as oak-pine and common associates include cottonwood (*Populus* sp.), willow (*Salix* spp.), ash (*Fraxinus* spp.), elm (*Ulmus* spp.), hackberry (*Celtis* sp.), and maple (*Acer* spp.). These forests are characterized by wet soils, and these sites are often flooded for most of the growing season (USFS, 2008).

The longleaf-slash pine group covers approximately 11 percent of the Cape Fear Study Area. These are forests in which longleaf or slash pine, singly or in combination, constitute a plurality of the stocking and common associates include oak, hickory, and gum. Additional forest groups in the Cape Fear Study Area are the oak-pine and the oak-hickory groups, each covering approximately 5 percent of the Cape Fear Study Area.

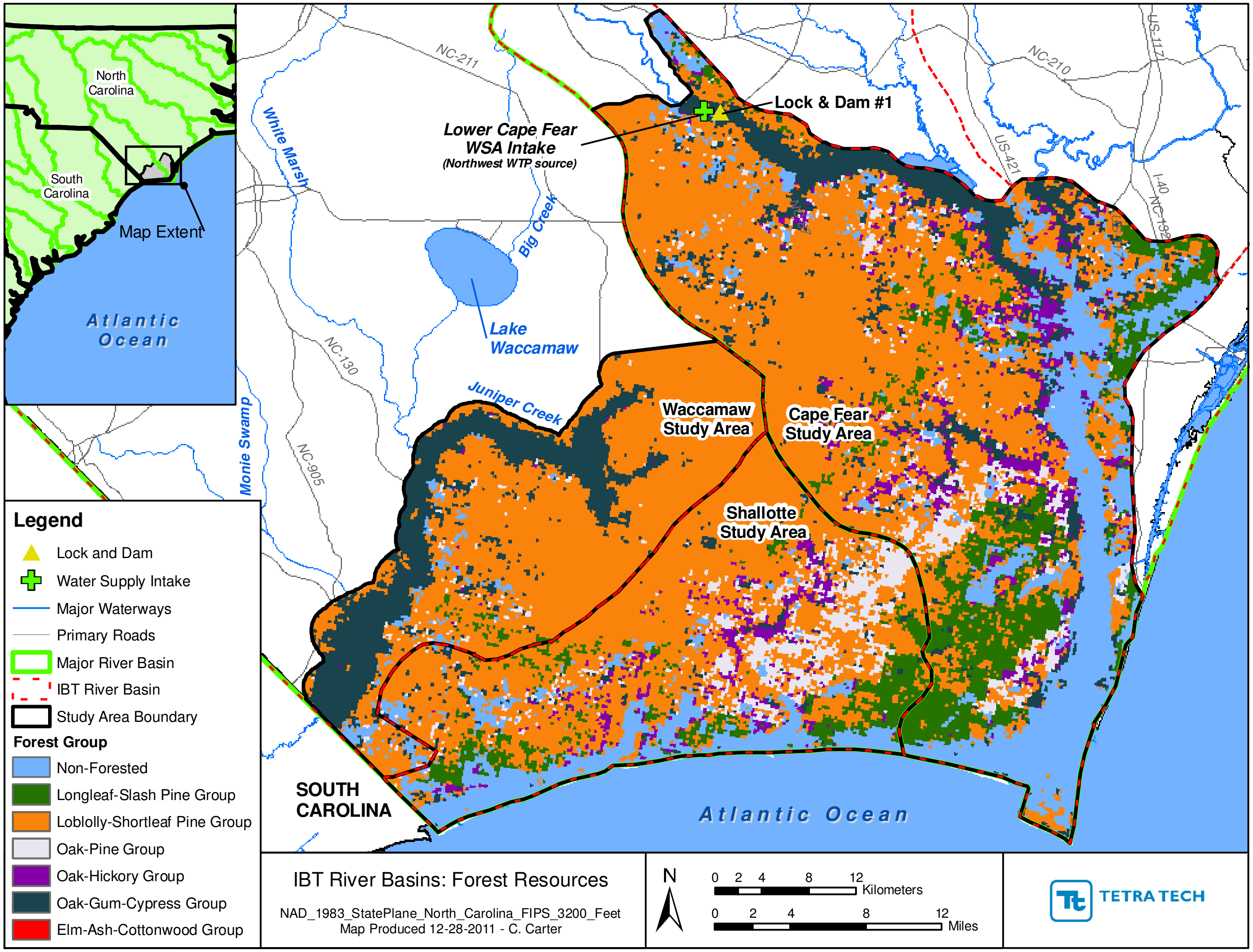

Figure 20. Forest Resources for the IBT River Basins Study Area

2.3.4 Prime and Unique Agricultural Land

Three categories of important farmlands are recognized in North Carolina-prime, unique, and statewide. Criteria for farmland of statewide importance were developed in 1988 by the North Carolina NRCS State Soils Staff in consultation with soil survey cooperators, resource conservationists, and key soil survey customers.

Ten percent of the Cape Fear Study Area has soils that are identified as prime farmland and an additional 19 percent of the Cape Fear Study Area includes soils identified as prime farmland if they were to be drained (Table 15, Figure 21). Prime farmland soils, as defined by USDA, are soils that are best suited for producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops (Barnhill, 1986).

Nine percent of the Cape Fear Study Area has soils that are farmlands of unique importance. Soils that have a special set of properties that are unique for producing certain high-value crops meet the requirements for unique farmland.

Seventeen percent of the Cape Fear Study Area has soils that are farmlands of statewide importance. In general, soils that do not meet the requirements of prime farmlands fall into this category, and they are classified as having statewide importance according to criteria established specifically for North Carolina.

Table 15. Farmland Classification for Farmed Areas in the Cape Fear Study Area

Farmland Classification	Percent of Cape Fear Study Area
Prime farmland	10%
Prime farmland if drained	19%
Not prime farmland	43%
Prime farmland if protected from flooding or not frequently flooded during the growing season	2%
Farmland of unique importance	9%
Farmland of statewide importance	17%

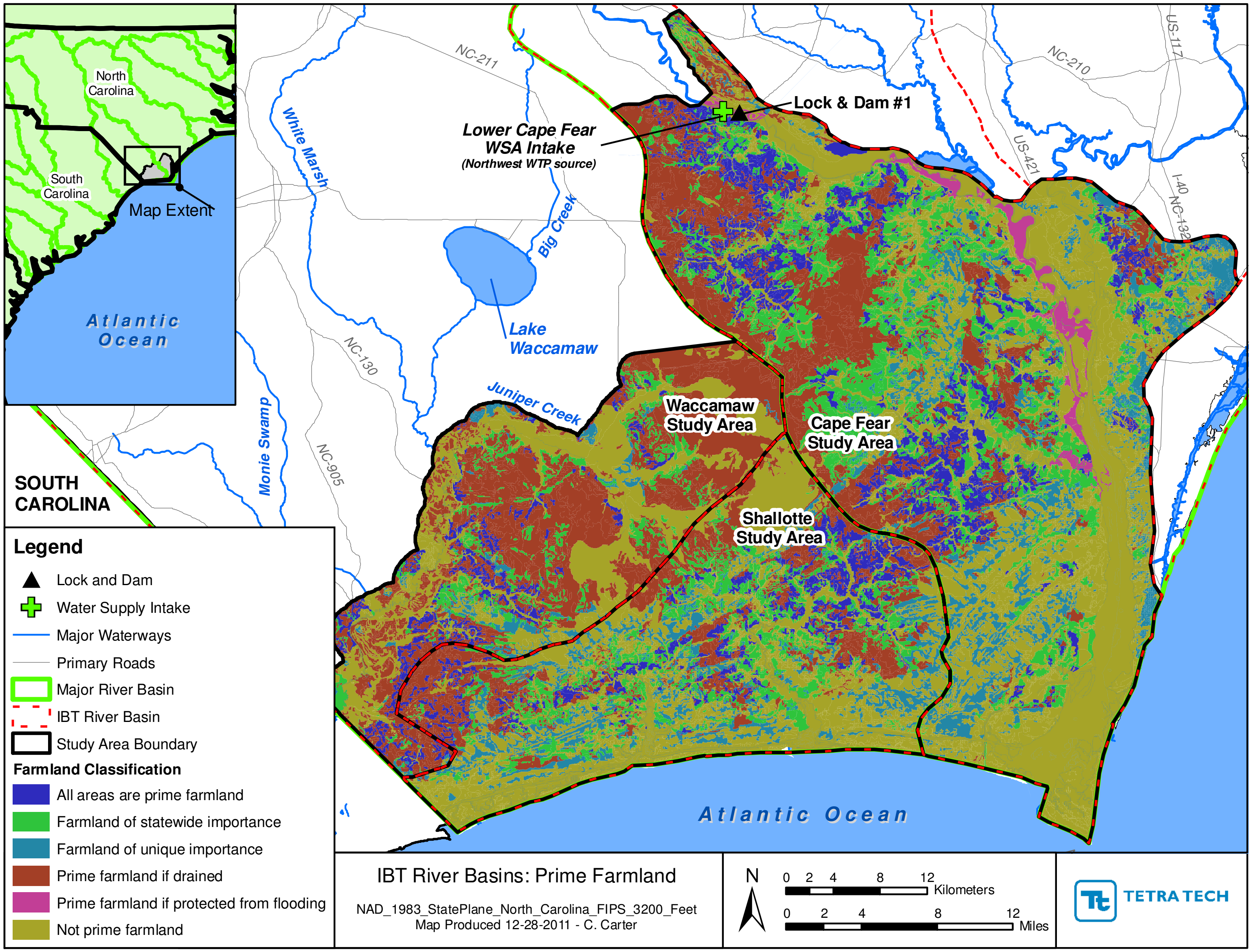

Figure 21. Prime Farmland in the IBT River Basins Study Area

2.3.5 Public Lands and Scenic, Recreational, and State Natural Areas

In 2002 the North Carolina Center for Geographic Information and Analysis developed a GIS data layer covering lands managed for conservation and open space (LMCOS; NCCGIA, 2002). This data layer serves as a composite inventory that integrates digital depictions of lands from multiple sources and resolves boundary discrepancies among sources. Several partners were included in the creation of this data layer (e.g., various divisions of DENR, the Nature Conservancy, and the U.S. Forest Service). LMCOS are a combination of lands that are permanently protected open space and farmland and other lands that are managed as *open space* as defined by North Carolina G.S.§160A-407. These lands encompass, for example, state parks, recreation areas, natural areas, nature preserves, lakes, historic sites, game lands, and coastal reserves, cultural and historic lands, preserved farmlands, submerged lands, public beach and coastal water access areas, and national forests and parks.

LMCOS in the Cape Fear Study Area are owned by several entities such as the state, land trusts, the federal government, The Nature Conservancy, municipalities, and counties (Figure 22). Table 16 through Table 18 provide a list of all LMCOS in the Cape Fear Study Area. Because the LMCOS data layer was created in 2002, additional data layers depicting state-owned lands, federally owned lands, and land trusts, created in 2010, 2006, and 2008, respectively, were used to provide an account of most recent land ownerships (NCDOA, 2010; NCCGIA, 2006; The Conservation Fund, 2008).

In all, approximately 140 square kilometers (km^2), or 9 percent of the Cape Fear Study Area, is designated as lands for conservation or open space for public use. The sites having the largest area are the state-owned Bald Head Island Natural Area (24 km^2, 1.5 percent) and Boiling Spring Lakes Preserve (16 km^2, 1 percent), and the Town Creek land trust areas (19 km^2, 1 percent).

Bald Head Island is a state natural area; it possesses a unique diversity of intact ecosystems including dune, beach, estuarine, salt marsh, maritime forest, maritime shrub, and freshwater aquifer.

The Boiling Spring Lakes Preserve is owned by the North Carolina Plant Conservation Program and managed by The Nature Conservancy. Large concentrations of Carolina bays (elliptical wetland depressions) are in the preserve area and fire-dependent natural communities, including high and low pocosins (evergreen shrub bogs), longleaf pine savannas, and flatwoods on the ridges and bay rims, form an intricate medley of habitats. The preserve houses rare flora and fauna including the federally endangered red-cockaded woodpecker, carnivorous plants, and orchids (TNC, 2011a).

Town Creek contains prime wildlife habitat and wetlands. The North Carolina Coastal Land Trust has worked with state and federal agencies, timber companies, and private individuals to protect land along Town Creek and its tributaries. Alligators are often seen in Town Creek, especially along the last few miles before reaching the Cape Fear (North Carolina Coastal Land Trust, 2011).

Table 16. LMCOS in the Cape Fear Study Area

Owner Type	Name	Owner/Management	Total Area in Cape Fear Study Area (km^2)	Percent of Cape Fear Study Area
State	Bald Head Island Natural Area, Boiling Springs Lakes Preserve, and several more (See Table 17)	North Carolina (Administration, Division of Parks and Recreation, Division of Coastal Management, Cultural Resources, Transportation, Marine Fisheries, Wildlife Resources Commission, UNC Wilmington), The Nature Conservancy	70.68	4.38%
Land Trust	Town Creek, Orton Plantation, and several more (See Table 18)	North Carolina Coastal Land Trust, Smith Island Land Trust, Conservation Trust for North Carolina, and North American Land Trust	57.58	3.57%
Federal	Eagle Island	USACE	6.16	0.38%
The Nature Conservancy	Green Swamp Preserve (Black Bear Sanctuary), Permanent Easement	The Nature Conservancy	4.37	0.27%
Municipal	Carolina Beach Lake II, Exchange Club Bicentennial Park, Franklin Square Park, Greenfield Lake, Greenfield Park, Lightship Municipal Park, Municipal Boat Ramp, Riverfront Park II, Western Corridor Southside Park	Municipalities of Carolina Beach, Wilmington, and Southport	0.66	0.04%
County	Arrowhead Park, Blair Noble Park, Kings Grant Park, Northwest Township District Park, Parkwood Recreation Area, Smithville Township District Park, Trask Park, Virginia Pearson Empie Park	New Hanover and Brunswick Counties	0.54	0.03%
Other	--	--	1.32	0.08%

Table 17. State-Owned Public Lands and Natural Areas in the Cape Fear Study Area

Site Name	Area in Cape Fear Study Area (km^2)	Percent of Cape Fear Study Area
Bald Head Island Natural Area	24.02	1.49%
Boiling Springs Lakes Preserve	16.46	1.02%
Zeke's Island - Estuarine Sanctuary	5.85	0.36%
Roan Island	5.13	0.32%
Fort Fisher	4.26	0.26%
Other	4.04	0.25%
Carolina Beach State Park	1.34	0.08%
Marine Fisheries - Submerged Lands Section	1.23	0.08%
Atlantic Intracoastal Waterway	1.18	0.07%
State Ports Authority - Eagle Island Spoil Area, Basin River Property, Southport Boat Harbor, Wilmington	1.05	0.07%
Carolina Beach State Park	0.99	0.06%
Wildlife Resources Commission Lands	0.97	0.06%
Eagles Island	0.96	0.06%
UNC Wilmington - Ecological Botanical Gardens	0.84	0.05%
CM Bald Head Woods Coastal Reserve	0.84	0.05%
Historic Brunswick Town	0.56	0.03%
NCSU Horticulture Crops Research Station	0.24	0.01%
NC Battleship (Site)	0.20	0.01%
Bird Island	0.18	0.01%
Brunswick County Conservation Easement Sites	0.17	0.01%
Columbus County Conservation Easement Sites	0.14	0.01%
Natural Heritage Areas (Various Islands)	0.02	< 0.01%
New Hanover County Conservation Easement Sites	0.001	< 0.01%

Table 18. Land Trusts in the Cape Fear Study Area

Trust	Site Name	Area in Cape Fear Study Area (km2)	Percent of Cape Fear Study Area
North Carolina Coastal Land Trust	Town Creek	19.25	1.19%
	Orton Plantation	12.42	0.77%
	Pleasant Oaks Plantation	9.02	0.56%
	Cape Fear River DuPont - Brunswick	5.67	0.35%
	Not Provided	5.54	0.34%
	Cape Fear Royal Tracts	3.21	0.20%
	Cape Fear River - Davis	0.55	0.03%
	Lords Creek Burnett	0.45	0.03%
	Lords Creek	0.19	0.01%
	Indigo Plantation Marsh Preserve	0.16	0.01%
	Alderman Nature Preserve	0.12	0.01%
	Oak Island Marshes	0.11	0.01%
	Telfairs Creek (Beach Walk)	0.08	< 0.01%
	Lords Creek Burnett - NCCLT Tract	0.02	< 0.01%
	Carolina Beach Lake	0.01	< 0.01%
Conservation Trust for North Carolina	Island Associates	0.003	< 0.01%
	Overstreet Easement	0.002	< 0.01%
	Cauthen Lacin Easement	0.002	< 0.01%
	Hobgood Easement	0.002	< 0.01%
	Klaine Easement	0.002	< 0.01%
	Wesson-Dimling Easement	0.001	< 0.01%
	Cauthen Easement	0.001	< 0.01%
	Himes Easement Part I	0.001	< 0.01%
	Hollinshed Easement	0.001	< 0.01%

Trust	Site Name	Area in Cape Fear Study Area (km2)	Percent of Cape Fear Study Area
	McQuiade Easement	0.001	< 0.01%
	Bentsen Easement	0.001	< 0.01%
	Quanstrom Easement	0.001	< 0.01%
	Cauthen III	0.001	< 0.01%
	Martin Property	0.001	< 0.01%
	Lacin Property	0.001	< 0.01%
	Himes Easement Part II	0.001	< 0.01%
	Kelly Easement	0.0002	< 0.01%
Smith Island Land Trust	Cape 2000 Campaign	0.01	< 0.01%
North American Land Trust	Not Provided	0.76	0.05%

Rivers identified as National Wild and Scenic Rivers that are under federal protection are not in the Cape Fear Study Area. Public trust waters are navigable waters open for public uses such as fishing and navigation; such waters are common and widespread throughout the Cape Fear Study Area.

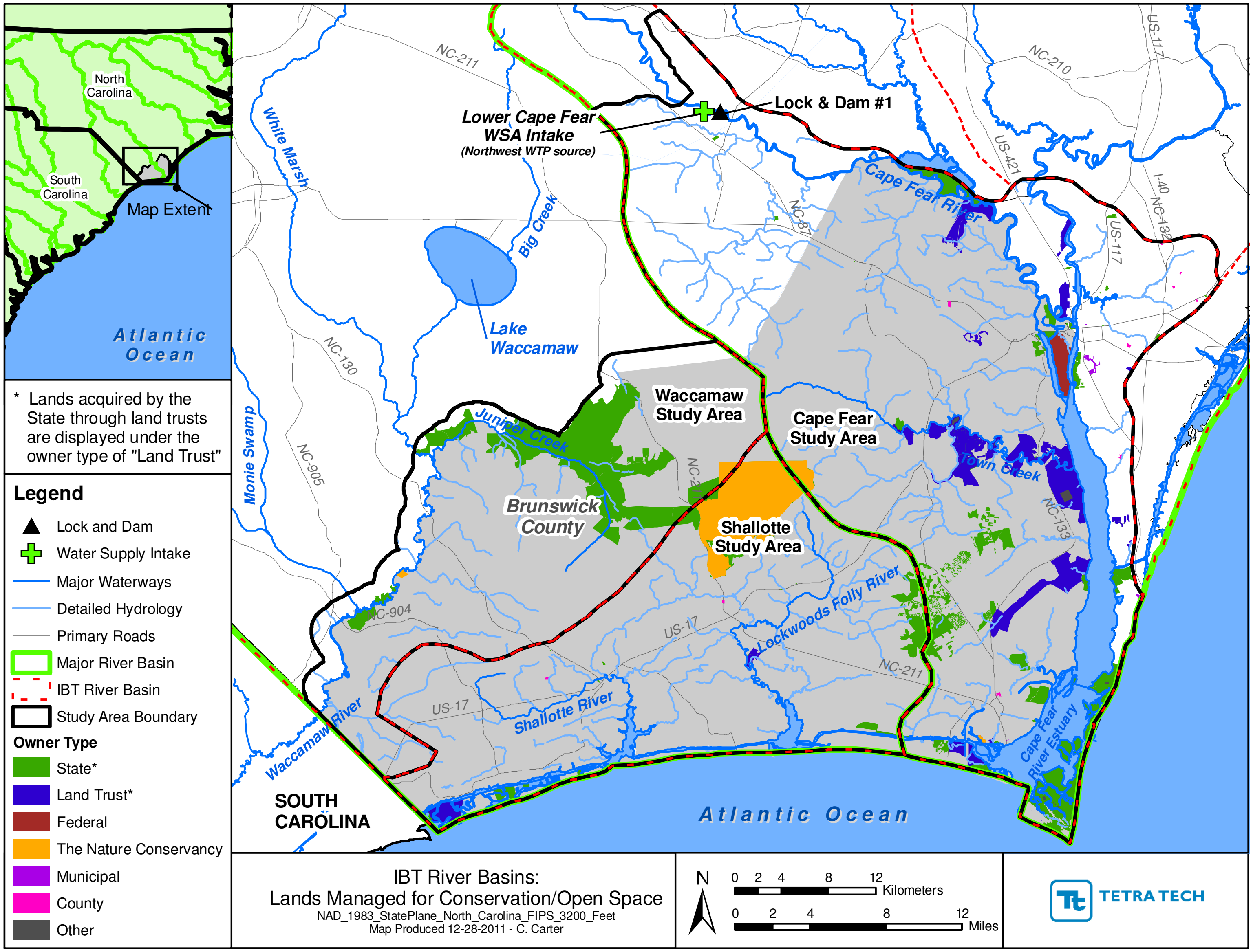

Figure 22. LMCOS in the IBT River Basins Study Area

2.3.6 Areas of Archaeological or Historical Value

The Cape Fear River is recognized as one the most significant and historically important waterways of the Carolinas. The Lower Cape Fear has served as a commercially important navigational artery for more than 300 years. Numerous shipwrecks are known and identified in the coastal section of the river (Jackson, 1996; Overton and Lawrence, 1996).

The Brunswick Town/Fort Anderson site is a State Historic Site in North Carolina and is on the west bank of the lower Cape Fear River. Brunswick Town was a major pre-Revolutionary port along the river; it was destroyed by British troops in 1776 and never rebuilt. During the Civil War, Fort Anderson was constructed atop the old village site and served as part of the Cape Fear River defenses below Wilmington. Archaeology was active on the site in the 1950s and 1960s, and the site now has several exhibits open to the public (NCDCR, 2011).

Fort Fisher is State Historic Site in North Carolina. This fort was constructed near the mouth of the Cape Fear River. Today only a few of the fort's mounds remain because much of the fort has been eroded by the ocean. This site also has several exhibits and is open to the public (NCDCR, 2011).

The battleship *USS North Carolina* is also recognized as a State Historic Site. This site is across the Cape Fear River from downtown Wilmington. During World War II, *USS North Carolina* participated in every major naval offensive in the Pacific area of operations. The battleship was decommissioned in 1947 and dedicated as North Carolina's memorial to its World War II veterans in 1962 (NCDCR, 2011).

2.4 SURFACE AND GROUNDWATER RESOURCES

2.4.1 Drainage Basins and Surface Water Supplies

The Cape Fear Study Area is in the Cape Fear *Major* River Basin. The majority of the Cape Fear Study Area is in the Lower Cape Fear subbasin, in U.S. Geological Survey (USGS) Hydrological Unit 03030005, and two North Carolina DWQ subbasins (03-06-16 and 03-06-17). This portion drains the coastal plain wetlands and bay lakes and includes slow-moving tannin stained tributary streams, the large Cape Fear River estuary, and tidal creeks. A small section in the northeast portion of the Cape Fear Study Area is in the Northeast Cape Fear subbasin, in USGS Hydrological Unit 03030007, and North Carolina DWQ subbasin 03-06-23.

2.4.2 Surface Water Use Classifications

All surface waters in North Carolina are assigned a primary classification by DWQ. All waters must at least meet the standards for Class C (fishable/swimmable) waters except in the case where natural conditions have led to additional classification (e.g., swampwaters). The other primary classifications provide additional levels of protection for primary water contact recreation (Class B) and drinking water (Water Supply Classes I through V). Classifications for major waterbodies are displayed in Figure 23 and described below.

Most tributaries to and mid-stream sections of the Cape Fear River in the Cape Fear Study Area are classified as C and Sw waters. Class C classification is for waters protected for uses such as secondary recreation, fishing, wildlife, fish consumption, aquatic life, and agriculture. Sw classification is for swamp waters and is a supplemental classification intended to recognize those waters that have low velocities and other natural characteristics that are different from adjacent streams.

Directly downstream from the LCFWSA intake, the waters of the Cape Fear River and associated tributaries (Weyman Creek, Copper Smith Branch, Turkeypen Branch, Turner Branch, Beaverdam Creek, Horsepen Branch, Double Branch, and Natmore Creek) are classified as WS-IV and Sw. WS-IV classification is for waters used as sources of water supply. In the Cape Fear Study Area, waters of Toomers Creek also are classified as WS-IV.

A large portion of the Cape Fear River and the Brunswick River (from source to the Cape Fear River) are classified as SC waters. SC classification is for tidal salt waters protected for secondary recreation such as fishing, boating, and other activities involving minimal skin contact; fish and noncommercial shellfish consumption; aquatic life propagation and survival; and wildlife.

Several of the tidal creeks, outlet channels, the mouth of the Cape Fear River, and the Intracoastal Waterway (ICWW) are classified as SA;HQW waters. SA waters are tidal salt waters that are used for commercial shellfishing or marketing purposes. All SA waters are also HQW by supplemental classification. HQW is a supplemental classification intended to protect waters that are rated excellent on the basis of biological and physical/chemical characteristics through DWQ monitoring or special studies, primary nursery areas designated by the Marine Fisheries Commission, and other functional nursery areas designated by the Marine Fisheries Commission.

Pretty Pond, Clear Pond, Allen Creek (Boiling Springs Lake), and a section of Toomers Creek are all class B and Sw. Class B waters are protected for all Class C uses in addition to primary recreation.

Walden Creek and associated tributaries (White Spring Creek, Nigis Creek, Nancy's Creek, Gum Log Branch, Governors Creek, Fishing Creek), the upstream portion of Dutchman Creek, Beaverdam Creek (from the source to the mouth of Polly Gully Creek), and Polly Gully Creek (from the source to Beaverdam Creek) are SC, Sw, and HQW waters.

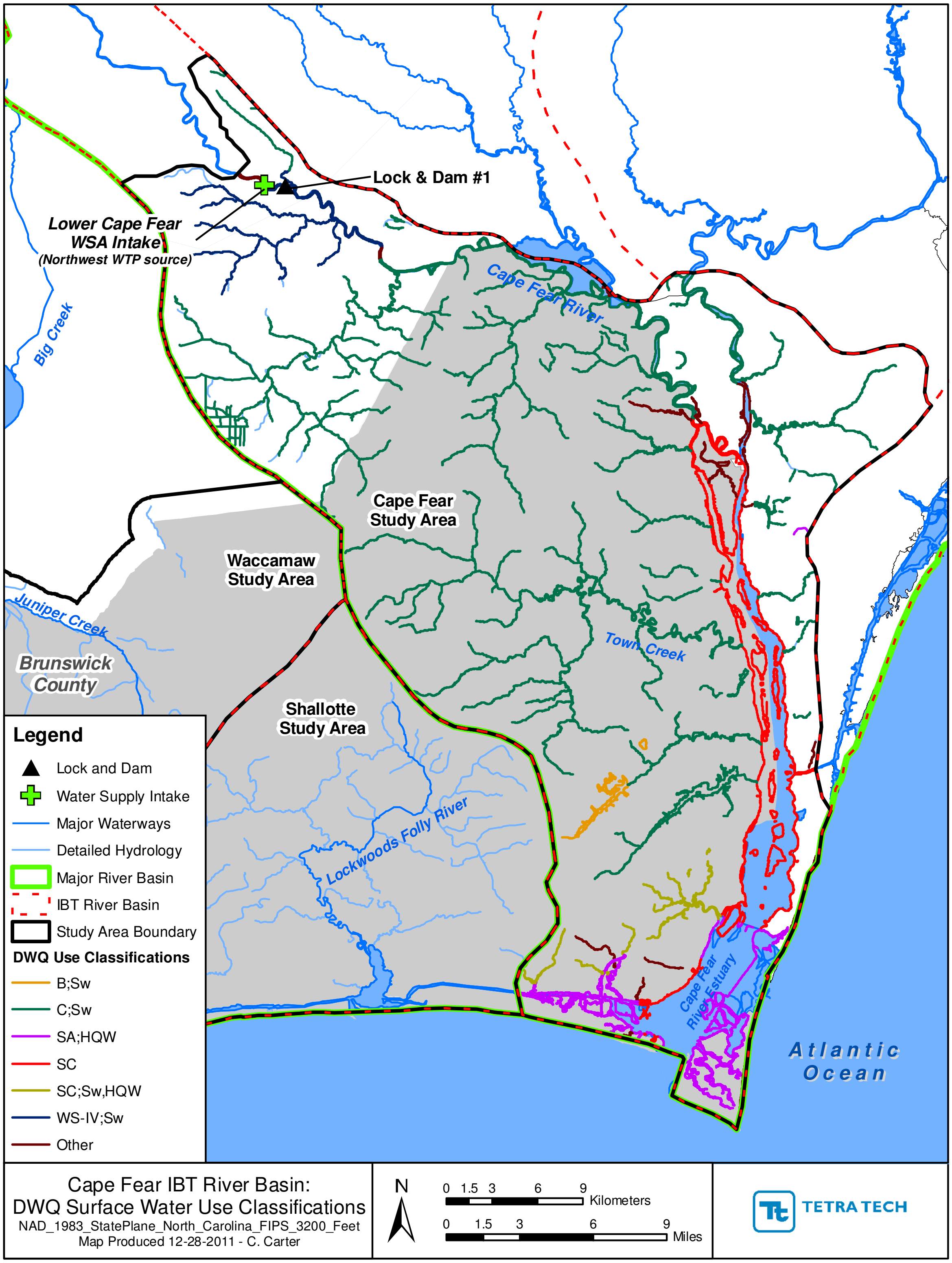

Figure 23. DWQ Surface Water Use Classifications for the Cape Fear Study Area

2.4.3 Existing Surface Water Quality

The North Carolina Water Quality Assessment and Impaired Waters List is an integrated report that includes both the Clean Water Act section 305(b) and 303(d) reports. DWQ's 2010 integrated report assessment lists 25 waterbodies in the Cape Fear Study Area as impaired for various designated use categories (e.g., recreation, shellfish harvesting, or aquatic life; NCDWQ, 2010a. Of the 25 waterbodies listed, 19 consist of coastal waters and tidal creeks, the Brunswick River, the Northeast Cape Fear River, Burnt Mill Creek, and Hewletts Creek (Table 19, Figure 24), and the remaining 6 waterbodies are sections of the Cape Fear River (Table 20).

Table 19. Waters with Impaired Use Support Rating in the Cape Fear Study Area (not including the Cape Fear River)

Waterbody	Use Category	Reason for Impairment	Parameter
Atlantic Ocean (Dolphin Court in Kure Beach to Spartanburg Avenue in Carolina Beach)	Recreation	Standard Violation	Enterococcus
Bald Head Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Beaverdam Creek (from the mouth of Polly Gully Creek to the ICWW)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Brunswick River	Aquatic Life	Standard Violation	Low Dissolved Oxygen
Burnt Mill Creek	Aquatic Life	Poor Bioclassification	Ecological/biological Integrity Benthos
Coward Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Denis Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Dutchman Creek (from CP&L Discharge Canal to the ICWW)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Dutchman Creek Outlet Channel	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Dutchman Creek Shellfish Area	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Elizabeth River (the section of Elizabeth River exclusive of the Elizabeth River Shellfishing Area)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited

Waterbody	Use Category	Reason for Impairment	Parameter
Elizabeth River Shellfishing Area	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Fishing Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Hewletts Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
ICWW	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Molasses Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Northeast Cape Fear River (from the mouth of Ness Creek to the Cape Fear River)	Aquatic Life	Standard Violation	Copper
Piney Point Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Southport Restricted Area	Aquatic Life	Standard Violation	Arsenic, Copper, Nickel

Table 20. Impairment Ratings for the Cape Fear River in the Cape Fear Study Area

Location along Cape Fear River	Use Category	Reason for Impairment	Parameter
From a line across the river between Lilliput Creek and Snows Cut to a line across the river from Walden Creek to the basin	Aquatic Life	Standard Violation	Arsenic
			Copper
			Nickel
From the raw water supply intake at Federal Paper Board Corporation (Riegelwood) to Bryant Mill Creek	Aquatic Life	Fair Bioclassification	Ecological/biological Integrity Benthos
From upstream of the mouth of Toomers Creek to a line across the river between Lilliput Creek and Snows Cut	Aquatic Life	Standard Violation	Turbidity
			Copper
			Low Dissolved Oxygen
			Low pH
Prohibited area east of the ICWW in the Cape Fear River	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Prohibited area north of Southport Restricted Area and west of the ICWW in the Cape Fear River	Aquatic Life	Standard Violation	Arsenic
			Copper
			Nickel
	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Prohibited area near Southport	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Prohibited area south of the Southport Restricted Area	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open

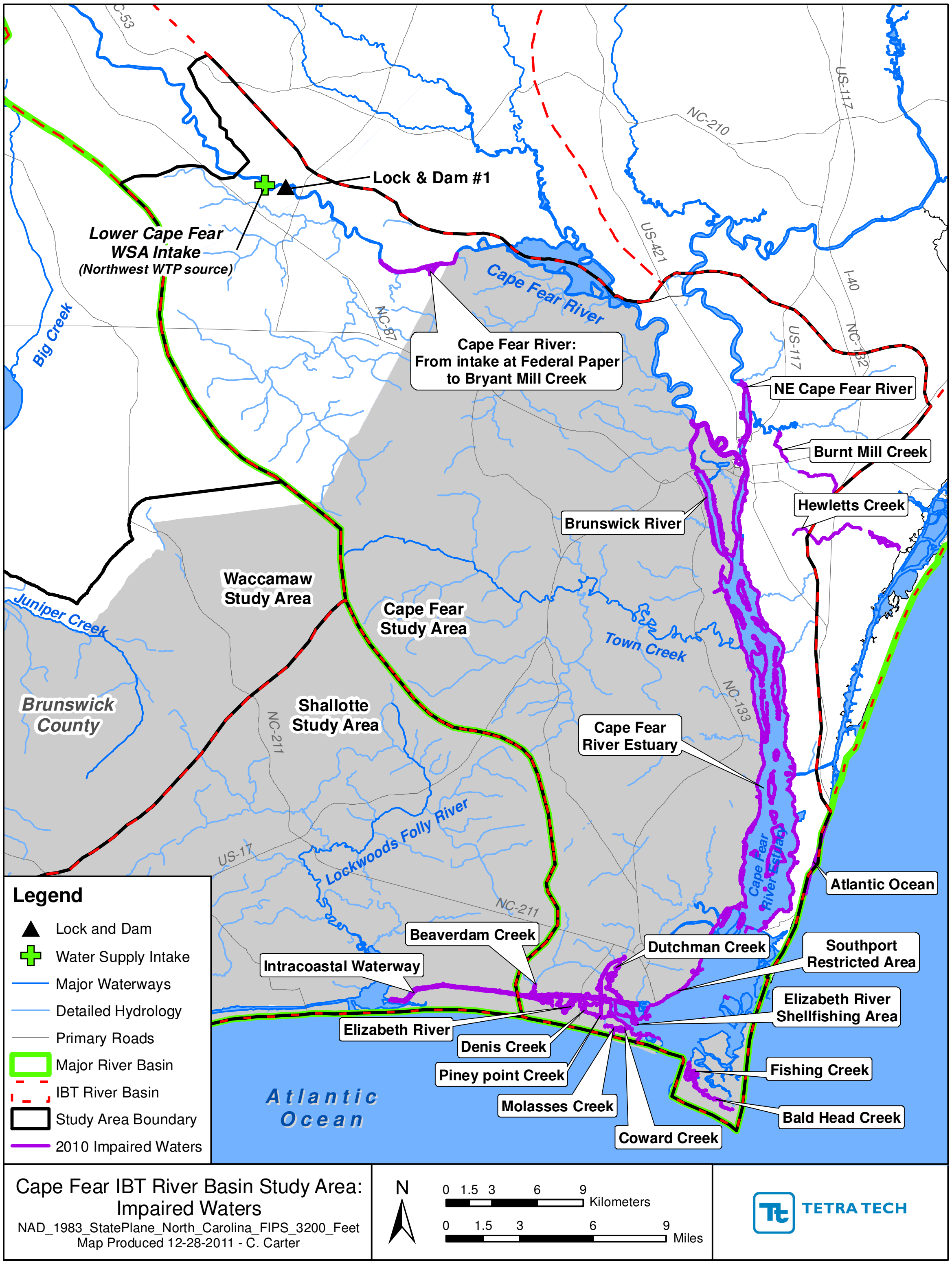

Figure 24. Impaired Waters of the Cape Fear Study Area

2.4.4 Total Maximum Daily Load (TMDL)

A TMDL was being developed for the Cape Fear Estuary (NCDWQ, 2005). The Cape Fear Estuary has been listed since 1998 as impaired for aquatic life because of dissolved oxygen standard violations (from upstream mouth of Toomers Creek to a line across the river between Lilliput Creek and Snow's Cut; NCDWQ, 2008). Sources of oxygen demand that cause the low dissolved oxygen levels include a considerable volume of blackwater and swamp drainage that contributes natural sources of oxygen-consuming materials and point and nonpoint sources from anthropogenic sources (e.g., agriculture and urban runoff). This portion of the estuary is influenced both by ocean tides and high freshwater flows from the entire upstream basin and therefore goes through many extreme changes in water column chemistry over the course of a year (NCDWQ, 2005). The University of North Carolina at Charlotte completed a final report discussing the results of the Cape Fear Estuary Dissolved Oxygen Model (Bowen et al. 2009). The model was used to investigate the effects of various organic matter and ammonia load reduction scenarios on the dissolved oxygen concentrations in the estuary. Given questions of natural versus anthropogenic sources of oxygen demand and what the dissolved oxygen criteria for the lower Cape Fear River should actually be, DWQ has placed the TMDL development on hold.

North Carolina has issued a statewide fish consumption advisory for mercury; therefore, all surface waters in the state are considered impaired by mercury (NCDWQ, 2013). As a result, a statewide mercury TMDL was developed by NCDWQ and approved by EPA in October 2012. The TMDL estimated the proportions of mercury contributions to water and fish from wastewater discharges, in-state air sources, and out-of-state air sources, and calculated the reductions needed to protect North Carolina waters from mercury impairment and remove the fish consumption advisory. Using statistical analysis and the Community Multi-scale Air Quality (CMAQ) model, NCDWQ determined that a 67% reduction is needed from the 2002 baseline mercury loading. Reductions in both point and nonpoint sources are required, though the most significant source of mercury is nonpoint atmospheric deposition. The NPDES program will play a role in managing mercury from wastewater point sources, which account for 2% of the mercury load, while reductions in atmospheric deposition will require strategies involving other agencies outside of NCDWQ such as the NC Division of Air Quality.

2.4.5 Groundwater Supplies

The Cape Fear Study Area is in the Coastal Plain physiographic province in the southern coastal portion of North Carolina. The aquifers underlying the Cape Fear Study Area include the surficial aquifer, the Castle Hayne aquifer, and aquifers of the Cretaceous Aquifer System including the Lower Cape Fear, Upper Cape Fear, Black Creek, and Pee Dee aquifers (NCDWR, 2011).

The surficial aquifer is widely used throughout North Carolina for individual home wells. The surficial aquifer is the shallowest and most susceptible to contamination from septic tank systems and other pollution sources (NCDWR, 2011). It is the saturated portion of the upper layer of sediments. The thickness of this layer, from the surface down to the first major confining bed, is typically from 20 to 50 feet. The surficial aquifer is unconfined, meaning that its upper surface is the water table rather than a confining bed. The composition of the surficial aquifer varies across the region, but it is generally 50 to 70 percent sand, allowing high infiltration rates (Huffman, 1996).

The Castle Hayne aquifer, underlying the eastern half of the Coastal Plain, is the most productive aquifer in the state. It is primarily limestone and sand. The Castle Hayne is noted for its thickness (more than 300 feet in places) and the ease of water movement within it, both of which contribute to high well yields. It lies fairly close to the surface toward the south and west, deepening rapidly toward the east. Water in the Castle Hayne aquifer ranges from hard to very hard because of its limestone composition. Iron concentrations tend to be high near recharge areas but decrease as the water moves further through the limestone (Huffman, 1996).

The Cretaceous aquifer system is a grouping of several of the oldest and deepest sedimentary deposits that lie directly over the basement rock. The Cretaceous is the primary source of water for the western half of the coastal plain with the exception of the Sandhills region. To the east, the Cretaceous dips underneath the Castle Hayne. Toward the west, it rises near the surface, covered only by the surficial deposits. Water cannot move as easily in the Cretaceous as it does in the Castle Hayne, but the Cretaceous aquifer is very thick, allowing deep and productive wells. Water from the Cretaceous is generally soft and slightly alkaline, requiring no treatment for most uses (Huffman, 1996).

2.5 WETLANDS

Wetlands in the Cape Fear Study Area primarily consist of managed pinelands, riverine swamp forests, pocosins, pine flats (including drained), salt/brackish marsh, freshwater marsh, and bottomland hardwood wetlands (Table 21, Figure 25). Over 40 percent of the Cape Fear Study Area is mapped as wetlands by the North Carolina Coastal Region Evaluation of Wetland Significance (NC-CREWS) assessment. NC-CREWS is a watershed-based wetlands functional assessment model performed by the North Carolina Division of Coastal Management (DCM) that uses GIS software and data to assess the level of water quality, wildlife habitat, and hydrologic functions of individual wetlands (NCDCM, 2003a). Definitions of each of the major wetland types in the Cape Fear Study Area were obtained from the NC-CREWS database and are as follows:

Managed Pineland

Seasonally saturated, managed pine forests (usually loblolly pine) occurring on hydric soils. This wetland category can also contain non-managed pine forests occurring on hydric soils. Generally these are areas that were not shown on National Wetlands Inventory maps. These areas may or may not be jurisdictional wetlands. Because this category is based primarily on soils data and 30-meter resolution satellite imagery, it is less accurate than the other wetland categories. The primary criteria for mapping these areas are hydric soils and a satellite imagery classification of pine forest.

Bottomland Hardwood and Riverine Swamp Forest

Riverine forested or occasionally scrub/shrub communities usually occurring in floodplains, that are semi-permanently to seasonally flooded. In bottomland hardwood systems, typical species include oaks (overcup, water, laurel, and swamp chestnut), sweet gum, green ash, cottonwoods, willows, river birch, and occasionally pines. In swamp forest systems, typical species include cypress, black gum, water tupelo, green ash and red maple.

Pocosin

Palustrine scrub/shrub communities (i.e., non-estuarine scrub/shrub) dominated by evergreen shrubs, often mixed with pond or loblolly pines. Typically occur on saturated, acid, nutrient poor, sandy or peaty soils; usually removed from large streams; and subject to periodic burning.

Pine Flat

Palustrine, seasonally saturated pine communities on hydric soils that can become quite dry for part of the year. Generally occur in flat or nearly flat areas that are not associated with a river or stream system. Pine flats are usually dominated by loblolly pine. This category does not include managed pine systems.

Salt/Brackish Marsh

Any salt marsh or other marsh subject to regular or occasional flooding by tides, including wind tides (whether or not the tide waters reach the marshland areas through natural or artificial watercourses), as long as this flooding does not include hurricane or tropical storm waters. Plant species include smooth cordgrass, black needlerush, glasswort, salt grass, sea lavender, salt marsh bullrush, saw grass, cattail, salt meadow cordgrass, and big cordgrass. Marshes in this category are also called Coastal Marshes.

Freshwater Marsh

Herbaceous areas that are flooded for extended periods during the growing season. Included are marshes within lacustrine systems, managed impoundments, some Carolina Bays, and other nontidal marshes (i.e., marshes that do not fall into the salt/brackish marsh category). Typical communities include species of sedges, millets, rushes, and grasses that are not specified in the coastal wetland regulations. Also included are giant cane, arrowhead, pickerelweed, arrow arum, smartweed, and cattail.

Table 21. NC-CREWS Wetland Types in the Cape Fear Study Area

Wetland Type	Area (km^2)	Percent of Cape Fear Study Area
Managed Pineland	202.28	12.54%
Riverine Swamp Forest	142.25	8.82%
Pocosin	55.49	3.44%
Pine Flat	54.93	3.41%
Drained Pine Flat	38.92	2.41%
Salt/Brackish Marsh	38.85	2.41%
Freshwater Marsh	34.57	2.14%
Bottomland Hardwood	19.98	1.24%
All Other Wetland Types[1]	68.25	4.23%

Note:

[1] Includes wetland types covering less than 1 percent of the Cape Fear Study Area

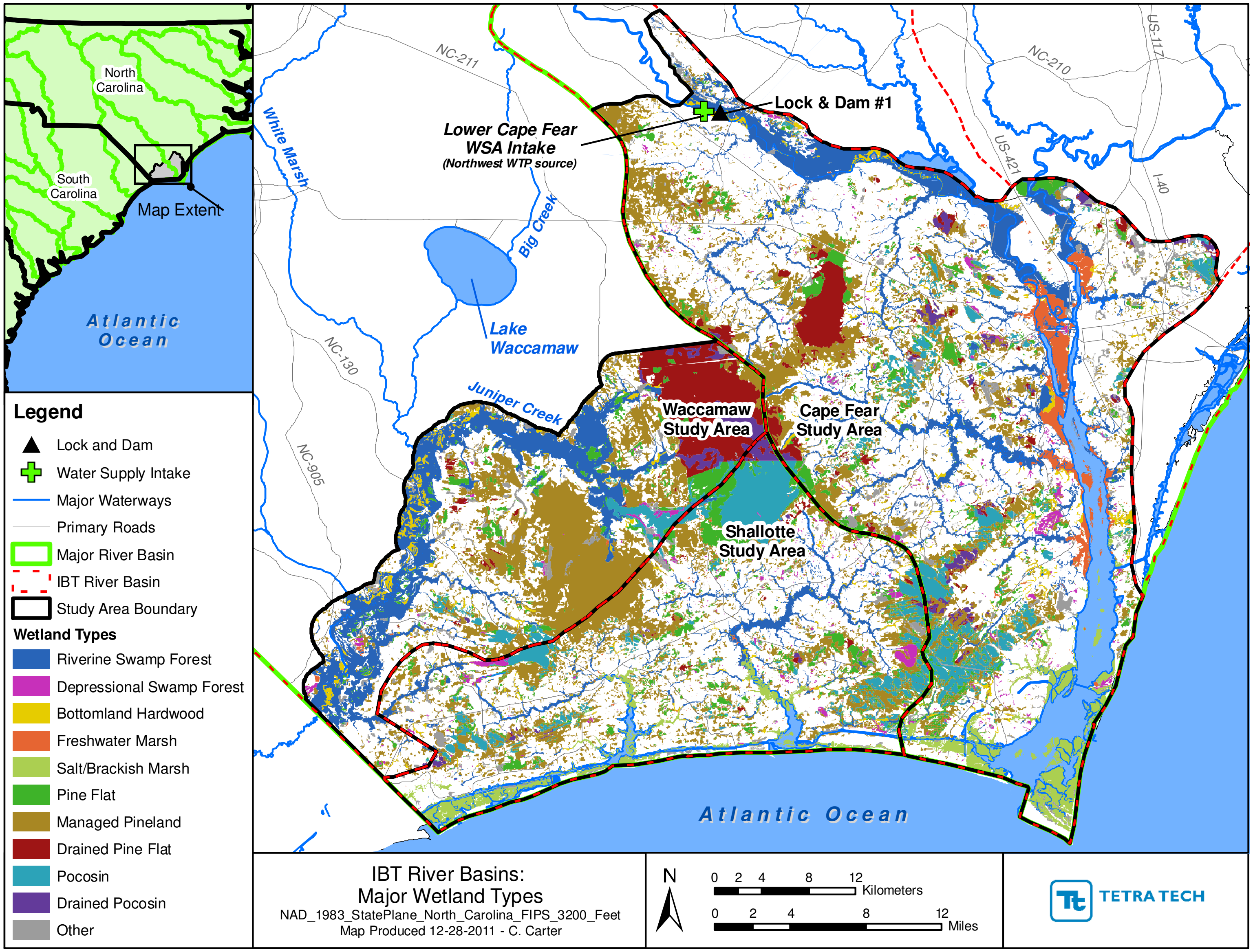

Figure 25. Wetland Types in the IBT River Basins Study Area

2.5.1 Wetland Function

The primary objective of the NC-CREWS wetland functional assessment is to provide information about the relative ecological importance of wetlands for use in planning and the overall management of wetlands (NCDCM, 2003b). NC-CREWS evaluates three main wetland functions: water quality, wildlife habitat, and hydrology functions and provides an overall wetland rating for wetlands on the basis of each wetland's ability and opportunity to provide the listed functions. NC-CREWS uses three relative rating scores to rate assessed wetlands: beneficial significance, substantial significance, and exceptional significance. Of the wetlands assessed in the Cape Fear Study Area, over 35 percent received a rating of exceptional functional significance (totaling 14 percent of the area), over 61 percent received a rating of substantial functional significance (totaling 25 percent of the area), and 1.5 percent received a rating of beneficial functional significance (totaling almost 1 percent of the area). Less than 2 percent of the area wetlands were unable to be evaluated (Table 22, Figure 26). A brief description of each significance level was obtained from the NC-CREWS documentation and is provided below.

Table 22. Wetland Significance Rating for Wetlands in the Cape Fear Study Area

Wetland Rating	Area (km^2)	Percent of Cape Fear Study Area	Percent of Wetlands Assessed
Exceptional Functional Significance	229.16	14.21%	35.19%
Substantial Functional Significance	403.50	25.01%	61.96%
Beneficial Functional Significance	9.69	0.60%	1.49%
Unable to Evaluate	8.87	0.55%	1.36%

Exceptional Functional Significance

A wetland is rated exceptional for its overall functional significance when it performs water quality, hydrologic and/or wildlife habitat functions at well above normal levels. Specifically, a wetland is rated exceptional when any two of the primary wetland functions (water quality, hydrology, and habitat) are rated exceptional. Salt or Brackish marshes, estuarine scrub-shrub wetlands; estuarine forested wetlands; unique natural ecosystems or special wildlife habitat areas, wetlands adjacent to primary nursery areas, and wetlands that contain threatened or endangered species are also rated exceptional.

Substantial Functional Significance

A wetland is rated substantial when the wetland performs the three primary wetland functions at normal or slightly above normal levels. A wetland is also rated substantial if it is a buffer to a wetland rated exceptional.

Beneficial Functional Significance

A wetland is rated beneficial when it performs the three primary wetland functions at below normal levels or, in some cases, not at all. Although most wetlands perform a variety of wetland functions, all wetlands do not provide all functions. A wetland is rated beneficial when any two of the primary wetland functions are rated low and none are rated high. Some jurisdictional wetlands might not perform some functions because of degradation or alteration, but might provide other functions at below normal levels.

Unable to Evaluate

Potential wetland areas that are not rated in the NC-CREWS model because satellite imagery indicates that they have been recently altered. Most of these areas were forested wetlands in 1988 but have been cleared according to 1994 satellite imagery.

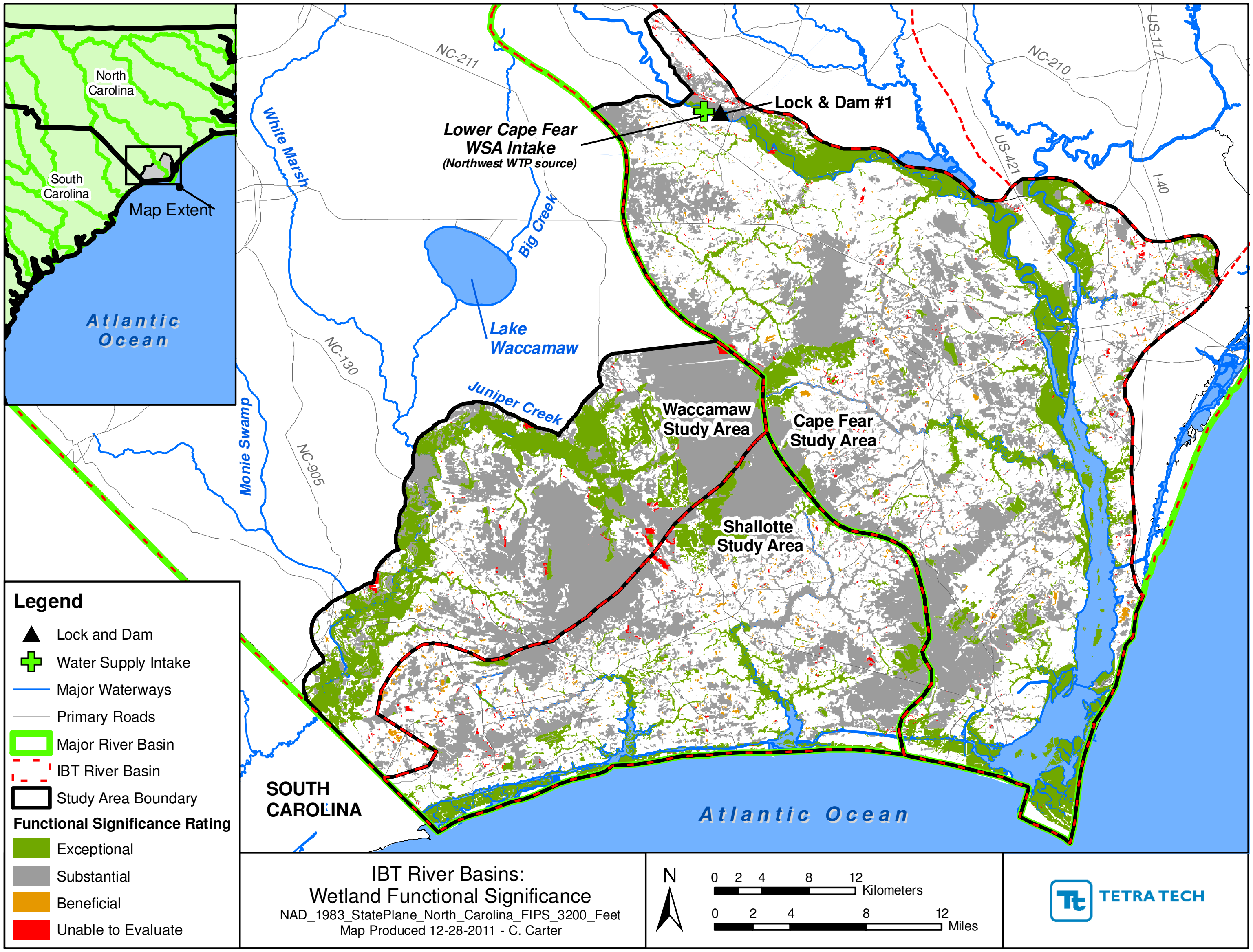

Figure 26. Wetland Functional Significance for Wetlands in the IBT River Basins Study Area

2.6 AQUATIC AND WILDLIFE HABITAT AND RESOURCES

2.6.1 Significant Natural Heritage Areas

The North Carolina Department of Environment and Natural Resources, Division of Parks and Recreation, Natural Heritage Program (NHP) in cooperation with the North Carolina Center for Geographic Information and Analysis (NCCGIA), developed the Significant Natural Heritage Areas (SNHAs) digital data to determine the areas containing ecologically significant natural communities or rare species (NCDENR, 2011b).

Just over 25 percent of the Cape Fear Study Area has been identified as SNHA (Figure 27). The NHP has assigned a level of significance to SNHA on the basis of national, state, regional, or county significance. The Cape Fear Study Area has 9 sites that are SNHA and identified as areas of national significance. These sites total approximately 7 percent of the Cape Fear Study Area and include Bald Head Island, Battery Island, Boiling Spring Lakes Wetland Complex, the Green Swamp, MOTSU Governors Creek Natural Area, Northeast Cape Fear River Floodplain, Orton Pond Aquatic Habitat, Town Creek Aquatic Habitat, and Town Creek Marshes and Swamp (Table 23).

Twenty-three sites were identified as areas of state significance and occupy approximately 14 percent of the Cape Fear Study Area (Table 23). Eighteen sites were identified as areas of regional significance and currently occupy approximately 4 percent of the area, and eight sites were identified as areas of county significance and occupy less than 1 percent of the area.

Table 23. SNHAs in the Cape Fear Study Area

Significance	Site Name
National (6.8% of Cape Fear Study Area)	Bald Head Island, Battery Island, Boiling Spring Lakes Wetland Complex, Green Swamp, MOTSU Governors Creek Natural Area, Northeast Cape Fear River Floodplain, Orton Pond Aquatic Habitat, Town Creek Aquatic Habitat, Town Creek Marshes and Swamp
State (13.7% of Cape Fear Study Area)	421 Sand Ridge, Battle Royal Bay, Bluff Island and East Beach, Boiling Spring Lakes Limesink Complex, Brunswick River/Cape Fear River Marshes, Bryant Mill (Greenbank) Bluff, Carolina Beach State Park, Hog Branch Ponds, Hood Creek Floodplain and Slopes, Lower Black River Swamp, Lower Cape Fear River Aquatic Habitat, Lower Cape Fear River Bird Nesting Islands, MOTSU Buffer Zone Natural Area, MOTSU Northwest Natural Area, MOTSU Three Ponds Natural Area, Natmore Sandhills, Orton Sandhills and Limesinks, Pleasant Oaks/Goose Landing Plantations, Pretty Pond Limesink Complex, Southport Ferry Landing Forest, Upper Smith Creek Natural Area, White Spring Ponds Complex, Zekes Island Estuarine Sanctuary
Regional (4.5% of Cape Fear Study Area)	Alligator Branch Sandhill and Flatwoods, Blue Pond/Allen Creek, Cape Fear River Lowlands, Clarendon Plantation Limesinks, Coast Guard Loran Station Natural Area, Doctor Point Hammocks, Fort Caswell Dunes and Marshes, Fort Fisher State Recreation Area, Funston Bays, Goose Pond Limesinks, Lords Creek Natural Area, Middle Island, Neils Eddy Landing, Rabontown Limesinks, Rattlesnake Branch Sandhills, South Wilmington Sandhills, Sturgeon Creek Tidal Wetlands, Winnabow Savanna and Sandhill
County (0.3% of Cape Fear Study Area)	Barnards Creek, Greenfield Lake, Henrytown Savanna, Little Green Swamp, MOTSU Brunswick Forest Natural Area, Mott Creek Natural Area, Orton Powerline Loosestrife Site, Turkey Branch Sandhill

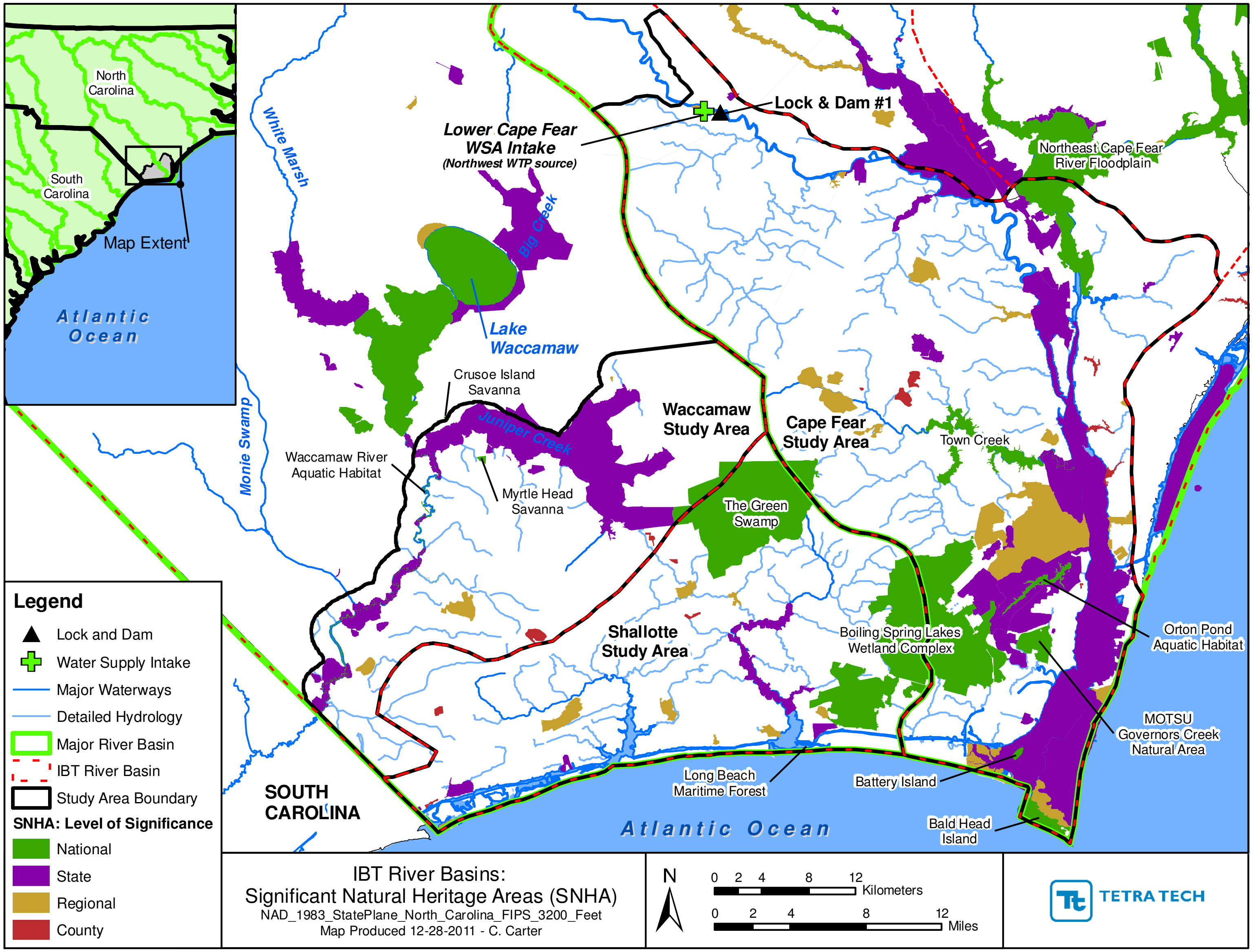

Figure 27. SNHAs in the IBT River Basins Study Area (Sites with National Level of Significance are Labeled)

2.6.2 Wildlife Habitat and Resources

The Cape Fear River forms the major riverine drainage outlet for eastern Brunswick County and the Cape Fear Study Area. Along the river is a mosaic of alluvial-influenced plant communities, such as levee and terrace forests, rich mesic slope forests, floodplain hardwood swamps, and cypress swamps. The banks of the southern section of the river are composed of brackish and saltwater marshes (Boyle et al. 2007).

On a larger scale, ecological systems have been identified and defined nationwide through the LANDFIRE mapping project. LANDFIRE is supported by the USDA Forest Service Office of Fire and Aviation Management, the U.S. Department of Interior Office of Wildland Fire Coordination, and The Nature Conservancy. The LANDFIRE data set provides an estimation of existing vegetation types (EVT) that represent the distribution of the terrestrial ecological systems classification developed by NatureServe for the western hemisphere. A terrestrial ecological system is defined as a group of plant community types (associations) that tend to co-occur within landscapes with similar ecological processes, substrates, or environmental gradients. EVTs are mapped in LANDFIRE using decision tree models, field reference data, Landsat imagery, digital elevation model data, and biophysical gradient data. The LANDFIRE data set used to analyze the Cape Fear Study Area was completed in 2011 and includes the analysis of images dated from 1999 to 2008 (USGS, 2010).

Ten dominant EVTs occur in the Cape Fear Study Area that were not developed or agricultural lands, each covering greater than 1 percent of the Cape Fear Study Area and in all covering approximately 68 percent of the area (Figure 28). Each of the 10 dominant EVTs are described below using information provided by NatureServe (NatureServe, 2007).

Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods. Covers 21 percent of the Cape Fear Study Area. This system occurs on wet mineral soil sites. Landforms include low areas in relict beach ridge systems; eolian sand deposits; and poorly drained clayey, loamy, or sandy flats. They occasionally occur on river terraces above flood levels. Soils range from clayey to sandy, with no accumulated organic surface layer. Soils are seasonally saturated, because of high water table or poor soil drainage. The unifying feature of this system is wet mineral soils associated with a high frequency of fire. Vegetation is a set of associations that are naturally woodlands or savannas dominated by longleaf pine (*P. palustris)* or, less frequently, by pond pine (*P. serotina)*, slash pine (*P. elliottii)*, or some combination. Hardwoods are present in any abundance only in examples altered by fire suppression. The ground cover is a dense combination of herbs and low shrubs. Frequent fire is the predominant natural force in this system and is crucial in determining its structure and even its identity. Communities naturally burned every few years, many averaging as often as every 3 years. Many plants have their flowering triggered by burning. Without fire, the shrubs increase and hardwoods can invade the system. Herb layer density and diversity decline after just a couple of years without fire.

In this system, areas where ponds are embedded in savannas or flatwoods are particularly important for reptiles, such as the mimic glass lizard (*Ophisaurus mimicus*) and the pigmy rattlesnake (*Sistrurus miliarius*) both of which are state species of concern, and amphibians, such as the significantly rare Mabee's salamander (*Ambystoma mabeei*), oak toad (*Bufo quercicus*), and ornate chorus frog (*Pseudacris ornata*), the state-threatened eastern tiger salamander (*A. tigrinum*), Carolina gopher frog (*Rana capito*), and the dwarf salamander (*Eurycea quadridigitata*) a species of special concern. The federally endangered red-cockaded woodpecker (*Picoides borealis*) also uses the sparse overstory and open midstory habitat provided by this system (NCWRC, 2011).

Managed Tree Plantation-Southeast Conifer and Hardwood Plantation Group. Covers 17 percent of the Cape Fear Study Area. Managed pine plantations that are densely planted. Most planted stands are loblolly pine (*P. taeda*), but slash (*P. elliottii*) and longleaf (*P. palustris*) pine also occur.

Gulf and Atlantic Coastal Plain Floodplain Systems. Covers 8 percent of the Cape Fear Study Area. This systems group comprises floodplain forests. It includes broad gradients of river size, soil nutrient levels, and flood frequency. Flooding ranges from semipermanent in the wettest areas to intermittent and short on the higher portions of the floodplain. Vegetation generally includes forests dominated by bottomland hardwood species and other trees tolerant of flooding. Some of the most typical and characteristic tree species found in stands of this systems group include bald cypress (*Taxodium distichum),* water tupelo (*N. aquatic),* silver maple (*A. saccharinum),* American sycamore (*Platanus occidentalis),* cottonwood (*Populus deltoids),* boxelder (*A. negundo),* and black willow (*S. nigra).* Other trees could include red maple (*A. rubrum var. rubrum),* Drummond's maple (*A. rubrum var. drummondii),* river birch (*Betula nigra),* water hickory (*Carya aquatic),* pecan (*Carya illinoinensis),* sugarberry (*Celtis laevigata),* Carolina ash *(Fraxinus caroliniana),* green ash (*Fraxinus pennsylvanica),* honeylocust (*Gleditsia triacanthos),* sweetgum *(L. styraciflua),* swamp tupelo (*N. biflora),* Ogeechee tupelo *(N. ogeche),* oaks (*Q. laurifolia, Q. lyrata, Q. michauxii, Q. nigra, Q. pagoda, Q. phellos, Q. similis, Q. texana, Q. virginiana),* black willow (*S. nigra),* American elm (*Ulmus Americana),* and cedar elm (*U. crassifolia)*. When flooded, these systems can have a substantial aquatic faunal component, with high densities of invertebrates, and can play an important role in the life cycle of fish in the associated river. Unusually long or deep floods can stress vegetation or act as a disturbance for some species. Larger floods cause local disturbance by scouring and depositing sediment along channels and occasionally causing channel shifts. Except for primary successional communities such as bars, most forests exist naturally as multi-aged old-growth forests driven by gap-phase regeneration. Windthrow is probably the most important cause of gaps. Fire is not believed to be important because of low flammability of much of the vegetation, wetness, and abundance of natural firebreaks.

Floodplain systems provide habitat for several priority species for conservation. Among them are state-threatened Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) and eastern woodrat (*Neotoma floridana*), significantly rare species such as the northern yellow bat (*Lasiurus intermedius*) and Mabee's salamander (*A. mabeei*), and species of state special concern such as the star-nosed mole (*Condylura cristata*), southeastern bat (*Myotis austroriparius*), dwarf salamander (*E. quadridigitata*), four-toed salamander (*Hemidactylium scutatum*), and the timber rattlesnake (*Crotalus horridus*) (NCWRC, 2011).

Gulf and Atlantic Coastal Plain Small Stream Riparian Systems. Covers 5 percent of the Cape Fear Study Area. This systems group encompasses the floodplains of small streams. Compared to larger river systems, flooding tends to be variable and of shorter duration. These landscapes usually encompass a variety of habitats resulting from natural hydrological spatial patterns (i.e., meander scars, sloughs, gravel bars, old depressions, and/or oxbows are present). Most of the communities are temporarily flooded, with the possible addition of smaller-scale seasonally flooded features such as beaver-created herbaceous wetlands and shrub-dominated features. The vegetation generally consists almost entirely of forests of wetland trees, but occasional, small shrubby or herbaceous sloughs can also be present. Examples of these systems include a number of different plant communities, each with distinctive floristic compositions. Wetter examples might be strongly dominated by bald cypress (*T. distichum)* and swamp tupelo (*N. biflora)*. Except in the very wet examples, subcanopy, shrub, and herb layers are generally well developed and woody vines are also prominent. Flooding is an important ecological factor in these systems and can be the most important factor separating them from adjacent systems. Flooding brings nutrients and excludes non-flood-tolerant species. Most of these forests exist naturally as multi-aged, old-growth forests driven by gap-phase regeneration. Windthrow is probably the most important cause of gaps. Fire is probably more important than in larger river systems because distances to uplands are short and because stream channels and sloughs are smaller and less effective as firebreaks. However, most of the vegetation is not very flammable and usually will not carry fire.

Herbaceous Wetlands. Covers 5 percent of the Cape Fear Study Area. In the Cape Fear Study Area, this system primarily includes tidal marshes but also contains maritime grasslands and fresh water emergent wetlands. The tidal marshes are fresh and brackish tidal marshes, with dominant vegetation of cord grass (*Spartina* spp.), wild rice (*Zizania*), sawgrass (*Cladium*), and needlerush (*Juncus roemerianus*). Maritime grasslands are a dune grass community consisting of sea oats (*Uniola paniculata*) and beach grasses.

Fresh water emergent wetlands are wetlands with emergent vegetation in fresh water seepage bogs, ponds and riverbeds. Dominant vegetation in freshwater emergent wetlands are sedges (*Carex spp.*), eelgrass (*Vallisneria* sp.), and cane (*Arundinaria gigantea spp. tecta*) found in unforested canebrakes.

Endangered or threatened sea turtles and diamond-backed terrapins (*Malaclemys terrapin*) depend on habitats provided by the tidal marsh systems. Tidal marshes provide some of the most important habitats for large numbers and types of immediate coastal wildlife that are federally or state listed, or are experiencing precipitous population declines (NCWRC, 2011).

Southern Atlantic Coastal Plain Mesic Hardwood Forest. Covers 4 percent of the Cape Fear Study Area. This is an upland system occurring in a variety of moist but non-wetland sites that are naturally sheltered from frequent fire. Soil textures are variable in both texture and pH. The vegetation consists of forests dominated by combinations of trees that include a significant component of mesophytic deciduous hardwood species, such as American beech (*Fagus grandifolia)* or southern sugar maple (*A. barbatum)*. Upland and bottomland oaks at the mid-range of moisture tolerance are usually also present, particularly white oak (*Q. alba)*, but sometimes other oaks (*Q. pagoda, Q. falcata, Q. michauxii, Q. shumardii*, or *Q. nigra)*. Loblolly pine (*P. taeda)* is sometimes present, but it is unclear if it is a natural component or has entered only as a result of past cutting. Understories are usually well-developed. Shrub and herb layers could be sparse or moderately dense. Within its range, dwarf palmetto (*Sabal minor)* could be a prominent shrub. Species richness can be fairly high in basic sites but is fairly low otherwise. Fire is naturally infrequent to absent in this system. If fire does penetrate, it is likely to be low in intensity but can have significant ecological effects.

Atlantic Coastal Plain Peatland Pocosin and Canebrake. Covers 3 percent of the Cape Fear Study Area. This system includes wetlands of organic soils, occurring on broad flats or gentle basins. Under current conditions, the vegetation is predominantly dense shrubland and very shrubby open woodlands. A characteristic suite of primarily evergreen shrubs, greenbriars, and pond pine (*P. serotina*) dominates. These shrubs include inkberry (*Ilex glabra),* fetterbush lyonia (*Lyonia lucida),* piedmont staggerbush (*Lyonia mariana),* titi (*Cyrilla racemiflora),* large gallberry (*I. coriacea)*, and honeycup (*Zenobia pulverulenta)*, along with laurel greenbrier (*Smilax laurifolia)*. Pond pine (*P. serotina)* is the characteristic tree, along with loblolly bay (*Gordonia lasianthus),* sweetbay (*Magnolia virginiana)*, and swamp bay (*Persea palustris)*. Herbs are scarce and largely limited to small open patches. Under pre-European settlement fire regimes, stands of canebrakes (*Arundinaria gigantea ssp. tecta)* would have been more common and extensive. Soil saturation, sheet flow, and peat depth create a distinct zonation, with the highest stature woody vegetation on the edges and lowest in the center. Catastrophic fires are important in this system, naturally occurring at moderate frequency. Fires generally kill all aboveground vegetation in large patches, creating a shifting mosaic. Vegetation structure and biomass recover rapidly in most of the burned areas, primarily by sprouting.

Priority animal species associated with pocosin habitat are the red-cockaded woodpecker, star-nosed mole, southern bog lemming (*Synaptomys cooperi helaletes*), and oak toad (NCWRC, 2011).

Atlantic Coastal Plain Upland Longleaf Pine Woodland. Covers 2 percent of the Cape Fear Study Area. This is a system of upland longleaf pine (*P. palustris)*-dominated vegetation. Examples and associations share the common feature of upland (non-wetland) moisture regimes and natural exposure to frequent fire. They occur on a variety of well- to excessively drained soils and on the higher parts of upland-wetland mosaics. The vegetation is naturally dominated by longleaf pine (*P. palustris)*. Most associations have an understory of scrub oaks. The herb layer is generally well-developed and dominated by grasses. Pineland threeawn (*Aristida stricta)* primarily dominates in the northern part of its range, and Beyrich threeawn (*A. beyrichiana)* in the southern part. Frequent, low-intensity fire is the dominant natural ecological force.

Dry longleaf pine woodlands offer habitat suitable for several priority species such as the red-cockaded woodpecker, eastern fox squirrel (*Sciurus niger*), eastern tiger salamander, oak toad, ornate chorus frog, carolina gopher frog, eastern diamondback rattlesnake (*C. adamanteus*), timber rattlesnake, southern hog-nosed snake (*Heterodon simus*), eastern coachwhip (*Masticophis flagellum*), eastern coral snake (*Micrurus fulvis*), northern pinesnake (*Pituophis melanoleucus*), and pigmy rattlesnake (*Sistrurus miliarius*). All these species are listed as state species of special concern, significantly rare, threatened, or endangered; the red-cockaded woodpecker is a federally endangered species (NCWRC, 2011).

Southern Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest. Covers 1 percent of the Cape Fear Study Area. This system encompasses oak-dominated forests of somewhat fire-sheltered dry to dry-mesic sites generally on upper to midslopes in bluff systems, but occasionally it occurs on broader uplands or on the highest parts of non-flooded river terraces. Soils are generally acidic. Vegetation consists of forests dominated by combinations of upland oaks, particularly white oak (*Q. alba),* southern red oak (*Q. falcata)*, and post oak (*Q. stellate)*. Hickories (*Carya* spp.) are also prominent (including *Carya alba, Carya glabra, and Carya pallida).* Other woody plants can include Carolina basswood (*Tilia americana var. caroliniana),* southern sugar maple (*A. barbatum),* red buckeye (*Aesculus pavia),* devilwood (*Osmanthus americanus var. americanus),* inkberry (*I. glabra),* American holly (*I. opaca),* farkleberry (*Vaccinium arboretum),* Elliott's blueberry (*Vaccinium elliottii)*, and coastal sweetpepperbush (*Clethra alnifolia)*. Sites where this system occurs are somewhat protected from most natural fires by some combination of steeper topography, isolation from the spread of fire, and limited flammability of the vegetation. If fires were more frequent, the vegetation would likely be replaced by more fire-tolerant southern pines, especially longleaf pine (*P. palustris)*.

Priority mammals, amphibians, and reptiles of conservation concern that use habitat provided by this system are the eastern fox squirrel, four-toed salamander, and timber rattlesnake (NCWRC, 2011).

Gulf and Atlantic Coastal Plain Swamp Systems. Covers 1 percent of the Cape Fear Study Area. This systems group consists of poorly drained, organic or mineral soil flats and basins. These areas are saturated by rainfall and seasonal high water tables. Most are not associated with river floodplains, although one component system is a tidal swamp. Dominant tree species vary with geography. South of Virginia, bald cypress (*T. distichum)* and tupelo (*Nyssa* spp.) are the most characteristic trees in many of these swamps. Tidal wooded swamps from Virginia to Florida are dominated by cypress (*Taxodium),* tupelo (*Nyssa)*, or ash (*Fraxinus)*. Important wetland oaks throughout much of the range include swamp chestnut oak (*Q. michauxii),* cherrybark oak (*Q. pagoda),* willow oak (*Q. phellos)*, and laurel oak (*Q. laurifolia)*.

Priority mammals and reptiles of conservation concern that use habitat provided by this system are the American alligator (*Alligator mississippiensis*), a federally threatened species, and the star-nosed mole (NCWRC, 2011).

Additional EVTs found within the Cape Fear Study Area that were not on developed, mined, or agricultural lands are as follows: Southern Atlantic Coastal Plain Maritime Forest, Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest, Central Atlantic Coastal Plain Maritime Forest, Atlantic Coastal Plain Fall-line Sandhills Longleaf Pine Woodland, Gulf and Atlantic Coastal Plain Tidal Marsh Systems, Atlantic Coastal Plain Streamhead Seepage Swamp-Pocosin-Baygall, Southern Coastal Plain Mesic Slope Forest, Southern Atlantic Coastal Plain Dune and Maritime Grassland, and Southern Atlantic Coastal Plain Wet Pine Savanna and Flatwoods.

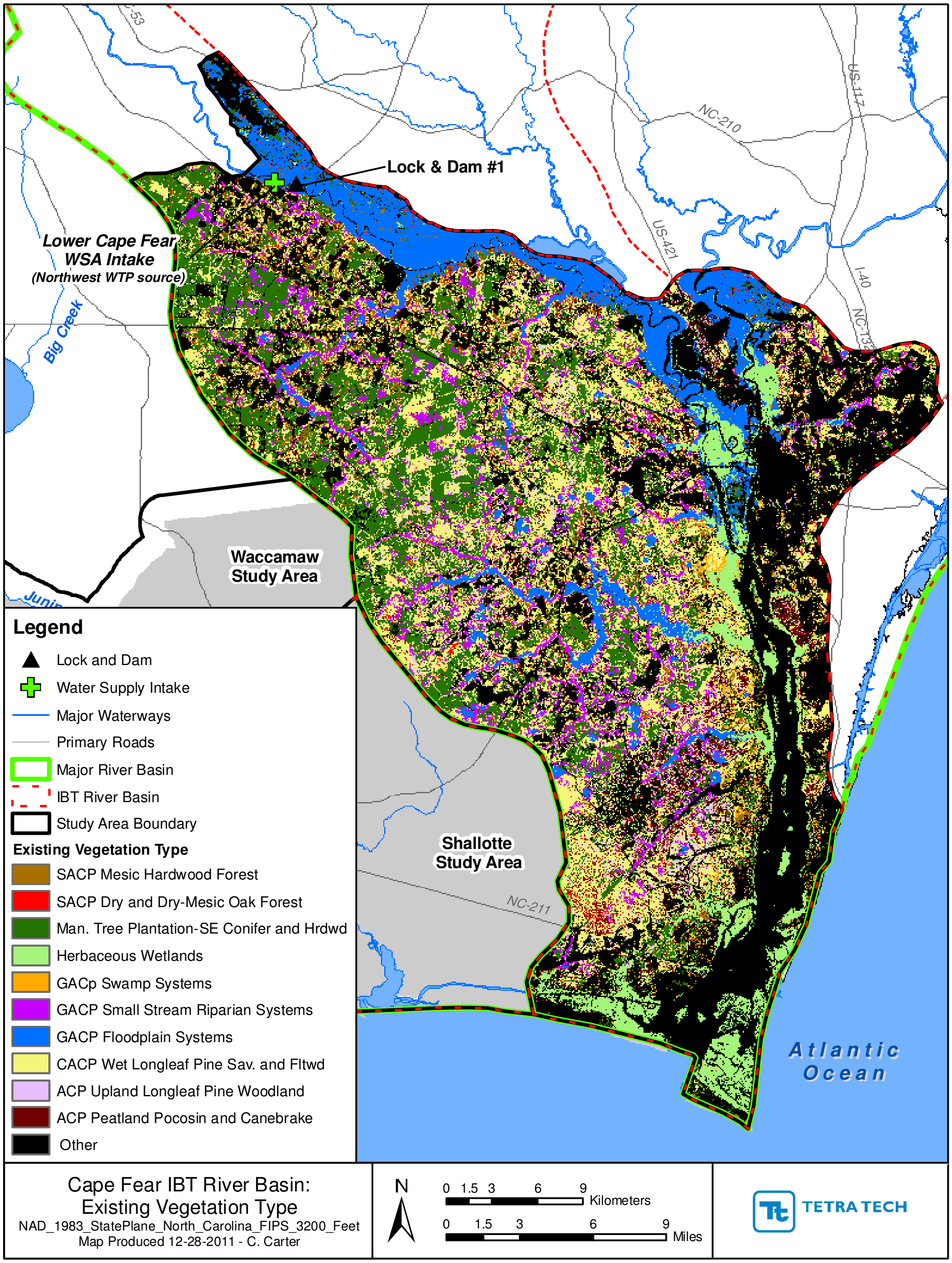

Figure 28. Existing Vegetation Types in the Cape Fear Study Area

2.6.3 Important Bird Areas

The Important Bird Areas (IBA) program is a global effort to identify and conserve areas that are vital to birds and other biodiversity. In the United States, the IBA program is administered by the National Audubon Society. IBAs are sites that provide essential habitat for one or more species of bird and include sites for breeding, wintering, and/or migrating birds (National Audubon Society, 2011).

In the Cape Fear Study Area, 7 IBAs have been identified (National Audubon Society, 2011) (Figure 29). Three of these are of global significance (G) and four are of state significance (S). IBAs of global significance provide habitat for species of global conservation concern; IBAs of state significance provide habitat for species of state conservation concern. All IBAs in the Cape Fear Study Area are islands in the lower Cape Fear River. Near the mouth of the Cape Fear River are Bald Head and Smith Islands (G), Battery Island (G), and Striking Island (S). Farther upstream and south of Wilmington are Eagles Island (S), Ferry Slip Island (G), and North (S) and South (S) Pelican Islands.

The following is a summary habitat and species characteristic of each IBA in the Cape Fear Study Area (National Audubon Society, 2011):

Bald Head and Middle Islands on the east bank of the lower Cape Fear River have well-developed maritime forest and are among the best examples of this habitat type in North Carolina. The site also has a spectacular tidal creek and marsh system. The diversity of habitats at this site supports a great diversity of bird life throughout the year. The site supports the state’s largest population of breeding painted buntings. Thousands of shorebirds (19 species) stopover during migration and winter in the area, using the extensive tidal flats, marshes, and beach. The area supports the state’s largest wintering population of common goldeneyes (10–20 birds).

Battery Island is a natural island guarding the mouth of the Cape Fear River. Wading birds gather to nest in the red cedars (*Juniperus virginiana*), yaupon (*I. vomitoria*), and other shrubs. Battery Island supports North Carolina’s largest colony of wading birds, which include approximately 10 percent of North America’s white ibises. The riverside beachfront is prime nesting habitat for American oystercatchers, and the grassy uplands support nesting willets.

Striking Island is a natural marsh island in the lower Cape Fear River south of Wilmington. The site consists primarily of intertidal and high saltmarsh with small islands of upland washed oyster shell banks, shrubs and grassy areas. Striking Island is an important foraging site for wading birds from the nearby Battery Island. The site supports nesting laughing gulls, American oystercatchers, willets and clapper rails.

Eagles Island is a large expanse of brackish marsh and swamp forest between the Brunswick and Cape Fear Rivers near Wilmington. The southern half of the island is brackish marsh with diked, dredged-material disposal impoundments. The impoundments support shorebirds, waterfowl, and waterbirds. The site supports great numbers and a great diversity of shorebirds during migration. The most numerous shorebirds include semipalmated sandpiper, least sandpiper, short-billed dowitcher, greater yellowlegs and lesser yellowlegs. It is a breeding site for black-necked stilts. The site is a good area for winter sparrows and nesting anhingas, painted buntings and tree swallows. Large numbers of bobolink, mixed flocks of red-winged blackbirds, and grackles roost in the marsh during winter migration.

Ferry Slip Island is an artificial, undiked, dredged-material island in the lower Cape Fear River south of Wilmington. The island provides excellent habitat for a variety of waterbird species, and nesting American oystercatchers and supports a large colony of royal and sandwich terns and a small colony of laughing gulls. The island also supports a significant colony of brown pelicans.

North Pelican Island comprises several islands, in the lower Cape Fear River, south of Wilmington. Shrub thickets on the islands support nesting wading birds and brown pelicans and laughing gulls. Nine species of wading birds nest on the site. The upland areas of the islands are surrounded by contiguous high and low saltmarsh. Marsh wrens nest in the marsh, along with clapper rails. Several pairs of willets and American oystercatchers also breed on the site.

South Pelican Island is a dredged-sand island in the lower Cape Fear River south of Wilmington. The island has been a haven for nesting pelicans, gulls and terns for more than two decades. South Pelican Island, together with Ferry Slip Island, are the most important nesting sites for royal and sandwich terns in southeastern North Carolina. The site supports the largest colony of brown pelicans in southeastern North Carolina.

In all, the lower Cape Fear River supports the state's largest group of great cormorants. Peregrine falcons are common during fall migration. Least Terns, black skimmers, willets, Wilson's plovers and American oystercatchers nest on area beaches. Saltmarsh sharp-tailed sparrows, seaside sparrows and clapper rails are abundant in area marshes. Raptors, especially peregrines, merlins, kestrels and Sharp-shins are regular visitors during migration.

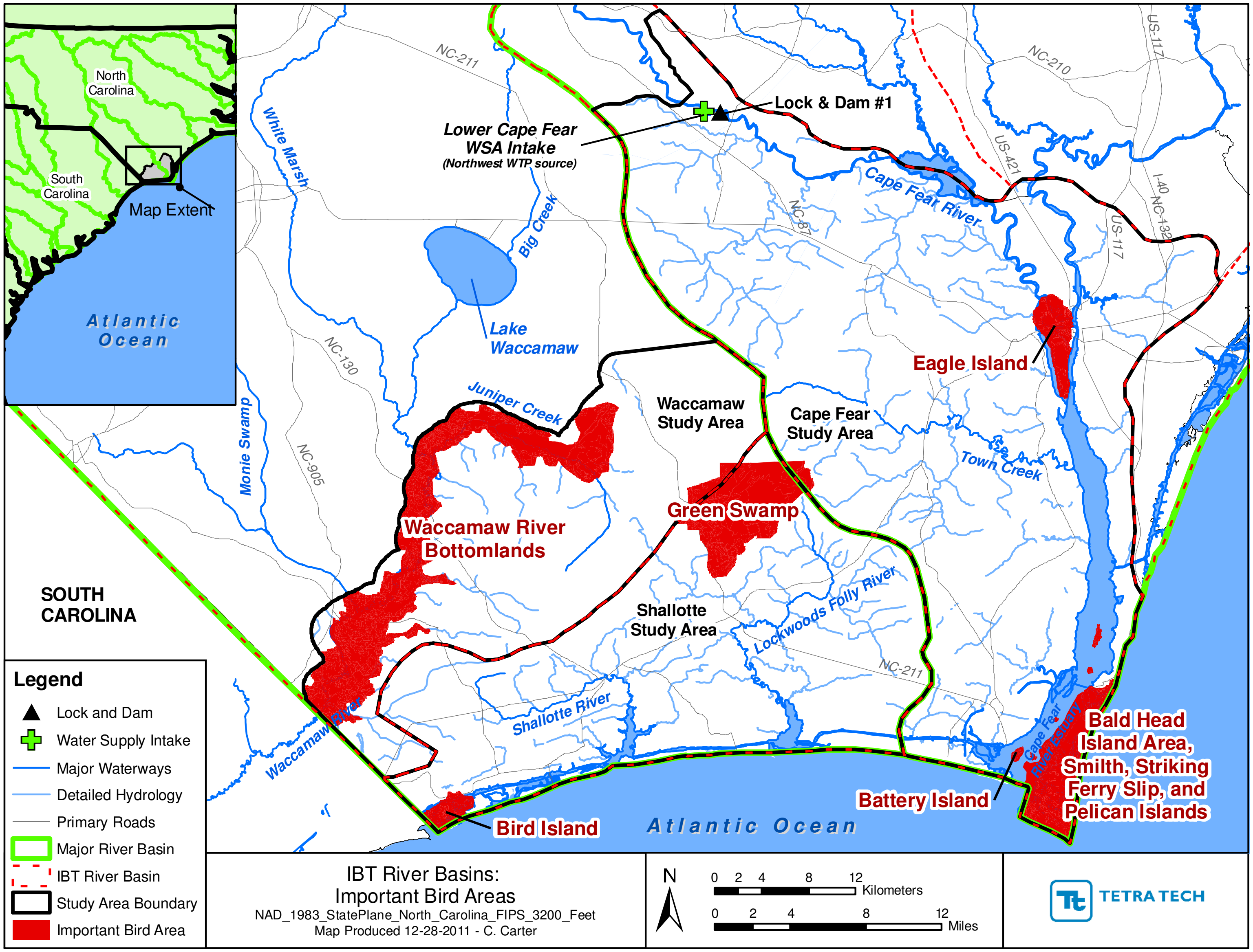

Figure 29. IBAs in the IBT River Basin Study Areas

2.6.4 Aquatic Habitat and Resources

The Cape Fear River and its tributaries in the Cape Fear Study Area have low-gradient sand sandy substrata. Dominant fishes in these waters are the longnose gar (*Lepisosteus osseus*), American eel (*Anguilla rostrata*), shad (*Alosa* and *Dorosoma* spp.), carp (*Cyprinus carpio*), golden shiner (*Notemigonus crysoleucas*), ironcolor shiner (*Notropis chalybaeus*), silver redhorse (*Moxostoma collapsum*), creek chubsucker (*Erimyzon oblongus*), channel catfish (*Ictalurus punctatus*), bullheads (*Ameiurus* spp.), pirate perch (*Aphredoderus sayanus*), Atlantic needlefish (*Strongylura marina*), mosquitofish (*Gambusia affinis*), white perch (*Morone americana*), striped bass (*M. saxatilis*), sunfishes (*Lepomis* spp.), largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), tessellated darter (*Etheostoma olmstedi*), and yellow perch (*Perca flavescens*) (Marotti, 2011).

The lower reach of the Cape Fear River, an important SNHA, is brackish and supports numerous rare marine fishes, including the endangered shortnose sturgeon (*Acipenser brevirostrum*), and freckled blennies (*Hypsoblennius ionthas*), marked gobies (*Gobionellus stigmaticus*), spinycheek sleepers (*Eleotris pisonis*), and opossum pipefish (*Microphis brachyurus*). The endangered manatee (*Trichechus manatus*) is an occasional visitor, especially in summer (NCDWQ, 2005).

Town Creek, a nationally significant site, is a short creek that flows eastward in eastern Brunswick County and empties into the Cape Fear River. Despite its short length, it contains the only known population of the Greenfield ramshorn snail (*Helisoma eucosmium*), a globally rare and imperiled mollusk, and several other rare animals and plants (NCDWQ, 2005).

In the Cape Fear Study Area, the Cape Fear River, Northeast Cape Fear River, Town Creek, Sturgeon Creek (and its tributary, Mill Creek), Indian Creek, Hood Creek, Liliput Creek, Mallory Creek, Little Mallory Creek, and Livignston Creek are anadramous fish spawning areas (One NC Naturally, 2011) (Figure 30).

In the Cape Fear Study Area, the following areas are designated fish nursery areas: Cape Fear River, Northeast Cape Fear River, tributaries to Walden Creek (Governor's Creek, Nancy's Creek, White Spring Creek, and Nigis Creek), the Intercoastal Waterway, and tidal creeks such as Deep Creek, Cape Creek, Bald Head Creek, Dutchman Creek, Molasses Creek, Denis Creek, Jump and Run Creek, Gulf Gully Creek, Beaverdam Creek, and Polly Gully Creek (Figure 31). Past and present sampling indicates that these areas support a high abundance and diversity of juvenile fish species (One NC Naturally, 2011).

Shellfish Growing Areas (SGAs) open for shellfish harvesting in the Cape Fear Study Area include waters on the east bank near the mouth of the Cape Fear River and Bald Head Island Area, including Bay Creek, Deep Creek, and Cape Creek (NCDEH-SSB, 2011), all other SGAs in waters of the lower Cape Fear River and select tributaries, the Northeast Cape Fear River, Town Creek, and the Intercoastal Waterway and associated tidal creeks are closed for harvesting because of the extent of contamination of waters in each SGA. Of the areas closed for harvesting, Fishing Creek and Bald Head Creek in the Bald Head Island Area and Elizabeth River in the Southport Area are closed only conditionally and could be reopened if water quality in these areas is improved (NCDEH-SSB, 2011) (Figure 32).

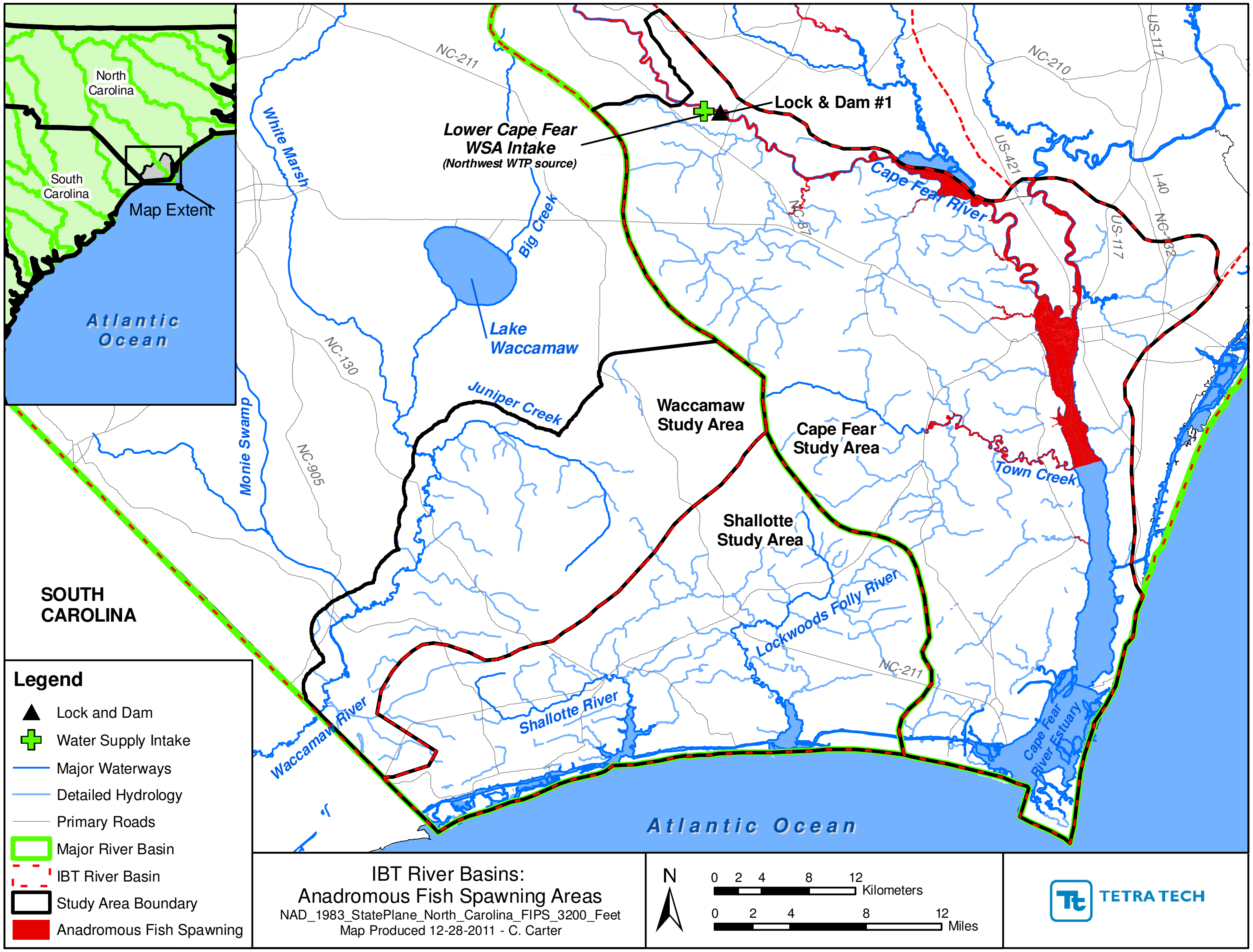

Figure 30. Anadromous Fish Spawning Areas in the IBT River Basins Study Area

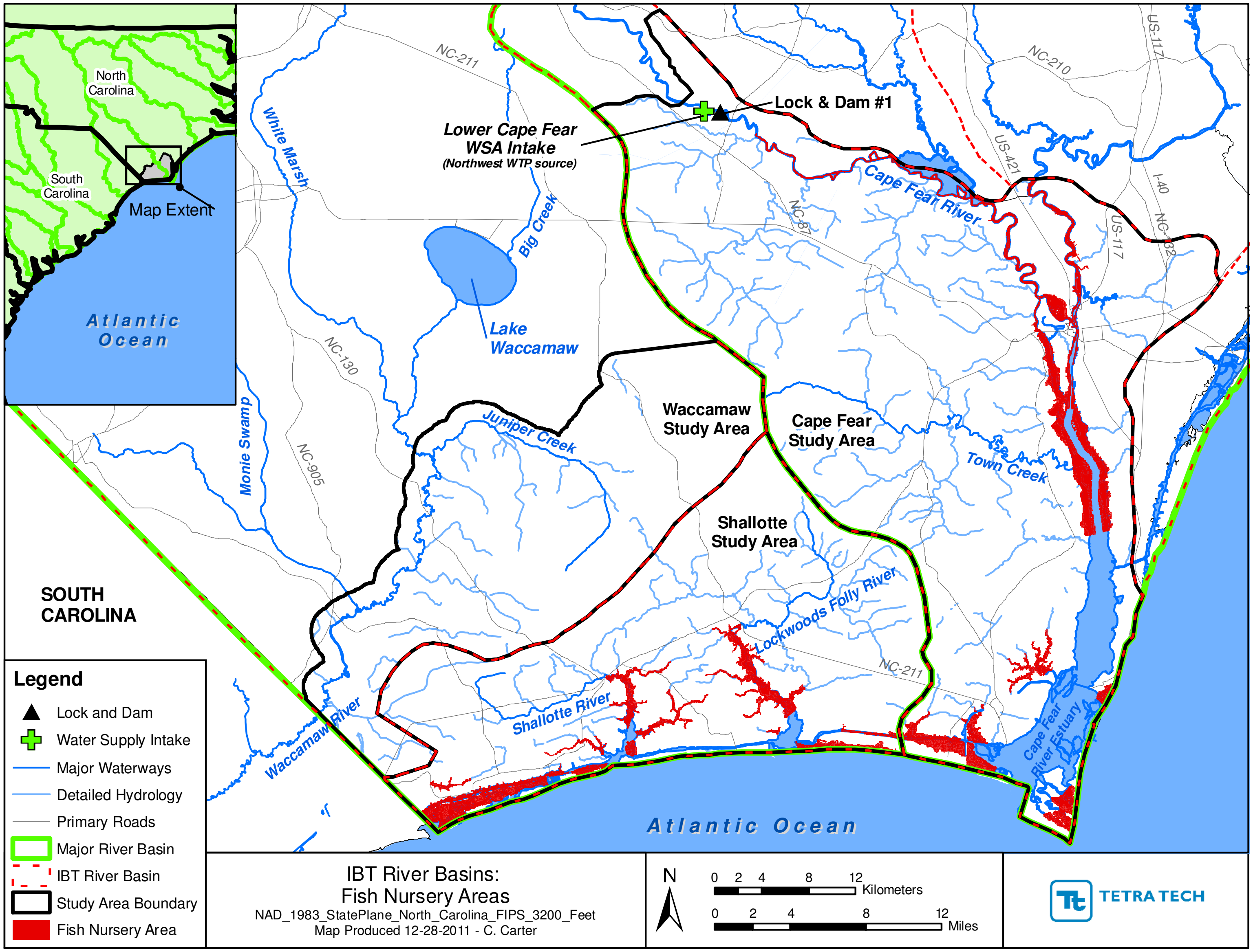

Figure 31. Fish Nursery Areas in the IBT River Basins Study Area

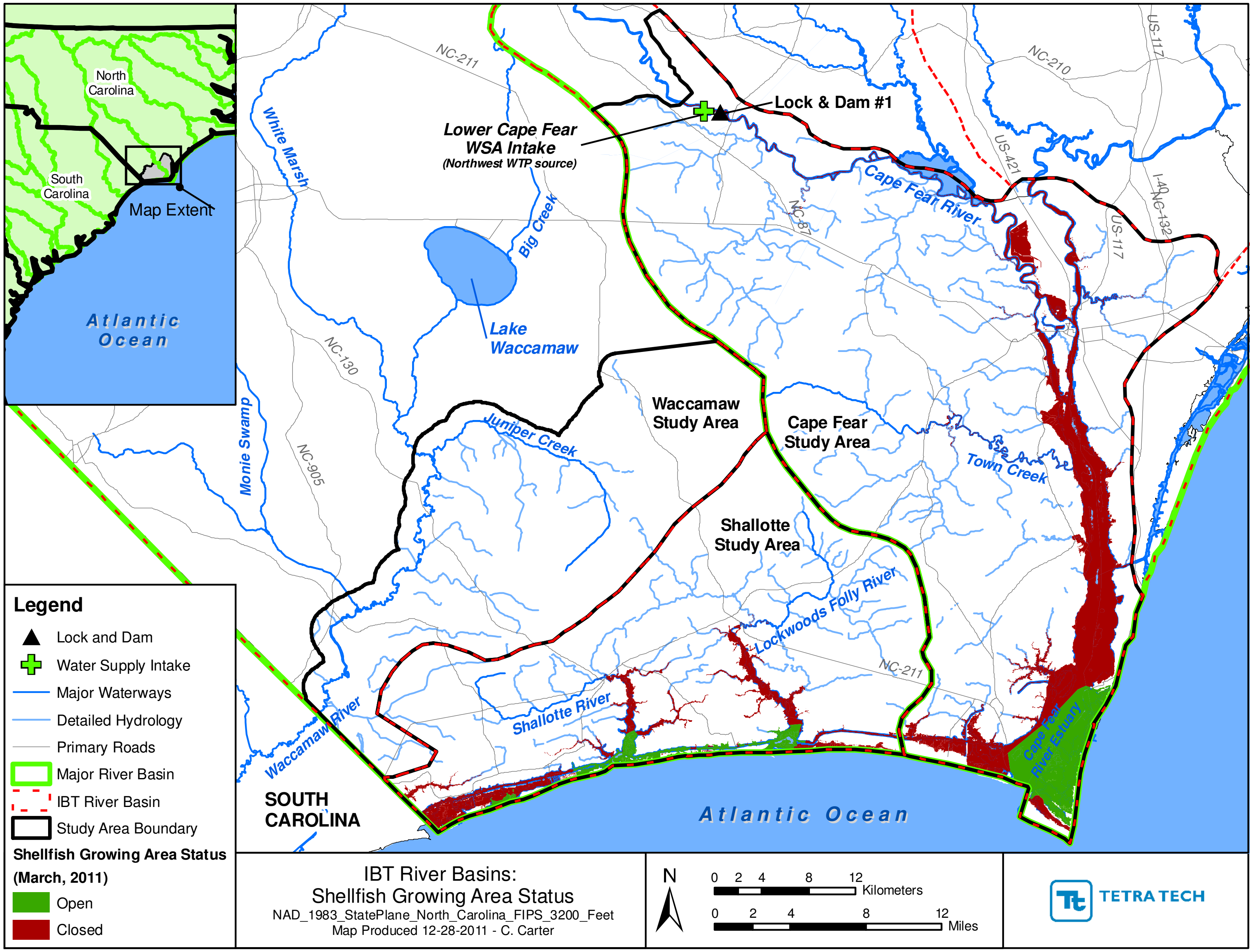

Figure 32. SGAs in the IBT River Basins Study Area

2.6.5 Rare and Protected Species

The Cape Fear Study Area boundary includes sections of five counties: Brunswick, New Hanover, Columbus, Bladen, and Pender. In these counties, several species are protected at the state or federal level. North Carolina NHP's Biotic Database (NCNHP, 2011) lists all protected species. In the study area are 28 invertebrate animals, 1 nonvascular plant, 157 vascular plants, and 54 vertebrate animals. A complete list of state and federally protected species in counties of the study area is in Appendix H.

2.7 AIR QUALITY

The North Carolina Division of Air Quality (DAQ) monitors compliance with the National Ambient Air Quality Standards. Two air quality monitoring sites are in New Hanover County. One site monitors sulfur dioxide levels, and the other monitors ozone levels and particulate matter. Table 24 provides the latest data from these two monitoring locations compared to the state and federal air quality standards. New Hanover County was found to exceed the newly established air quality standard (June 2010) for sulfur dioxide by 47 percent. As a result, DAQ submitted a New Hanover Nonattainment Boundary recommendation to the U.S. Environmental Protection Agency (EPA) in June of 2011. The boundary is in the northwest portion of New Hanover County (NCDAQ, 2011).

Both New Hanover and Brunswick counties require emissions testing (OBD) and safety inspections for all cars and light-duty trucks (NCDAQ, 2008).

Table 24. North Carolina Air Quality Standards and Average Monitoring Values for New Hanover County

Air Pollutant	North Carolina Air Quality Standard (and Period of Average)		Average Value	Year Range
Ozone (O_3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years	0.075 ppm	0.061 ppm	2008-2010
Sulfur Dioxide (SO_2)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years	75 ppb	110 ppb	2008-2010[1]
Particulate Matter - 2.5 microns	annual standard: annual mean, averaged over 3 years	15.0 µg/m^3	9.7 µg/m^3	2006-2008[2]
	daily standard: 98th percentile, averaged over 3 years	35 µg/m^3	25 µg/m^3	2006-2008[2]

Notes:

[1] For the year range of 2008–2010, New Hanover County was found to exceed the air quality standard established for sulfur dioxide by 47 percent. EPA issued the new primary National Ambient Air Quality Standard for sulfur dioxide on June 2, 2010

[2] The year range of 2006–2008 was the most recent range in which three consecutive years of data were available for particulate matter in New Hanover County.

2.8 NOISE LEVELS

Noise is subject to the federal Noise Control Act of 1972 (PL-92-574) and Quiet Communities Act of 1978 (PL-95-6009), which require standards of compliance and recommend approaches to abatement for stationary noise sources such as airports, highways, and industrial facilities. In the Cape Fear Study Area, developed and undeveloped areas exhibit day-to-day normal noise conditions.

3 Existing Environmental Characteristics: Shallotte IBT River Basin

The Shallotte IBT River Basin is entirely within the County and will be referred to as *Shallotte Study Area* in this section (see Figure 15 at the beginning of Section 2).

3.1 TOPOGRAPHY, GEOLOGY, AND FLOODPLAINS

The Shallotte Study Area is in the Inner and Outer Coastal Plain physiographic provinces, which are characterized by gently rolling hills and valleys at higher elevations and flat, poorly drained areas near the coast (NCGS, 2004). Elevations in the Shallotte Study Area range from sea level near the coast and outlets of the Shallotte and Lockwoods Folly rivers to 83 feet above mean sea level in the northern part of the Shallotte Study Area.

The underlying geology of the Shallotte Study Area consists of formations from the Tertiary, Cretaceous, and Quaternary periods. These formations include the Waccamaw Formation from the Tertiary period; the Peedee Formation from the Cretaceous period; and surficial deposits, undivided, from the Quaternary period. These formations are characterized by loosely consolidated sedimentary rock composed of materials such as silt, sand, gravel, clay, limestone, and peat that were alluvial deposits or marine sediments deposited by the ocean.

Portions of the Shallotte Study Area are in the FEMA 100- and 500-year floodplains. These areas are mainly associated with the Shallotte and Lockwoods Folly rivers and their tributaries, and areas associated with the Green Swamp.

3.2 SOILS

3.2.1 Soil Series

County soil survey data for the County was retrieved from USDA's NRCS (NRCS, 2011a). Although 36 soil series are in the Shallotte Study Area, 50 percent of the area is composed of only 7 major soil series: Leon, Baymeade, Murville, Torhunta, Goldsboro, Croatan, and Lynchburg soils (Table 25; Figure 33).

Table 25. Soil Series in the Shallotte Study Area

Series Name	Percent of Shallotte Study Area
Leon	11.6%
Baymeade	9.8%
Murville	8.6%
Torhunta	6.5%
Goldsboro	6.3%
Croatan	6.2%
Lynchburg	5.2%

Series Name	Percent of Shallotte Study Area
All Other Soil Series	45.8%

Five of the seven major soil series in the Shallotte Study Area are described in Section 2.2.1. The remaining two soils series are described below according to information obtained from the USDA's NRCS Official Soil Series Descriptions database (NRCS, 2011b).

Croatan

The Croatan series consists of very poorly drained, organic soils that formed in highly decomposed organic material underlain by loamy textured marine and fluvial sediment. The organic material was derived from herbaceous plants. Slopes are 0 to 2 percent. Runoff is very slow to ponded, and permeability is slow to moderately rapid (it is moderate in organic layers and moderate or moderately slow in mineral layers.). Except when drained, Croatan soils are saturated for 8 to 10 months of the year.

Vegetation on Croatan series consists of scattered pond pine with a dense understory of titi, gallberry, huckleberry, southern bayberry, greenbrier, sphagnum moss, redbay, sweetbay, switchcane, and giant cane. Croatan soils also support mixed hardwoods, mainly water and swamp tupelo, southern baldcypress, Atlantic white-cedar, and other hyperphytic species. Cultivated areas are used as pasture or have corn, soybeans, small grain, and vegetable crops.

Lynchburg

The Lynchburg series consists of somewhat poorly drained soils that formed from marine or fluvial sediments and generally occur on marine terraces or flats. Slopes are 0 to 5 percent. Runoff is negligible, and permeability is moderate. Depth to the seasonal high water table is 6 to 18 inches from November to April.

Where Lynchburg soils have not been cultivated for cropland (corn, soybeans, cotton, tobacco, truck crops, small grains) or pasture, the remainder is in forest where the dominant vegetation is oak, sweetgum, blackgum, longleaf pine, slash pine, loblolly pine, and an understory of gallberry and pineland threeawn.

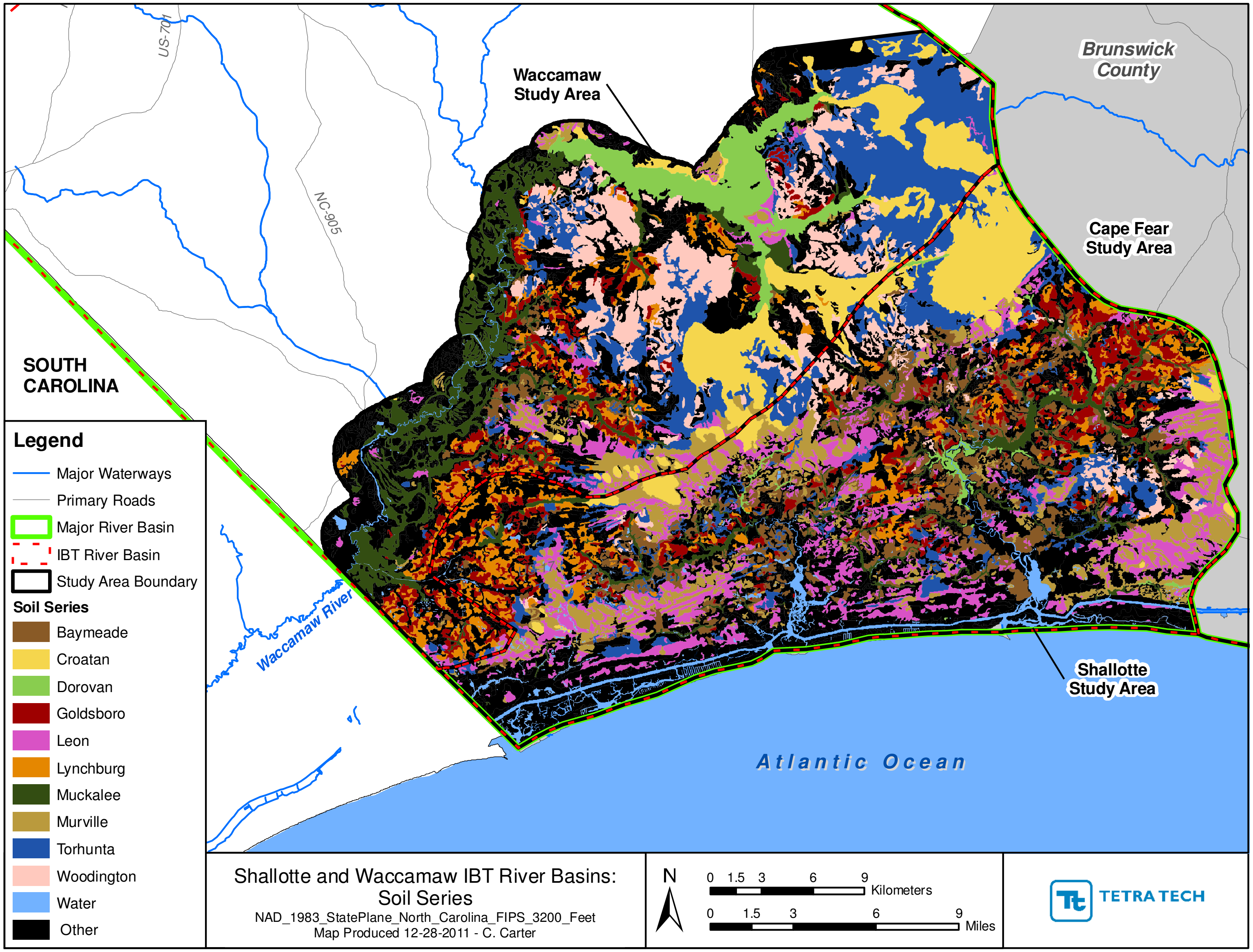

Figure 33. Soil Series in the Shallotte and Waccamaw Study Areas

3.2.2 Hydrologic Soil Groups

Soil survey data retrieved from USDA NRCS (NRCS, 2011a) provides soil series assignments to specific HSG. Twenty-three percent of the Shallotte Study Area is composed of Group A soils, 20 percent is composed of Group B/D soils, and 19 percent is composed of Group B soils (Table 26, Figure 17). This translates to over 60 percent of the total Shallotte Study Area being composed of soils that have either low runoff potential with high-infiltration rates (Group A) or moderate infiltration rates when thoroughly wetted (Group B) or in drained conditions (Group B/D). These soil groups consist chiefly of deep, well- to excessively drained sands or gravels and have a high rate of water transmission (Group A) or of moderately deep to deep, moderately well- to well-drained soils with moderately fine to moderately coarse textures (Group B) (NRCS, 2011a).

Table 26. HSG for Shallotte Study Area

HSG	Percent of Shallotte Study Area
A	22.5%
B/D	19.5%
B	18.8%
C	11.9%
A/D	9.0%
D	8.9%
C/D	6.2%
Not Classified	3.1%

3.3 LAND USE

3.3.1 Existing Land Use

Land use in the Shallotte Study Area (Table 27, Figure 18) consists of forested lands (63 percent), lands developed for low-, medium-, and high-density residential purposes (totaling 17 percent), agricultural lands and open fields used for crops primarily consisting of corn, soybeans, and tobacco (7 percent), lands covered by water and wetlands (5 percent), transportation (4 percent), recreational uses (3 percent), lands developed for commercial, educational, institutional, and industrial purposes (1 percent), lands used for communications and utilities (< 1 percent), and mining and extraction (< 1 percent).

Table 27. Land Use for the Shallotte Study Area

Land Use Group	Area (km^2)	Percent of Shallotte Study Area
Forest	473.21	62.72%
Low-Density Residential	125.45	16.63%
Agricultural Land/Open Field	50.56	6.70%
Water/Wetlands	35.94	4.76%
Transportation	30.40	4.03%
Recreation	22.57	2.99%
Developed Land	8.73	1.16%
Communications & Utilities	4.21	0.56%
High-Density Residential	1.36	0.18%
Mining & Extraction	1.32	0.17%
Medium-Density Residential	0.74	0.10%

3.3.2 Future Land Use

Future land uses for the Shallotte Study Area, created as a result of the Brunswick County CAMA Core Land Use Plan (Holland Consulting Planners, Inc., 2007a) and additional CAMA Core Land Use Plans for municipalities that did not participate in Brunswick County's Future Land Use classification are listed in Table 28 and displayed in Figure 19. The three most prevalent categories are low-density residential (49 percent), medium-density residential (17 percent), and conservation (12 percent). Low- and medium-density residential areas are designated for agricultural uses (low density only), single-family residences, multifamily residences in certain cases, single-wide and double-wide manufactured homes, emergency shelters, parks, and places of worship. The conservation designation is intended to be used for the permanent protection and preservation of environmentally sensitive lands and areas with historical, cultural, and archeological significance (Holland Consulting Planners, Inc., 2007a). The future land use projections are focused on land use rather than land cover, thus it is reasonable to expect that lower density residential areas would contain natural land covers of forest, wetlands, and water.

Table 28. Future Land Use in the Shallotte Study Area

Future Land Use	Area (km^2)[1]	Percent of Study Area
Low Density Residential	367.88	48.76%
Medium Density Residential	126.50	16.77%
Conservation	88.98	11.79%

Future Land Use	Area (km²)[1]	Percent of Study Area
Protected Lands	49.15	6.51%
Commercial	36.66	4.86%
Mixed Use	14.43	1.91%
High Density Residential	14.09	1.87%
Industrial	12.06	1.60%
Recreation	10.53	1.40%
Right-of-Way	3.91	0.52%
Community Commercial	1.82	0.24%
Government/Airport	1.38	0.18%

Note:

[1] Some municipalities of the Shallotte Study Area within the County were not included in the Brunswick County Future Land Use classification. Future land use data for these areas were obtained from the following municipalities and were added to the Brunswick County Future Land Use classification: Varnamtown (Holland Consulting Planners, Inc., 2006), Calabash (Cape Fear COG, 2006), Sunset Beach (Cape Fear COG, 2010), Shallotte (Holland Consulting Planners, Inc., 2007c), and Oak Island (Town of Oak Island, 2009). Future land use data is not currently available for Bolivia, Ocean Isle Beach, or Holden Beach.

3.3.3 Forest Resources

Forest groups identified by the USDA Forest Service – FIA Program and RSAC (USFS, 2008) cover approximately 74 percent of the total land area in the Shallotte Study Area and are composed of 5 dominant forest groupings (Figure 20). The loblolly-shortleaf pine group is most prevalent, covering approximately 56 percent of the Shallotte Study Area; this forest group is described in Section 0.

The next most prevalent forest group in the Shallotte Study Area is the oak-pine group, covering approximately 11 percent of the Shallotte Study Area. Forests in this group can be dominated by post oak and blackjack oak in very dry settings but include various pine species in disturbed sites. This forest group includes sites that might have been longleaf pine stands at one time but without fire have regenerated into closed canopy mixed hardwood/pine stands with crowded midstory development and low understory species diversity (NCWRC, 2011).

The longleaf-slash pine group covers approximately 9 percent of the Shallotte Study Area. These are forests in which longleaf or slash pine, singly or in combination, constitute a plurality of the stocking and common associates include oak, hickory, and gum. Additional forest groups in the Shallotte Study Area are the oak-hickory and the oak-gum-cypress groups, covering approximately 5 and 3 percent of the Shallotte Study Area, respectively.

3.3.4 Prime and Unique Agricultural Land

Nine percent of the Shallotte Study Area has soils that are identified as prime farmland and an additional 21 percent of the Shallotte Study Area includes soils identified as prime farmland if they were to be drained (Table 29, Figure 21). Prime farmland soils, as defined by the USDA, are soils that are best suited for producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops (Barnhill, 1986).

Twelve percent of the Shallotte Study Area has soils that are farmlands of unique importance. Soils that have a special set of properties that are unique for producing certain high-value crops meet the requirements for unique farmland.

Fifteen percent of the Shallotte Study Area has soils that are farmlands of statewide importance. In general, soils that do not meet the requirements of prime farmlands fall into this category, and they are classified as having statewide importance using criteria established specifically for North Carolina.

Approximately 281 km^2 of prime farmland, unique importance farmland, or farmland of statewide importance are in the Shallotte Study Area. According to the existing land use data for the County, approximately 74 km^2 (equal to 26 percent) of this farmland is already developed as either general developed areas; transportation areas; communications/utility areas; or high-, medium-, or low density residential areas.

Table 29. Farmland Classification for Farmed Areas in the Shallotte IBT River Basin Study Area

Farmland Classification	Area (km^2)	Percent of Shallotte Study Area
Not prime farmland	336	43%
Prime farmland if drained	160	21%
Farmland of statewide importance	119	15%
Farmland of unique importance	90	12%
All areas are prime farmland	72	9%

3.3.5 Public Lands and Scenic, Recreational, and State Natural Areas

LMCOS in the Shallotte Study Area are owned by several entities such as the state, land trusts, The Nature Conservancy, municipalities, and counties (Figure 22). Table 30 provides a list of all LMCOS in the Shallotte Study Area. Since the LMCOS data layer was created in 2002, additional data layers depicting state owned lands and land trusts, created in 2010 and 2008, respectively, were used to provide an account of most recent land ownerships (NCDOA, 2010; The Conservation Fund, 2008). No federally owned lands are in the Shallotte Study Area.

The Green Swamp Preserve is a black bear sanctuary owned and managed by The Nature Conservancy. The Green Swamp alone makes up approximately 6 percent of the Shallotte Study Area. The Green Swamp contains some of the country’s finest examples of longleaf pine savannas. The open savannas have a diverse herb layer with many orchids and insectivorous plants. Almost 13,000 acres of the preserve, however, are composed of a dense evergreen shrub bog (pocosin) dominated by gallberry, titi, and sweetbay (TNC, 2011b).

Table 30. LMCOS in the Shallotte Study Area

Owner Type	Name	Owner/Management	Total Area in Shallotte Study Area (km^2)	Percent of Shallotte Study Area
Conservation group	Green Swamp Preserve (Black Bear Sanctuary)	The Nature Conservancy	48.62	6.25%
State	Atlantic Intercoastal Waterway, Atlantic Intercoastal Waterway-Davis Creek, ENR Estuarine Preserve, Sunset Harbor Access - Lockwood Folly, State Government Center, Boiling Springs Lakes Preserve, Shallotte National Guard Armory, Vacant (Joseph Brooks), Brunswick County Visitor Center, Brunswick County Forestry Headquarters, and Ocean Isle Beach Boating Access Area	North Carolina (Administration, Environment and Natural Resources, Wildlife Resources Commission, Coastal Management, Transportation, Forest Service)	12.63	1.62%
Land trust	Bird Island, Lockwood Folly - Hewett	North Carolina Coastal Land Trust	12.42	1.60%
Municipality	Middleton Park and others	Municipalities of Long Beach and Oak Island	0.16	< 1%
County	Lockwood Folly Township Park and Shallotte Township District Park	Brunswick County	0.14	< 1%
Other nonprofit	Permanent Easement	North Carolina Agricultural Foundation	0.12	< 1%

Rivers identified as National Wild and Scenic Rivers that are under federal protection are not in the Shallotte Study Area. Public trust waters are navigable waters open for public uses such as fishing and navigation; these waters are common and widespread throughout the Shallotte Study Area.

3.3.6 Areas of Archaeological or Historical Value

No known areas of archaeological or historic significance are in the Shallotte Study Area.

3.4 Surface and Groundwater Resources

3.4.1 Drainage Basins and Surface Water Supplies

The Shallotte Study Area is in the Lumber River Basin. It contains a small system of coastal rivers that empty into the Atlantic Ocean. The significant majority of the Shallotte Study Area is in the Long Bay Subbasin, in USGS Hydrological Unit 03040208. This subbasin is mainly in the poorly drained flatwoods ecoregion of the Coastal Plain but also has barrier islands, coastal marshes, and swampy peat lands (NCDWQ, 2010b)

3.4.2 Surface Water Use Classifications

All surface waters in North Carolina are assigned a primary classification by NCDWQ. Classifications of major waterbodies are displayed in Figure 34 and described below.

The Intercoastal Waterway, mouth of the Shallotte River, mouth of Lockwoods Folly River, Saucepen Creek, and Calabash River are classified as SA and HQW waters. SA waters are tidal salt waters that are used for commercial shellfishing or marketing purposes. All SA waters are also HQW by supplemental classification. HQW is a supplemental classification intended to protect waters that are rated excellent on the basis of biological and physical/chemical characteristics through DWQ monitoring or special studies, primary nursery areas designated by the Marine Fisheries Commission, and other functional nursery areas designated by the Marine Fisheries Commission.

Upstream sections of the mainstem of both the Shallotte River and the Lockwoods Folly River are classified as SC and HQW waters. SC classification is for tidal salt waters protected for secondary recreation such as fishing, boating, and other activities involving minimal skin contact; fish and noncommercial shellfish consumption; aquatic life propagation and survival; and wildlife.

Tributaries throughout the Shallotte Study Area and Cawcaw Swamp are generally classified as either C; SW, HQW waters or C and Sw waters. Class C is for waters protected for uses such as secondary recreation, fishing, wildlife, fish consumption, aquatic life, and agriculture.

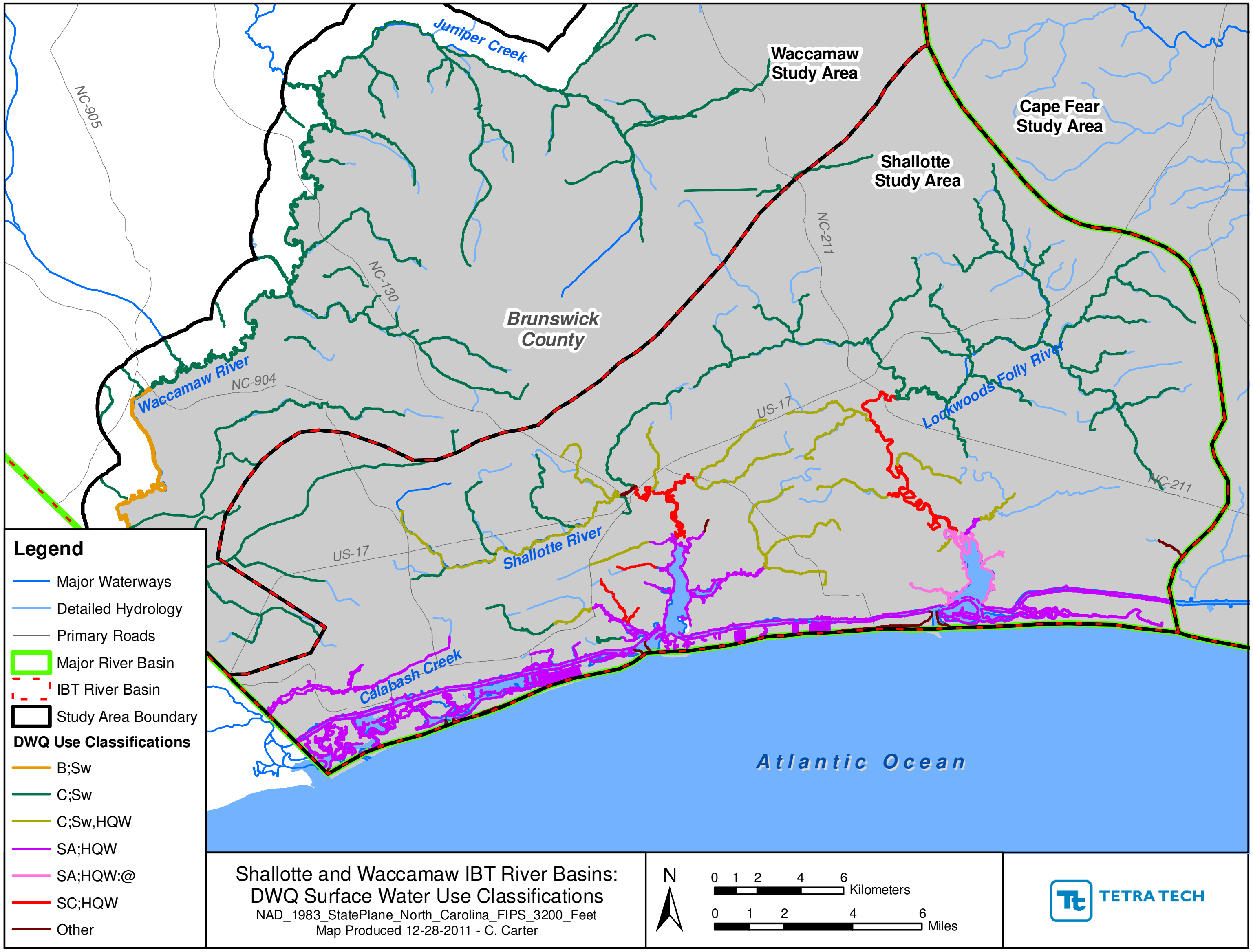

Figure 34. DWQ Surface Water Use Classifications for the Shallotte and Waccamaw Study Areas

3.4.3 Existing Surface Water Quality

DWQ's 2010 integrated report assessment of North Carolina waterbodies lists 37 waterbodies in the Shallotte Study Area as impaired for the designated use of shellfish harvesting (Figure 35; NCDWQ, 2010a). Of the 37 waterbodies listed, 2 are also impaired for the aquatic life designated use category. Table 31 lists all impaired waterbodies in the Shallotte Study Area. New coastal stormwater rules as a result of Session Law 2008-211 went into effect on October 1, 2008 place stricter stormwater standards on the County and 19 other coastal counties. Upon implementation, these rules should reduce fecal coliform bacteria from future developments.

Table 31. Waters with Impaired Use Support Rating in the Shallotte Study Area

Waterbody	Use Category	Reason for Impairment	Parameter
Big Gut Slough	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Closed
Blane Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Bonaparte Creek (from the ICWW to the Little River)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Bull Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Calabash River (from the source to the North Carolina-South Carolina state line)	Aquatic Life	Standard Violation	Copper, High Water Temperature, Turbidity
	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Clam Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Clayton Creek (from the ICWW to the Little River)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Cooter Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Dead Backwater	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
East River	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Eastern Channel	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Fox Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open

Waterbody	Use Category	Reason for Impairment	Parameter
Gause Landing Creek (from Kilbart Slough to the ICWW)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Goose Creek (from Brunswick County SR 1143 to Saucepan Creek)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Hangman Branch	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
ICWW (several sections)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area (either Conditionally Approved Open, Conditionally Approved Closed, or Prohibited)
Jinks Creek (from the Eastern Channel to the ICWW)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Jinnys Branch (from Brunswick County SR 1143 to Saucepan Creek)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Kilbart Slough	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Little River	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Lockwoods Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Lockwoods Folly River (several sections)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area (either Prohibited or Conditionally Approved Closed)
Marina south of the ICWW (Holden Beach Marina)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Mill Creek (from Brunswick County SR 1112 to Lockwoods Folly River)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Montgomery Slough (from the ICWW west of Lockwoods Folly Inlet extending eastward 2.4 miles)	Aquatic Life	Standard Violation	Low Dissolved Oxygen
	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Mullet Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Salt Boiler Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open

Waterbody	Use Category	Reason for Impairment	Parameter
Sams Branch (from the proposed dam approximately 3/4 mile upstream from the Shallotte River channel to the Shallotte River 0.56 miles)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Saucepan Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Shallotte Creek (from Bell Branch to Shallotte River)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Closed
Shallotte River (several sections)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area (either Prohibited or Conditionally Approved Closed)
Sols Creek (from Eastern Channel to the ICWW)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Spring Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Closed
Still Creek (from Eastern Channel to the ICWW)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
The Big Narrows (from Jinks Creek to the ICWW)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
The Mill Pond (from a point 1.0 mile below Brunswick County SR 1145 to the Shallotte River)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
The Swash	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Closed

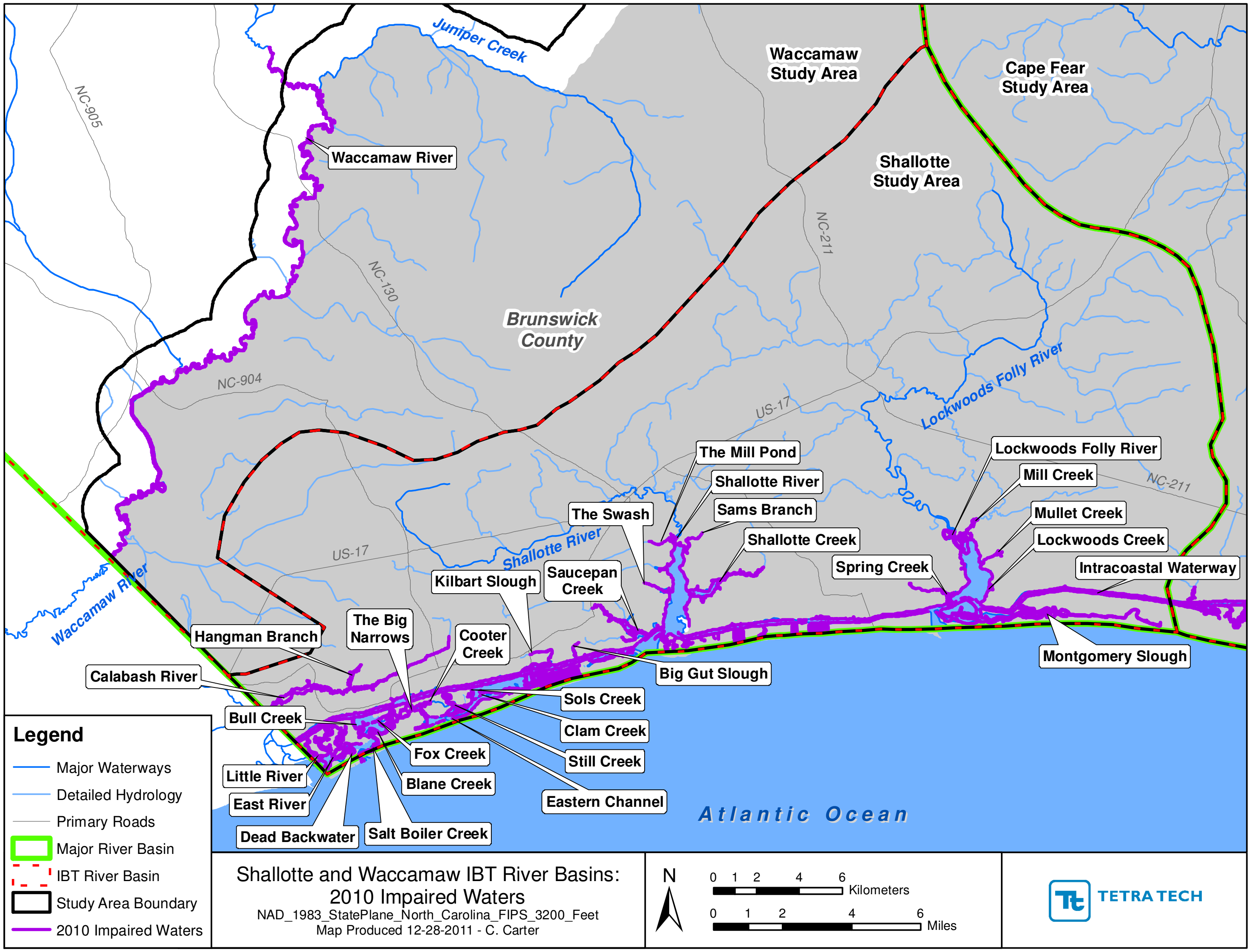

Figure 35. Impaired Waters in the Shallotte and Waccamaw Study Areas

3.4.4 Total Maximum Daily Load (TMDL)

The Lockwoods Folly River and the upriver portion of the estuary are prohibited for shellfish harvesting because of excessive levels of fecal coliform bacteria (NCDWQ, 2010c). In 2007 the DWQ Watershed Assessment Team completed a water quality study in the Lockwoods Folly River watershed as part of an agreement with the North Carolina Ecosystem Enhancement Program (NCDWQ, 2010c). Also in 2007 a local watershed plan for the Lockwoods Folly watershed was created by the North Carolina Coastal Federation, North Carolina Ecosystem Enhancement Program, North Carolina Department of Transportation, the North Carolina Shellfish Sanitation Program, with support from Stantec. Nonpoint Source 319 Grant Program funds were subsequently approved to support third-party development of the Lockwoods Folly River Fecal Coliform TMDL. EPA approved the TMDL, and it will be implemented with the goal to reduce high fecal coliform concentrations to levels whereby the designated uses for these waterbodies will be met (NCDWQ, 2010c).

North Carolina has issued a statewide fish consumption advisory for mercury; therefore, all surface waters in the state are considered to be impaired by mercury (NCDWQ, 2011). A brief discussion is provided in Section 2.4.3.

3.4.5 Groundwater Supplies

The Shallotte Study Area is in the Coastal Plain physiographic province in the southern coastal portion of North Carolina. The aquifer underlying the Shallotte Study Area is the surficial aquifer composed of unconsolidated sand and gravel (NCDWR, 2011). Surficial aquifers are described in Section 2.4.5.

3.5 WETLANDS

Wetlands in the Shallotte Study Area primarily consist of managed pinelands, pocosins, pine flats, riverine swamp forests, salt/brackish marsh, and depressional swamp forests (Table 32, Figure 25). Over 44 percent of the Shallotte Study Area is mapped as wetlands by NC-CREWS assessment. NC-CREWS is described in more detail in Section 2.5. Definitions of each of the major wetland types in the Shallotte Study Area were obtained from the NC-CREWS database (NCDCM, 2003a) and are as follows (the other wetland types are described in Section 2.5 and only Depressional Swamp Forests is described here):

Depressional Swamp Forests

Depressional Swamp Forests are very poorly drained riverine or non-riverine forested or occasionally shrub/scrub communities which are temporarily flooded. Typical species include cypress, black gum, water tupelo, green ash and red maple.

Table 32. NC-CREWS Wetland Types in the Shallotte Study Area

Wetland Type	Area (km^2)	Percent of Shallotte Study Area
Managed Pineland	130.39	16.76%
Pocosin	69.60	8.94%
Pine Flat	42.02	5.40%
Riverine Swamp Forest	35.00	4.50%
Salt/Brackish Marsh	26.58	3.42%

Wetland Type	Area (km^2)	Percent of Shallotte Study Area
Depressional Swamp Forest	9.09	1.17%
All Other Wetland Types[1]	31.91	4.10%

Note:

[1] Includes wetland types covering less than 1 percent of the Shallotte Study Area

3.5.1 Wetland Function

Over 22 percent of the wetlands assessed by NC-CREWS (NCDCM, 2003b) in the Shallotte Study Area received a rating of exceptional functional significance (totaling 10 percent of the area), over 73 percent received a rating of substantial functional significance (totaling 33 percent of the area), and 1.8 percent received a rating of beneficial functional significance (totaling almost 1 percent of the area). Less than 2 percent of the Shallotte Study Area wetlands could not be evaluated (Table 33, Figure 26). A brief description of each significance level was obtained from the NC-CREWS documentation and is provided in Section 2.5.1.

Table 33. Wetland Significance Rating for Wetlands in the Shallotte Study Area

Wetland Rating	Area (km^2)	Percent of Shallotte Study Area	Percent of Wetlands Assessed
Exceptional Functional Significance	78.53	10.09%	22.93%
Substantial Functional Significance	253.04	32.52%	73.89%
Beneficial Functional Significance	6.16	0.79%	1.80%
Unable to Evaluate	4.70	0.60%	1.37%

3.6 Aquatic and Wildlife Habitat and Resources

3.6.1 Significant Natural Heritage Areas

Approximately 19 percent of the Shallotte Study Area has been identified as SNHA (NCDENR, 2011a) (Figure 27). The Shallotte Study Area has three sites that are SNHA that have been identified as areas of national significance. These sites total approximately 16 percent of the Shallotte Study Area and include the Boiling Spring Lakes Wetland Complex, the Green Swamp, and the Long Beach Maritime Forest (Table 34).

Seven sites were identified as areas of state significance and occupy approximately 2 percent of the Shallotte Study Area (Table 34). Eight sites were identified as areas of regional significance and occupy approximately 1 percent of the Shallotte Study Area, and 4 sites were identified as areas of county significance and occupy less than 1 percent of the area. A description for each level of significance is provided in Section 2.6.1.

Table 34. SNHAs in the Shallotte Study Area

Significance	Site Name
National (15.9% of Shallotte Study Area)	Boiling Spring Lakes Wetland Complex, Green Swamp, and Long Beach Maritime Forest
State (2.0% of Shallotte Study Area)	Brantley Island, Colkins Neck Remnant, Juniper Creek Floodplain, Juniper Creek/Driving Creek Aquatic Habitat, Lockwoods Folly River Tidal Wetlands, Sunset Beach Wood Stork Ponds, Sunset Harbor/Ash Swamp
Regional (1.4% of Shallotte Study Area)	Big Cypress Bay and Ponds, Bird Island, Fall Swamp/Middle River Limesink Complex, Royal Oak Swamp Marl Outcrop, Sandy Branch Sand Ridge and Bay Complex, Secession Maritime Forest, Shallotte Creek Sandhills, Stanly Road Coastal Fringe Forest
County (0.2% of Shallotte Study Area)	Bonaparte Landing Maritime Forest, Cumbee Pond and Sandhills, Gause Savanna, Middle Swamp

3.6.2 Wildlife Habitat and Resources

The Shallotte Study Area is mainly in the poorly drained flatwoods ecoregion of the Coastal Plain between the Cape Fear and Waccamaw rivers. Carolina bays and pocosins are abundant in some areas. The flatwoods region is a significant center of endemic biota, with biological diversity and rare species. Pine flatwoods, pine savannas, freshwater marshes, pond pine woodlands, pocosins, and some sandhill communities were once common. Pine plantations are now widespread with an active forest industry (Griffith and Omernik, 2008).

The Shallotte Study Area's coast is lined with barrier islands, coastal marshes, and swampy peat lands. Most of the barrier islands have been completely developed with one exception. Bird Island was purchased by North Carolina and added to the National Estuary Research Reserve (NCDWQ, 2010b). Although no more than 2 to 3 kilometers wide, barrier islands provide for a diversity of maritime vegetation communities, including tidal salt marshes, hypersaline sand flats, foredunes, backdunes and interdune swales (Boyle et al. 2007).

Eleven dominant EVTs (USGS, 2010) occur in the Shallotte Study Area that were not developed lands, agricultural lands, or recently logged:

- Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (30 percent of the area)
- Managed Tree Plantation-Southeast Conifer and Hardwood Plantation Group (15 percent of the area)
- Atlantic Coastal Plain Peatland Pocosin and Canebrake (5 percent of the area)
- Gulf and Atlantic Coastal Plain Small Stream Riparian Systems (5 percent of the area)
- Herbaceous Wetlands (4 percent of the area)
- Southern Atlantic Coastal Plain Mesic Hardwood Forest (3 percent of the area)
- Atlantic Coastal Plain Upland Longleaf Pine Woodland (3 percent of the area)
- Gulf and Atlantic Coastal Plain Floodplain Systems (2 percent of the area)

- Southern Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest (2 percent of the area)
- Gulf and Atlantic Coastal Plain Swamp Systems (1 percent of the area)
- Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (1 percent of the area)

Each dominant EVT covers greater than 1 percent of the Shallotte Study Area and in all cover approximately 71 percent of the Shallotte Study Area (Figure 36). Ten of the 11dominant EVTs for the Shallotte Study Area were described in Section 2.6.2, the remaining EVT is described below (NatureServe, 2007).

Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest. Covers 1 percent of the Shallotte Study Area. This system consists of poorly drained, organic or mineral soil flats of the outer Atlantic Coastal Plain. These areas are saturated by rainfall and seasonal high water tables without influence of river or tidal flooding. Fire is generally infrequent but could be important for some associations. Vegetation consists of hardwood or mixed forests of bald cypress (*T. distichum)*, tupelo (*Nyssa* spp.), bottomland oaks, red maple (*A. rubrum)*, or other wetland trees of similar tolerance. The lower strata have affinities with pocosin or baygall systems rather than the river floodplain systems that have affinities with the canopy. The combination of hardwood/deciduous canopy dominants and nonriverine, non-seepage hydrology distinguishes this system from other Coastal Plain systems. Stands with a high cover of Atlantic white cedar (*Chamaecyparis thyoides)* formerly occupied much of the acreage of this system. This phase is present only in high-quality examples, and it helps distinguish this system from other Coastal Plain systems. Disturbed and fire-disrupted examples (those dominated by tupelo, bottomland oaks, red maple) might be hard to distinguish from other wetland forests based purely on canopy composition.

Additional EVTs in the Shallotte Study Area that were not on developed, mined, recently logged, or agricultural lands are as follows: Southern Atlantic Coastal Plain Maritime Forest, Central Atlantic Coastal Plain Maritime Forest, Gulf and Atlantic Coastal Plain Tidal Marsh Systems, Southern Coastal Plain Mesic Slope Forest, Atlantic Coastal Plain Streamhead Seepage Swamp-Pocosin-Baygall, Atlantic Coastal Plain Fall-line Sandhills Longleaf Pine Woodland, Southern Atlantic Coastal Plain and Maritime Grassland, and Southern Atlantic Coastal Plain Wetl Pine Savanna and Flatwoods.

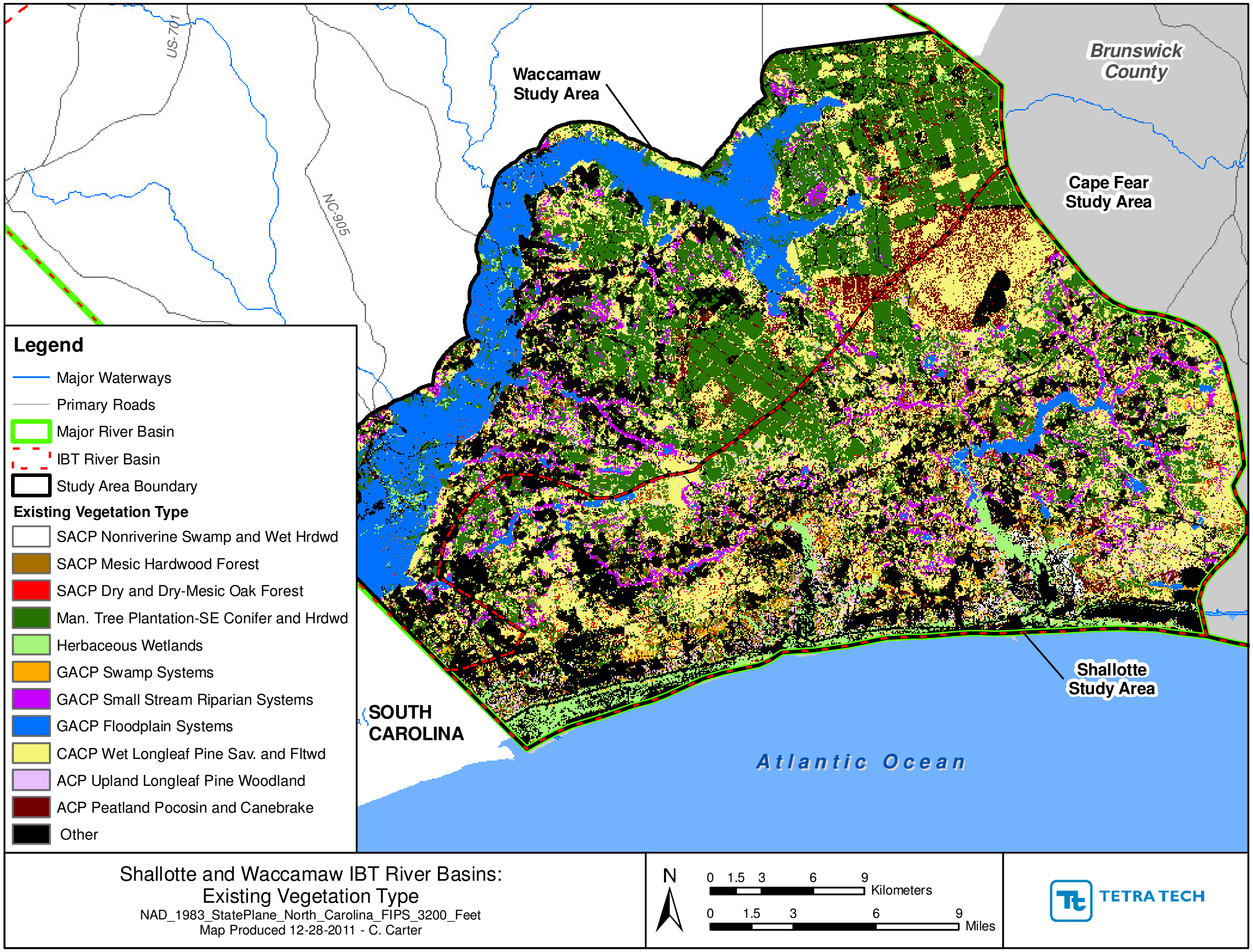

Figure 36. EVTs in the Shallotte and Waccamaw Study Areas

3.6.3 Important Bird Areas

In the Shallotte Study Area, two IBAs have been identified – Bird Island and the Green Swamp (National Audubon Society, 2011). Both are of state significance (S) and provide habitat for species of state conservation concern (Figure 29).

The following is a summary habitat and species characteristic of each IBA in the Shallotte Study Area (National Audubon Society, 2011):

Bird Island (S) is on the North Carolina-South Carolina border (the southwestern end of Bird Island is in South Carolina). It is one of the few undeveloped barrier islands remaining in southern North Carolina. In addition to barrier island beach and dunes, this site includes extensive salt marsh that supports a variety of bird species throughout the year. The Twin Lakes portion of this site consists of two freshwater ponds bounded by residential development and a golf course, and adjacent salt marsh on the mainland. The lakes provide a resting area and roost for wood storks and other species of waterbirds. This is the only site in North Carolina where wood storks occur regularly. The species does not nest at this site and is not known to nest in North Carolina.

The Green Swamp (S) is an area of open longleaf pine savannah interspersed with areas of dense, nearly impenetrable, shrubby pocosin. This is one of the state's best examples of longleaf pine savannah and pocosin, and supports birds typical of both habitats. The area is known for its great diversity of plants, many of which are significantly rare, but it also harbors a great diversity of bird species throughout the year including prothonotary, pine, yellow-throated, and hooded warblers.

3.6.4 Aquatic Habitat and Resources

Carolina flatwoods are regions where flow is often slow and ephemeral. This low flow contributes to the coastal plain being dominated by blackwater systems that often consist of braided streams, wide floodplains and pocosin wetlands. The water is usually absent of sediment but has a dark color from tannins that are leached from organic matter. This tannic acid produces a pH that is naturally much lower than other river systems. Also these low-flow streams and wetlands can have natural dissolved oxygen levels below the 5 milligrams per liter (mg/L) freshwater standard (NCDWQ, 2010b). Two major rivers within the Shallotte Study Area are the Shallotte and Lockwoods Folly rivers.

A unique type of wetland known as Carolina bays are throughout much of the basin. Carolina bays are a type of isolated depressional wetland that range in size from a few acres to several hundred acres. They are on the Atlantic Coastal Plain from northern Florida to southern New Jersey, but are most highly concentrated in southeastern North Carolina and northeastern South Carolina. These depressional wetlands are distinguished from other wetlands by their elliptical shape, orientation, and an eolian sand rim that is most pronounced along the southeastern shoreline. Many of these wetlands, especially the smaller ones, are ephemeral and provide an ideal habitat for amphibians. They have a high degree of biodiversity mainly from varying amounts of soil moisture from inundated in the center to increasingly drier at the edges. Because these wetlands are often isolated from interaction with other surface waters, rare or endemic species are in and around many of them (NCDWQ, 2010b).

In the Shallotte Study Area, the Shallotte River including Sharron Creek, the Lockwoods Folly River including Mill Creek and Pamlico Creek, Long Bay, The Millpond, the ICWW, and Calabash Creek are designated fish nursery areas (Figure 31). Past and present sampling indicates that these areas support a high abundance and diversity of juvenile fish species (One NC Naturally, 2011).

SGAs open for shellfish harvesting in the Shallotte Study Area include waters of the inlets and downstream portions of the Shallotte and Lockwoods Folly rivers, Tubbs Inlet Area, and the Calabash Area (NCDEH-SSB, 2011); all other SGAs in the Shallotte Study Area are closed for harvesting because of the extent of contamination of waters in each SGA. Of the areas closed for harvesting, Shallotte Creek, Saucepen Creek, Davis Creek, upstream portions of the Shallotte and Lockwoods Folly rivers, portions of the Calabash Area and ICWW west of the Shallotte River inlet, Calabash/Sunset Beach/Boneparte Creek Area, and the Ocean Isle Beach Area are closed only conditionally and could be reopened if water quality in these areas is improved (NCDEH-SSB, 2011) (Figure 32).

Anadromous fish spawning areas have not been identified in the Shallotte Study Area (One NC Naturally, 2011).

3.6.5 Rare and Protected Species

The Shallotte Study Area is entirely within the County. Several species are protected either on the state or federal level in the County. The North Carolina Natural Heritage Program's (NCNHP's) Biotic Database (NCNHP, 2011) lists all protected species. In the Shallotte Study Area are 13 invertebrate animals, 1 nonvascular plant, 114 vascular plants, and 43 vertebrate animals. A complete list of state and federally protected species in the Shallotte Study Area is provided in Appendix H.

3.7 AIR QUALITY

No air quality monitoring stations are in the Shallotte Study Area. The closest active monitoring stations to the Shallotte Study Area are in New Hanover County and are summarized in Section 2.7.

3.8 NOISE LEVELS

Noise is subject to the federal Noise Control Act of 1972 (PL-92-574) and Quiet Communities Act of 1978 (PL-95-6009), which require standards of compliance and recommend approaches to abatement for stationary noise sources such as airports, highways, and industrial facilities. The Shallotte Study Area has developed and undeveloped areas that exhibit day-to-day normal noise conditions.

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4 Existing Environmental Characteristics: Waccamaw IBT River Basin

For this assessment, the study area in receiving basin #2, the Waccamaw IBT River Basin, begins 1 mile north (as Euclidean distance) of the County line and extends into the southern portion of the IBT River Basin (referred to as the *Waccamaw Study Area* in this section) (Figure 15 in Section 2). The inclusion of area north of the County line is meant to capture portions of this receiving basin that might be affected by any potential impacts without including the remainder of the basin (extending another 20 to 30 miles north) that would reasonably be expected to be unimpacted.

4.1 Topography, Geology, and Floodplains

The Waccamaw Study Area is in the Outer Coastal Plain physiographic province, which is characterized by gently rolling hills and valleys at higher elevations and flat, poorly drained areas at lower elevations (NCGS, 2004). Elevations in the Waccamaw Study Area range from sea level at the Waccamaw River to 77 feet above mean sea level in areas between Scippio Swamp and Wet Ash Swamp near the southern portion of the Waccamaw Study Area and the northeast portion of the Waccamaw Study Area near the Green Swamp.

The underlying geology of the Waccamaw Study Area consists of formations from the Tertiary and Cretaceous periods. These formations include the Waccamaw Formation from the Tertiary period and the Peedee Formation from the Cretaceous period. These formations are characterized by loosely consolidated sedimentary rock composed of materials such as silt, sand, clay, and limestone.

Portions of the Waccamaw Study Area are in the FEMA 100- and 500-year floodplains. These areas are the majority of the Waccamaw Study Area excluding lands at higher elevations between Shingletree Swamp, Scippio Swamp, Wet Ash Swamp, Bear Branch River, and Horse Pen Swamp.

4.2 Soils

4.2.1 Soil Series

County soil survey data for the County was retrieved from the NRCS (NRCS, 2011a). Whereas 43 soil series are in the Waccamaw Study Area, 50 percent of the Waccamaw Study Area is composed of only five major soil series: Torhunta, Woodington, Muckalee, Croatan, and Dorovan soils (Table 35, Figure 33).

Table 35. Soil Series in the Waccamaw Study Area

Series Name	Percent of Waccamaw Study Area
Torhunta	16.0%
Woodington	10.9%
Muckalee	10.3%
Croatan	10.0%
Dorovan	6.1%
All other soil series	46.7%

Three of the five major soil series in the Waccamaw Study Area are described either in Section 2.2.1 or Section 3.2.1. The remaining two soils series are described below according to information obtained from the NRCS Official Soil Series Descriptions database (NRCS, 2011b).

Woodington

The Woodington series consists of poorly drained soils with slow runoff and moderately rapid permeability on broad, smooth interstream divides on the Coastal Plain. They are formed in loamy textures in Coastal Plain sediments. Slopes range from 0 to 2 percent. A seasonal high water table is within 10 inches of the surface in periods of high rainfall. Most areas covering Woodington soils are in forest of mixed hardwood and pine with loblolly and pond the principal pine species. Cleared areas are used for corn, soybeans, small grains, and pasture.

Muckalee

The Muckalee series consists of poorly drained moderately permeable soils with very slow runoff formed in loamy and sandy alluvium. These soils are on floodplains of streams in the Coastal Plain. Stream channels are generally shallow and meandering. The soils flood frequently for brief periods. Slopes range from 0 to 2 percent. Muckalee soils are generally covered by native woodlands of bay, sweetgum, blackgum, water tupelo, red maple, water oak, loblolly pine, and willow. A few areas have been cleared, drained and used for pasture.

4.2.2 Hydrologic Soil Groups

Soil survey data retrieved from USDA NRCS (NRCS, 2011a) provides soil series assignments to specific HSG. Twenty-seven percent of the Waccamaw Study Area is composed of Group B/D soils, and 24 percent is composed of Group C soils (Table 36, Figure 17). This translates to over 50 percent of the total Waccamaw Study Area being composed of soils that have either moderate infiltration rates and low runoff potential when drained (Group B) and high runoff potential with slow infiltration rates when thoroughly wetted (Group C) and in undrained conditions (Group D). These soil groups consist chiefly of moderately deep to deep, moderately well- to well-drained soils with moderately fine to moderately coarse textures (Group B) or soils with moderately fine textures (Group C) or, in undrained areas, claypan or clay near the surface and shallow soils over nearly impervious material (Group D) (NRCS, 2011a).

Table 36. HSG for Waccamaw Study Area

HSG	Percent of Waccamaw Study Area
B/D	26.8%
C	23.9%
D	20.7%
B	13.4%
C/D	10.0%
A/D	2.6%
A	1.9%
Not Classified	0.5%

4.3 Land Use

4.3.1 Existing Land Use

Land use in the portion of the Waccamaw Study Area in the County (Table 37, Figure 18) consists of forested lands (84 percent), agricultural lands and open fields used for crops primarily consisting of corn, soybeans, and tobacco (9 percent), lands developed for low, medium, and high-density residential purposes (totaling 4 percent), recreational uses (< 1 percent), lands covered by water and wetlands (< 1 percent), lands used for communications and utilities (< 1 percent), lands developed for commercial, educational, institutional, and industrial purposes (< 1 percent), and lands used for mining and extraction (< 1 percent). Outside the County, the Waccamaw Study Area primarily consists of water and wetlands (52 percent), forested lands (26 percent), agricultural lands or open fields (12 percent), areas covered by scrub/shrub (8 percent), and developed areas (2 percent) (Fry et al. 2011).

Table 37. Land Use for the Waccamaw Study Area in Brunswick County

Land Use Group	Area (km^2)	Percent
Forest	445.96	84.34%
Agricultural Land/Open Field	47.34	8.95%
Low-Density Residential	20.70	3.92%
Transportation	7.22	1.37%
Recreation	3.01	0.57%
Water/Wetlands	1.95	0.37%
Communications & Utilities	1.04	0.20%
Developed	0.85	0.16%
Mining & Extraction	0.42	0.08%
High-Density Residential	0.18	0.03%
Medium-Density Residential	0.07	0.01%

4.3.2 Future Land Use

Future land uses for the Waccamaw Study Area, created as a result of the Brunswick County and Town of Shallotte CAMA Core Land Use Plans (Holland Consulting Planners, Inc., 2007a, Holland Consulting Planners, Inc., 2007c), are listed in Table 38 and displayed in Figure 19. The two most prevalent categories are conservation (66 percent) and low-density residential (30 percent). The conservation designation is intended to be used for the permanent protection and preservation of environmentally sensitive lands, and areas with historical, cultural, and archeological significance (Holland Consulting Planners, Inc., 2007a). Low-density residential areas are designated for agricultural uses, single family residences, multifamily residences in certain cases, single-wide and double-wide manufactured homes, emergency shelters, parks, and places of worship (Holland Consulting Planners, Inc., 2007a). The future land use projections are focused on land use rather than land cover, thus it is reasonable to expect that low density residential areas would contain natural land covers of forest, wetlands, and water.

Table 38. Future Land Use for Brunswick County in the Waccamaw Study Area

Future Land Use	Area (km^2)[1]	Percent of Study Area
Conservation	350.06	66.21%
Low Density Residential	157.45	29.78%
Medium Density Residential	9.10	1.72%
Commercial	2.55	0.48%
Protected Lands	2.10	0.40%
Community Commercial	1.03	0.19%
Industrial	0.86	0.16%
Recreation	0.65	0.12%
Office & Institutional	0.17	0.03%

Note:

[1] Some municipalities of the Waccamaw Study Area within the County were not included in the Brunswick County Future Land Use classification. Future land use data for these areas were obtained from the following municipalities and were added to the Brunswick County Future Land Use classification: Shallotte (Holland Consulting Planners, Inc., 2007c). Future land use data for Calabash is not included here; all future land use for Calabash was added to the future land use for the Shallotte Study Area since only a very small portion of Calabash is within the Waccamaw Study Area.

4.3.3 Forest Resources

Forest groups identified by the USDA Forest Service – FIA Program and RSAC (USFS, 2008) cover approximately 97 percent of the total land area in the Waccamaw Study Area and are composed of 5 dominant forest groupings (Figure 20). The loblolly-shortleaf pine group is most prevalent, covering approximately 68 percent of the Waccamaw Study Area; this forest group is described in Section 0.

The next most prevalent forest group in the Waccamaw Study Area is the oak-gum-cypress group, covering approximately 27 percent of the Waccamaw Study Area; this forest group is also described in Section 0 (NCWRC, 2011).

The oak-pine group covers approximately 1 percent of the Waccamaw Study Area. These are forests in which oaks can dominate in very dry settings or in settings that might have been longleaf pine stands at one time and are now closed canopy mixed hardwood/pine stands (NCWRC, 2011). Additional forest groups in the Waccamaw Study Area are the longleaf-slash pine and the oak-hickory groups, each covering less than 1 percent of the Waccamaw Study Area.

4.3.4 Prime and Unique Agricultural Land

Seven percent of the Waccamaw Study Area has soils that are identified as prime farmland and an additional 50 percent of the Waccamaw Study Area includes soils identified as prime farmland if they were to be drained (Table 39, Figure 21). Prime farmland soils, as defined by the USDA, are soils that are best suited for producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops (Barnhill, 1986).

Three percent of the Waccamaw Study Area has soils that are farmlands of unique importance. Soils that have a special set of properties that are unique for producing certain high-value crops meet the requirements for unique farmland.

Nine percent of the Waccamaw Study Area has soils that are farmlands of statewide importance. In general, soils that do not meet the requirements of prime farmlands fall into this category, and they are classified as having statewide importance on the basis of criteria established specifically for North Carolina.

Table 39. Farmland Classification for Farmed Areas in the Waccamaw Study Area

Farmland Classification	Area (km^2)	Percent
Prime farmland if drained	313	50%
Not prime farmland	197	31%
Farmland of statewide importance	58	9%
All areas are prime farmland	42	7%
Farmland of unique importance	20	3%

4.3.5 Public Lands and Scenic, Recreational, and State Natural Areas

LMCOS in the Waccamaw Study Area are owned by North Carolina or The Nature Conservancy (Figure 22). Table 40 lists all LMCOS in the Waccamaw Study Area. Since the LMCOS data layer was created in 2002, additional data layers depicting state-owned lands and land trusts, created in 2010 and 2008, respectively were used to provide an account of most recent land ownerships (NCDOA, 2010; The Conservation Fund, 2008). Federally owned lands were not found in the Waccamaw Study Area.

Juniper Creek game land covers approximately 73km^2 (12 percent) of the Waccamaw Study Area. Juniper Creek drains the Green Swamp as it flows into the Waccamaw River. Primarily surrounded by cypress-gum swamp and bottomland hardwood forest, Juniper Creek supports several smaller longleaf savanna natural areas that provide habitat for a variety of rare plants. This region also provides excellent habitat for animals, including the fox squirrel and the potential for the endangered red-cockaded woodpecker. The game land provides an important natural corridor between the Conservancy's Green Swamp Preserve and the Waccamaw River (TNC, 2009).

Table 40. LMCOS in the Waccamaw Study Area

Owner Type	Name	Owner/Management	Total Area in Waccamaw Study Area (km^2)	Percent of Waccamaw Study Area
State	Juniper Creek (Black Bear Sanctuary), State Government Center, Columbus County Conservation Easements, Waccamaw Island Gamelands, and 904-Bridge/Pireway Access Area	State of North Carolina (Wildlife Resources Commission, Administration, Environment and Natural Resources)	83.23	13.23%
Conservation Group	Green Swamp Preserve (Black Bear Sanctuary) and Wells Tract	The Nature Conservancy	7.33	1.17%

Rivers identified as National Wild and Scenic Rivers that are under federal protection are not in the Waccamaw Study Area. Public trust waters are navigable waters open for public uses such as fishing and navigation; these waters are common and widespread throughout the Waccamaw Study Area.

4.3.6 Areas of Archaeological or Historical Value

No known areas of archaeological or historic significance are in the Waccamaw Study Area.

4.4 Surface and Groundwater Resources

4.4.1 Drainage Basins and Surface Water Supplies

The Waccamaw Study Area is in the Lumber River Basin. The significant majority of the Waccamaw Study Area is in the Waccamaw subbasin, in USGS Hydrological Unit 03040206. All the waters in the subbasin are supplementally classified as swamp waters. Swamp waters have lower pH and dissolved oxygen standards than other waterbodies (NCDWQ, 2010b)

4.4.2 Surface Water Use Classifications

All surface waters in North Carolina are assigned a primary classification by the North Carolina DWQ. Classifications of major waters in the Waccamaw Study Area are displayed in Figure 34 and described below.

Only two classifications of waters are in the Waccamaw Study Area. The Waccamaw River (from N.C. Hwy 904 to North Carolina-South Carolina state line) is classified as B and Sw waters. All other waters in the Waccamaw Study Area are classified as C and Sw waters. Class C is for waters protected for uses such as secondary recreation, fishing, wildlife, fish consumption, aquatic life, and agriculture. Class B waters are protected for all Class C uses in addition to primary recreation. Class Sw is for swamp waters and is a supplemental classification intended to recognize those waters that have low velocities and other natural characteristics that are different from adjacent streams.

4.4.3 Existing Surface Water Quality

DWQ's 2010 integrated report assessment of North Carolina waterbodies list one waterbody in the Waccamaw Study Area as impaired for the designated uses of fish consumption and aquatic life (NCDWQ, 2010a). All impairments are along the mainstem of the Waccamaw River (Figure 35). Table 41 lists the specific impairments of the Waccamaw River.

Table 41. Waters with Impaired Use Support Rating in the Waccamaw Study Area

Waterbody	Description	Use Category	Reason For Impairment	Parameter
Waccamaw River	From N.C. Hwy. 904 to North Carolina-South Carolina State Line	Fish Consumption	Standard Violation	Water column Mercury
	From NC 130 to NC 904	Fish Consumption	Standard Violation	Water column Mercury
	From SR 1928 to NC 130	Aquatic Life	Standard Violation	Low pH
		Fish Consumption	Standard Violation	Water column Mercury

Lake Waccamaw drains to the Waccamaw River; this lake has been designated as an outstanding resource water (ORW), and all waters draining to it are part of the ORW management strategy area. The ORW classification is a supplemental classification that is intended to protect unique and special waters having excellent water quality and being of exceptional state or national ecological or recreational significance (NCDWQ, 2010b).

4.4.4 Total Maximum Daily Load (TMDL)

North Carolina has issued a statewide fish consumption advisory for mercury; therefore, all surface waters in the state are considered to be impaired by mercury (NCDWQ, 2011). A brief discussion is in Section 2.4.3.

Besides the statewide mercury TMDL, no known TMDLs are being developed for the Waccamaw Study Area. However, a TMDL for biochemical oxygen demand for the Waccamaw River and Atlantic ICWW near Myrtle Beach, South Carolina, was approved by EPA in 1999; this area is downstream from the Waccamaw Study Area.

4.4.5 Groundwater Supplies

The Waccamaw Study Area is in the Coastal Plain physiographic province in the southern coastal portion of North Carolina. The aquifer underlying the Waccamaw Study Area is the surficial aquifer composed of unconsolidated sand and gravel (NCDWR, 2011). Surficial aquifers are described in Section 2.4.5.

4.5 WETLANDS

Wetlands in the Waccamaw Study Area primarily consist of managed pinelands, riverine swamp forests, pine flats (including drained pine flats), pocosins (including drained pocosins), and bottomland hardwoods (Table 42, Figure 25). Over 69 percent of the Waccamaw Study Area is mapped as wetlands by NC-CREWS assessment. NC-CREWS is described in more detail in Section 2.5 with definitions of each of the major wetland types in the Waccamaw Study Area.

Table 42. NC-CREWS Wetland Types in the Waccamaw Study Area

Wetland Type	Area (km^2)	Percent
Managed Pineland	156.70	24.91%
Riverine Swamp Forest	123.25	19.59%
Drained Pine Flat	61.02	9.70%
Pine Flat	27.48	4.37%
Pocosin	16.60	2.64%
Drained Pocosin	16.06	2.55%
Bottomland Hardwood	14.36	2.28%
All Other Wetland Types[1]	20.57	3.27

Note:

[1] Includes wetland types covering less than 1 percent of the Waccamaw Study Area.

4.5.1 Hydrogeomorphic Characteristics

NC-CREWS assigned a hydrogeomorphic (HGM) classification to each wetland type on the basis of a series of HGM characteristics. Below is a description of each HGM classification followed by a list of the Waccamaw Study Area major wetland types that received each classification:

Riverine HGM Classification

These wetlands are those in which hydrology is determined or heavily influenced by proximity to a perennial stream of any size or order. Overbank flow from the stream exerts considerable influence on their hydrology. (Bottomland Hardwood and Riverine Swamp Forest)

Flat/Depressional HGM Classification

These wetlands are generally not in direct proximity to surface water. While they can be either isolated from or hydrologically connected to surface water, the hydrology of depressional wetlands is primarily determined by groundwater discharge, overland runoff, and precipitation. (Managed Pineland, Pocosin, and Pine Flat)

4.5.2 Wetland Function

Over 32 percent of the wetlands assessed by NC-CREWS (NCDCM, 2003b) in the Waccamaw Study Area received a rating of exceptional functional significance (totaling 22 percent of the Waccamaw Study Area), over 66 percent received a rating of substantial functional significance (totaling 46 percent of the Waccamaw Study Area), and less than 1 percent received a rating of beneficial functional significance (totaling less than 1 percent of the Waccamaw Study Area). Approximately 1 percent of the Waccamaw Study Area wetlands could not be evaluated (Table 43, Figure 26). A brief description of each significance level was obtained from the NC-CREWS documentation and is provided in Section 2.5.1.

Table 43. Overall Wetland Significance Rating for Wetlands in the Waccamaw Study Area

Overall Wetland Rating	Area (km^2)	Percent of Waccamaw Study Area	Percent of Wetlands Assessed
Exceptional Functional Significance	140.77	22.37%	32.33%
Substantial Functional Significance	287.92	45.76%	66.12%
Beneficial Functional Significance	2.35	0.37%	0.54%
Unable to Evaluate	4.42	0.70%	1.02%

4.6 Aquatic and Wildlife Habitat and Resources

4.6.1 Significant Natural Heritage Areas

Approximately 19 percent of the Waccamaw Study Area has been identified as SNHA (NCDENR, 2011a) (Figure 27). The Waccamaw Study Area has five sites that are SNHA that have been identified as areas of national significance, these sites total approximately 1 percent of the Waccamaw Study Area and include Crusoe Island Savanna, the Green Swamp, Highway 130/Waccamaw River Rare Plant Site, Myrtle Head Savanna, and the aquatic habitat provided by the Waccamaw River (Table 44).

Thirteen sites were identified as areas of state significance and occupy approximately 17 percent of the Waccamaw Study Area (Table 44). Three sites were identified as areas of regional significance and occupy less than 1 percent of the Waccamaw Study Area, and 2 sites were identified as areas of county significance and also occupy less than 1 percent of the Waccamaw Study Area. A description for each level of significance is provided in Section 2.6.1.

Table 44. SNHAs in the Waccamaw Study Area

Significance	Site Name	Area (km^2)	Percent of Waccamaw Study Area
National (1.4% of the Waccamaw Study Area)	Crusoe Island Savanna, Green Swamp, Highway 130/Waccamaw River Rare Plant Site, Myrtle Head Savanna, and Waccamaw River Aquatic Habitat	9.11	1.45%
State (16.6% of the Waccamaw Study Area)	Big Neck Road at Millpond Bay, Camp Branch Savanna Remnant, Juniper Bay Savanna, Juniper Creek Floodplain, Juniper Creek/Driving Creek Aquatic Habitat, Lay's Lake, Regan Ridge-and-Swale Boggy Openings, Waccamaw Island Savanna and Bottomlands, Waccamaw River Cross Swamp Bottomlands, Waccamaw River Oxbow Site, Waccamaw River Reeves and Gore Lake Bottomlands, Waccamaw River Ridgea-and-Swale Boggy Openings, and Wards Lake	104.25	16.57%

Significance	Site Name	Area (km^2)	Percent of Waccamaw Study Area
Regional (0.8% of the Waccamaw Study Area)	Hoy Savanna Remnant, Long Bays Savanna and Carolina Bays, and Scippio Swamp Ridge-and-Swale Boggy Openings	5.10	0.81%
County (0.3% of the Waccamaw Study Area)	Firetower Sandhill and Prospect Ridge White Cedar Forest	1.80	0.29%

4.6.2 Wildlife Habitat and Resources

The Waccamaw Study Area encompasses the western section of the County that is drained by the Waccamaw River. Flowing south from Lake Waccamaw in Columbus County, the Waccamaw River is a blackwater river that has a floodplain reminiscent of larger Piedmont – Coastal Plain brownwater rivers. A mosaic of blackwater swamps and brownwater levee communities is throughout the Waccamaw Study Area (Boyle et al. 2007). The river is home to a collection of diverse and rare flora and fauna. Most notably, the American Black Bear makes its home along the Waccamaw and travels its intra-Carolina corridors.

Seven dominant EVTs (USGS, 2010) were found in the Waccamaw Study Area that were not developed lands, agricultural lands, or recently logged and are as follows:

- Managed Tree Plantation-Southeast Conifer and Hardwood Plantation Group (31 percent of the area)
- Gulf and Atlantic Coastal Plain Floodplain Systems (21 percent of the area)
- Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (19 percent of the area)
- Atlantic Coastal Plain Peatland Pocosin and Canebrake (5 percent of the area)
- Gulf and Atlantic Coastal Plain Small Stream Riparian Systems (3 percent of the area)
- Herbaceous Wetlands (1 percent of the area)
- Atlantic Coastal Plain Upland Longleaf Pine Woodland (1 percent of the area)

Each dominant EVT covers greater than 1 percent of the Waccamaw Study Area and, in all, cover approximately 81 percent of the Waccamaw Study Area (Figure 36). All seven dominant EVTs for the Waccamaw Study Area are described in Section 2.6.2 (NatureServe, 2007).

Additional EVTs in the Waccamaw Study Area that were not on developed, mined, recently logged, or agricultural lands are as follows: Southern Atlantic Coastal Plain Mesic Hardwood Forest, Southern Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest, Gulf and Atlantic Coastal Plain Swamp Systems, Atlantic Coastal Plain Fall-line Sandhills Longleaf Pine Woodland, Southern Atlantic Coastal Plain Maritime Forest, Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest, Central Atlantic Coastal Plain Maritime Forest, Atlantic Coastal Plain Stream head Seepage Swamp-Pocosin-Baygall, Gulf and Atlantic Coastal Plain Tidal Marsh Systems, and Southern Coastal Plain Mesic Slope Forest.

4.6.3 Important Bird Areas

One IBA has been identified in the Waccamaw Study Area—the Waccamaw River Bottomlands (National Audubon Society, 2011) (Figure 29). This IBA is of state significance (S) and provides habitat for species of state conservation concern.

The Waccamaw River Bottomlands (S) IBA includes the bottomlands associated with the Waccamaw River. This is an extensive area of bottomland hardwood forest and cypress-gum swamp forest. This site is one of the largest areas of bottomland forest in North Carolina and is critical to North Carolina birds. The site provides excellent habitat for breeding and migrating songbirds and migratory waterfowl. White ibises from Battery Island travel to the Waccamaw River swamps to forage during the nesting season (National Audubon Society, 2011).

4.6.4 Aquatic Habitat and Resources

The portion of the Waccamaw River that flows through the Waccamaw Study area is a slow-moving, blackwater river surrounded by vast wetlands. The Waccamaw River is the only river originating from a Carolina Bay – Lake Waccamaw.

Within the Waccamaw Study Area, anadromous fish spawning areas, fish nursery areas, and SGAs have not been identified, but water quality is a concern in these waters because they flow through South Carolina to the Atlantic Ocean (One NC Naturally, 2011).

4.6.5 Rare and Protected Species

The Waccamaw Study Area boundary includes sections of three counties: Brunswick, Columbus, and Bladen. Within these counties, several species are protected either on the state or federal level. The NCNHP's Biotic Database (NCNHP, 2011) lists all protected species. In the Waccamaw Study Area are 27 invertebrate animals, 1 nonvascular plant, 137 vascular plants, and 52 vertebrate animals. A complete list of state and federally protected species in counties of the Waccamaw Study Area is in Appendix H.

4.7 Air Quality

No air quality monitoring stations are in the Waccamaw Study Area. The closest active monitoring stations to the Waccamaw Study Area are in New Hanover County and are summarized in Section 2.7.

4.8 Noise Levels

Noise is subject to the federal Noise Control Act of 1972 (PL-92-574) and Quiet Communities Act of 1978 (PL-95-6009), which require standards of compliance and recommend approaches to abatement for stationary noise sources such as airports, highways, and industrial facilities. In the Waccamaw Study Area are developed and undeveloped areas that exhibit normal day-to-day noise conditions.

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5 Alternatives Analysis

An analysis of water supply alternatives is a requirement of the IBT evaluation and environmental document and is important for determining the most viable alternative for the County. Options for an increase in IBT associated with an expansion of the Northwest WTP are weighed against alternatives that do not require additional IBT or combinations of alternatives that could limit the quantity of the IBT. Factors considered during alternatives analysis are the technical viability of the option, the constructability of the alternative, potential environmental impacts, technical difficulty, permitting issues, and estimates of opinions of probable costs, both construction costs and O&M. A discussion of the reasons for choosing the preferred alternative over other alternatives is provided.

5.1 NO ADDITIONAL IBT ALTERNATIVE

A No Additional IBT alternative must be considered as an alternative to an IBT. This alternative is defined as one in which no amount of water *over the grandfathered IBT* is transferred to customers in the Shallotte IBT River Basin as a result of any changes or improvements to the County's water treatment facilities would occur. The 1999 *Preliminary Engineering Report* (PER) (HDR, 1999a), the 2008 PER (Hazen and Sawyer, 2008), and the *Water Master Plan* (Hazen and Sawyer, 2006) discuss reasons why the system is not reliable in its existing condition and how future water demands could further erode its reliability.

To determine whether a No Additional IBT alternative could be considered viable, future growth projections and current permitted capacities of the County's facilities were examined. This information, which is presented in Section 1.3 (Water Demand Projections), indicates that future growth is projected in the County, resulting in a projected increase in water demand. Nearly half of the future demand is in the Shallotte IBT River Basin.

Typically, municipalities begin a WTP expansion process when the maximum day demand reaches 80 percent of treatment plant capacity. The County provided finished water quantity data of water produced by its WTPs, the Northwest WTP and NC 211 WTP. A review of the 2008 through 2011 data indicates the following:

- In 2008 the daily flow averaged 13.80 MGD. The peak day flow reported for 2010 was 25.55 MGD (approximately 85 percent of permitted water treatment capacity of 30 MGD) on July 5, 2008, resulting in a peak day peaking factor of 1.85.
- In 2010 the daily flow averaged 12.820 MGD. The peak day flow reported for 2010 was 21.32 MGD (approximately 70 percent of permitted water treatment capacity of 30 MGD) on July 5, 2010, resulting in a peak day peaking factor of 1.66.
- In 2011 the daily flow averaged 13.78 MGD. The peak day flow reported for 2011 was 25.80 MGD (approximately 86 percent of permitted water treatment capacity of 30 MGD) on July 6, 2011, resulting in a peak day peaking factor of 1.87.

The data indicate that average and maximum daily flows decreased and then increased since 2008. The most recent annual flows (2011) are similar to the 2008 flows. The 2011 data also indicate that the maximum day demand exceeded 80 percent of the plant capacity in 2008 and 2011, suggesting that a water treatment system expansion process should begin.

If the County's ability to provide reliable, high-quality potable water to its customers is limited, the County will have difficulty in accommodating growth in the service area and particularly in the Shallotte IBT River Basin. On the basis of the data provided, the County has demonstrated the need for an expansion of its water treatment system and a No Additional IBT alternative is not recommended.

5.2 Increase in IBT from Cape Fear - Northwest WTP Expansion

The existing Northwest WTP provides the majority of the County's potable water. The WTP is permitted to produce 24 MGD of potable water. The source of the raw water supply is the Cape Fear River. Because the County's water service area is in the Waccamaw and Shallotte IBT river basins of the Lumber Major River Basin in addition to the Cape Fear Major River Basin, increased withdrawals from the Cape Fear River to meet demand would result in an IBT. NCDWR has concluded that full demand for all withdrawals at Lock and Dam #1 would be met through 2050 (NCDWR, 2008).

Various treatment options are discussed in the *Expansion of Brunswick County Northwest Water Treatment Plant Preliminary Engineering Report* (NWWTP PER) prepared by Hazen and Sawyer (2008) and the earlier *Water Supply/Treatment Study* (WS/TS), prepared by HDR (1999b). On the basis of raw water quality results from January 2008 to April 2011, the raw water quality appears to be similar to the raw water quality identified in the 2008 NWWTP PER, and the proposed water treatment processes identified in the 2008 NWWTP PER are still applicable. Review of raw water quality results for DWQ Ambient WQ Station #B8350000 from January 2008 to April 2011 indicates that the average raw water turbidity was approximately 16.2 nephelometric turbidity units (NTU), which is similar to the raw water turbidity documented in the NWWTP PER (17 NTU). Additionally, the average raw water pH from January 2008 to April 2011 was about 6.5 NTU, which is similar to the average pH of approximately 6.7 NTU that is documented in the NWWTP PER.

The WTP expansion will not only include improved treatment capabilities but also increase the capacity of the plant. Construction cost estimates from the 2008 NWWTP PER have been updated to reflect 2012 construction pricing and are used for comparison to other alternatives. Per Table 1 of the 2008 NWWTP PER, the preliminary construction cost estimate for expanding the facility to a treatment capacity of 36 MGD is $34,640,000. The breakdown of this cost is shown in Table 45.

Table 45. 2008 PER Northwest WTP Construction Costs (24 MGD Improvements and Expansion to 36 MGD)

Description	24-MGD Improvements	36-MGD Expansion
Parallel 36-inch Raw Water Transmission (on WTP site)	NA	$850,000.00
Chemical Facility	$1,800,000.00	$3,500,000.00
Rapid Mix/Flow Meters	$300,000.00	$1,400,000.00
SuperPulsator Conversion and Additional Filter Module	NA	$9,400,000.00
Chlorine Dioxide Contact Tank	$1,500,000.00	$600,000.00
Clearwell	$5,000,000.00	NA
High Service Pump Station	$3,800,000.00	$1,800,000.00
Yard Piping	$2,300,000.00	$1,700,000.00
Sitework (Paving/Fencing)	NA	$250,000.00
Subtotal	$14,700,000.00	$19,500,000.00
Contingency (30%)	$4,410,000.00	$5,850,000.00
Total	$19,110,000.00	$25,350,000.00

Description	24-MGD Improvements	36-MGD Expansion
Residuals/Recycle Improvements (from Residuals Treatment Memo)		$9,290,000.00
Grand Total		$34,640,000.00

This preliminary cost was increased by a factor of 1.12 to account for inflation using *Engineering News-Record's* (ENR's) Construction Cost Index (CCI) for July 2008 (8293) and the March 2012 CCI (9267.57), resulting in a preliminary cost of approximately $38.8 million as reflected in Table 4-2.

The existing WTP site was master planned in the 2008 NWWTP PER and is considered to have adequate room to support the expansion, so no additional land would need to be acquired. The expansion plans would allow the WTP to maintain its current operations with minimal disruption. An expansion would increase the reliability of the WTP, which is crucial because the WTP is the main potable water supply for the County. The reliability of the WTP has been discussed in the *Preliminary Engineering Report* prepared by HDR (1999a).

The location of the surface water WTP is in the northern portion of the County's service area; the growth is mainly occurring in the southern and southwestern areas. Thus, the expansion alternative includes an evaluation of the costs to upgrade the distribution system and high service pumping as discussed in the WS/TS and further developed in the *Water System Master Plan* prepared by Hazen and Sawyer (2006). The *Water System Master Plan* includes hydraulic modeling to determine the necessary improvements. The following improvements are included in the preliminary opinion of cost to expand the Northwest WTP:

- Modification IIA-3 (Parallel 30-inch Pipeline to Bell Swamp PS)
- Modification IIA-5 (Parallel 30-inch Pipeline, Bell Swamp PS to Highway 211/17 Intersection)
- Modification IIB-3 (Bell Swamp Southwest Booster Pumps)

Table 45 gives the preliminary opinion of construction cost for expanding the Northwest WTP from 24 to 36 MGD.

Table 46. Budgetary Capital Costs - Expand Northwest WTP from 24 to 36 MGD

	Quantity	Unit	Unit Cost	Preliminary Cost Opinion
NW WTP Expansion (24 to 36 MGD)	1	EA	$38,796,800.00	$38,796,800.00
Modification IIA-3 (Parallel 30-inch Pipeline to Bell Swamp PS)	20,000	LF	$250.00	$5,000,000.00
Modification IIA-5 (Parallel 30-inch Pipeline, Bell Swamp PS to Hwy 211/17 Intersection)	70,000	LF	$250.00	$17,500,000.00
Modification IIB-3 (Bell Swamp Southwest Booster Pumps)	1	EA	$200,000.00	$200,000.00
			Sub Total	$61,496,800.00
Mobilization/Demobilization			6%	$3,689,808.00

	Quantity	Unit	Unit Cost	Preliminary Cost Opinion
General Requirements			4%	$2,459,872.00
Bonds and Insurance			2.5%	$1,537,420.00
Contingency			20%	$12,299,360.00
Engineering, Permitting, Legal and Admin			15%	$9,224,520.00
		Total		$90,707,780.00

O&M costs attributed to expanding the Northwest WTP to 36 MGD are based on existing O&M costs as documented by the County and O&M costs that would be associated with the new 30-inch diameter pipelines. The County's budget for years 2010 and 2011 for the Northwest WTP were reviewed to develop budgetary O&M costs for expanding the Northwest WTP from 24 to 36 MGD. It is assumed that no additional personnel will be needed to operate the Northwest WTP at 36 MGD. Costs that are expected to change because of the plant expansion are listed in Table 4-3 below. Annual O&M costs for the pipelines are projected to be 1 percent of the pipeline construction costs and additional annual O&M costs for the Bell Swamp Pump Station are projected to be 2.5 percent of the pump station modification costs.

Table 46 gives the breakdown of the actual budget for years 2010 and 2011, and the budgetary costs for the expanding the plant from 24 to 36 MGD.

Table 47. Budgetary Annual O&M Costs - Expand Northwest WTP from 24 to 36 MGD

Description	Actual 2010 O&M Costs	Actual 2011 O&M Costs	Additional O&M Costs
Chemicals	$919,600	$758,400	$459,800
Electricity	$311,100	$311,400	$155,550
Equipment	$41,000	$61,900	$20,500
Contract Services	$425,700	$261,800	$212,850
LCFWSA	$913,200	$991,700	$456,600
		Additional Annual O&M Cost – NW WTP	$1,305,300
	% of Capital Costs	Capital Costs	Budgetary O&M Costs
Pipelines	1.00%	$22,500,000	$225,000
Pump Station (Bell Swamp)	2.50%	$200,000	$5,000
		Total Budgetary O&M Costs	$1,535,300

On the basis of this information, the budgetary O&M costs for expanding the Northwest WTP from 24 to 36 MGD are approximately $1.54 million per year.

5.3 WATER SUPPLY ALTERNATIVES IN RECEIVING BASINS

State policy gives preference to alternatives that involve water supply transfers in the receiving river basin as opposed to alternatives that would require transfer from another major river basin. In the receiving river basin, the potential sources of water include surface water impoundments, purchase of water from other suppliers in the basin, groundwater wells, and seawater desalination. Alternatives for water supply in the receiving river basins are discussed below.

5.3.1 New Surface WTP

A new surface WTP would improve overall system reliability and could be closer to the future growth projected in the southwest portion of the service area. The Waccamaw River is the only potential surface water supply source in the area. The Waccamaw River is in the Waccamaw subbasin of the Lumber River Basin. Withdrawals from the Waccamaw River would require an IBT to transfer water from the Waccamaw to the Shallotte IBT River Basin. The WS/TS (HDR, 1999b) evaluates the Waccamaw River as a source and determined that there are low flows during the summer months and extremely low to potentially no flow during drought conditions. The WS/TS also provides a cursory review of expected water quality and determines that the Waccamaw River water quality is not as desirable as the Cape Fear River water quality because of high color, total and dissolved organic carbon, and possibly high levels of iron and manganese.

To confirm sufficient availability of source water, the most recent 7Q10 low-flow discharge estimate for the Waccamaw River at Highway 130 (upstream of the confluence with Bear Branch) was requested from the USGS. Per North Carolina regulations, no in-stream flow study is required if the run-of-river withdrawal for the proposed project is less than 20 percent of a source's 7Q10. Per communication with the USGS in April 2012, the most recent and provisional 7Q10 low-flow discharge estimate for monitoring station #02109500 (Waccamaw River at Freeland, NC) is 1.5 cfs (see Appendix I). Twenty percent of 1.5 cfs is 0.3 cfs, which is approximately 193,923 gpd. The Northwest WTP is proposed to be expanded from 24 MGD to 36 MGD. If the Northwest WTP is not expanded, the additional 12 MGD of finished water would need to be provided by another WTP. Up to 12.5 MGD of source water would need to be withdrawn from the Waccamaw River to produce 12 MGD of finished water (accounting for treatment losses). This volume is 60 times greater than 20 percent of the 7Q10 low-flow discharge estimate (193,923 gpd); therefore, an in-stream flow study would be required for a withdrawal on the Waccamaw River. A review of the USGS flow data for station #02109500 beginning October 1, 2010 through September 30, 2011, indicates that, river flow is typically less than 20 cfs (approximately 13 MGD) in June, July, and August. Thus, an in-stream reservoir (i.e., impoundment) on the Waccamaw River, an off-stream reservoir, or an Aquifer Storage and Recovery (ASR) system would be necessary to provide the water supply for a 12-MGD WTP and to ensure supply reliability when Waccamaw River flows are low. It is anticipated that at least a 1.5-billion gallon reservoir covering up to 400 acres would be necessary to store excess flow collected in the wet season to meet average annual water supply demands of a 12-MGD WTP. Flow studies of the Waccamaw River would need to be conducted to determine if enough volume of water could be stored in the wet season to provide source water supply year-round and not affect the ecological health of the Waccamaw River.

Raw water quality data from January 2008 to April 2011 were analyzed to compare the Waccamaw River with the Cape Fear River source waters and provide a basic assessment of the type and level of treatment required compared to the alternative of expanding the Northwest WTP. Review of raw water quality results for DWQ Ambient WQ Station #I8970000 from January 2008 to April 2011 indicates that the average raw water turbidity was approximately 4.4 NTU, and all turbidity results were no greater than 12 NTU. The turbidity in the Waccamaw River is generally more variable than for the Cape Fear.

Additionally, the average raw water pH from January 2008 to April 2011 was about 4.7, which is significantly lower than the average pH of the Cape Fear River from January 2008 to April 2011 (6.5) and 6.7 as documented in the 2008 NWWTP PER. A lower pH requires greater volumes of chemicals to adjust the water to a neutral or higher pH for surface water treatment.

Because the Waccamaw WTP would be on an undeveloped site, construction costs are associated with developing a *greenfield* WTP including site work, stormwater facilities, operations and control facilities, and new potable water distribution piping to reach the existing distribution system. Also, the costs for a raw water storage reservoir are included in this option. A factor in evaluating this alternative also includes the increased permitting efforts required for a new facility and its associated storage reservoir and a new withdrawal point along the river. Last, an in-stream flow study would need to be conducted to determine the feasibility of a 12-MGD WTP using Waccamaw River water as source water because of the potential effects on the river's habitat and aquatic biota. Budgetary cost estimates for this alternative are shown in Table 48 below.

Table 48. Budgetary Capital Costs for New Surface Water WTP – 12 MGD (Waccamaw River at Highway 130)

	Quantity	Unit	Unit Cost	Preliminary Cost Opinion
Withdrawal Structure	1	EA	$250,000.00	$250,000.00
New SWTP - Waccamaw River (12 MGD)	1	EA	$60,200,000.00	$60,200,000.00
Off-Stream Reservoir (1.5 billion gallon)	1	EA	$22,000,000.00	$22,000,000.00
30-inch Water Main (Hwy 130/Waccamaw River to Whiteville Rd NW/Hwy 17 Intersection)	67,000	LF	$250.00	$16,750,000.00
Property Acquisition	400	AC	$10,000.00	$4,000,000.00
			Sub Total	$103,200,000.00
Mobilization/Demobilization			6%	$6,192,000.00
General Requirements			4%	$4,128,000.00
Bonds and Insurance			2.5%	$2,580,000.00
Contingency			20%	$20,640,000.00
Engineering, Permitting, Legal and Admin			25%	$25,800,000.00
		Total		$162,540,000.00

The Waccamaw River has average raw water turbidity values (4.4 NTU), which are less than those of the Cape Fear River (16.2 NTU), less coagulant would be required, resulting in lower operational costs. However, because the raw water average pH value for the Waccamaw River (4.7 NTU) is lower than that of the Cape Fear River (6.5 NTU), additional sodium hydroxide (NaOH) would need to be added to raise the pH of the Waccamaw River source water, resulting in increased operational costs. Additionally, per the WS/TS (HDR 1999b), higher color, total and dissolved organic carbon and iron and manganese in the Waccamaw River (as compared to the Cape Fear River) would increase the cost of treating source water from the Waccamaw River.

O&M costs attributed to operating a new 12-MGD WTP are based on existing O&M costs associated with the Northwest WTP and O&M costs that would be associated with the new 30-inch diameter pipeline and with the off-stream reservoir (Table 49). Additionally, new water treatment personnel would be assigned to the Waccamaw WTP. Annual O&M costs for the pipeline are projected to be 1 percent of the pipeline construction costs.

Table 49. Budgetary Annual O&M Costs – 12 MGD Waccamaw WTP

Description	Budgetary O&M Costs - 12 MGD WTP
Salary Expenditures	$958,200.00
Non-Salary Expenditures (chemicals, electricity, raw water intake and storage, equipment O&M)	$2,266,080.00
Pipelines	$167,500.00
Total	$3,391,780.00

On the basis of this information, the budgetary O&M costs for a 12-MGD Waccamaw River WTP and associated raw water storage reservoir and pipelines are approximately $3.4 million per year.

5.3.2 Purchase Water from Existing Utility in Receiving Basin

The County has entered into agreements, in the form of a water purchase contract and an water system interconnection infrastructure cooperative agreement, with the Little River Water and Sewerage Company, Inc. (Little River) in South Carolina for Little River to establish an emergency interconnection and to provide up to a maximum of 170,000 gallons per day of potable water to the County. This value is an upper quantity limit, and Little River does not guarantee emergency supply for the County. This quantity provides additional potable water to the County and will be used to supply the Waccamaw IBT River Basin with future supply (eliminating the need for additional IBT water), but because the maximum quantity is 170,000 gallons per day, the County would need to proceed with an alternative that will supply additional potable water to meet demand in the Shallotte IBT River Basin. The emergency interconnection with the Little River Water Company has been planned for a number of years. No additional infrastructure beyond the actual connection is required since the Little River system is immediately adjacent to the Waccamaw portion of the County’s water system.

5.3.3 Expanded or New Groundwater WTP

Withdrawals of raw water from a groundwater source would not require an IBT. Two groundwater source/treatment options have been evaluated. One option is to expand the County’s existing 211 WTP in the southeastern portion of the County’s service area. The second option is to construct a new groundwater WTP in the western portion of the service area, closer to where future growth is expected to occur.

5.3.3.1 Expansion of 211 WTP

The existing 211 WTP is a lime-softening plant with a permitted capacity of 6 MGD. Its source water is fresh groundwater from the Castle Hayne aquifer, which occurs only in the southeastern portion of the

County. The Castle Hayne aquifer is approximately 175 feet below land surface. It is regarded as fairly permeable, but because it has limited thickness (< 60 feet), the transmissivity is fairly low according to the USGS Water Resources Investigations Report 03-4051 (Harden et al. 2003). The low transmissivity would limit the yield of each well, requiring more wells. Increasing withdrawal from the Castle Hayne aquifer could also cause unacceptable effects on surface water quality, existing water users, and sensitive ecological systems. In many areas, the Castle Hayne aquifer is poorly confined or unconfined, and in places exposed to rapid recharge of surface water via sinkholes.

The existing wellfield would need to be expanded to supply additional capacity. Because drawdown is an issue for this aquifer, future wells could require considerable setbacks from other wells so as not to increase the drawdown or reduce the yield of the well site. A review of the existing wellfield layout indicates that, in general, the existing wells are at least 1,500 linear feet away from each other. The existing wellfield includes 15 wells. If the Northwest WTP were not expanded and the 211 WTP were required to produce the additional 12 MGD of water, the 211 WTP would need to be expanded from a 6-MGD plant to an 18-MGD plant. If the new wells produced water quantity and quality similar to the existing groundwater wells, it is expected that 30 additional wells would be required. Groundwater modeling needs to be conducted to determine the potential hydraulic conditions of an expanded wellfield and the potential for migration of higher TDS water into the wellfield.

Lime softening might be an option for treatment and further evaluation of the groundwater quality is necessary to confirm the required treatment process. Because of the potential variability of the groundwater quality and the potential for saltwater intrusion, a nanofiltration water treatment system is proposed, and the costs associated with a nanofiltration system are provided. As documented in the *Water Supply Master Plan* (Hazen & Sawyer, 2006), preliminary costs for a new 6-MGD nanofiltration WTP at the 211 WTP are approximately $14 million. This cost was increased by a factor of 1.2 to account for inflation using ENR's CCI for July 2006 (7721) and the March 2012 CCI (9267.57) and the preliminary cost is adjusted to account for a 12-MGD WTP.

A review of the County's water mains indicates that the water distribution system piping paralleling Highway 211 from the 211 WTP west to Highway 17 ranges from 12 inches to 16 inches in diameter. The water distribution system piping would need to be upsized or a parallel pipeline would need to be installed along Highway 211 to accommodate the additional 12 MGD of potable water flow from the 211 WTP. Hydraulic modeling would be needed to confirm the recommended diameter of the pipeline. For the purposes of this IBT evaluation, a 30-inch diameter pipeline is assumed in the preliminary opinion of cost for this option. Because the 211 WTP is an existing site, permitting requirements and ancillary facilities are anticipated to be less than for an undeveloped site.

The nanofiltration process produces a concentrate stream that would need to be discharged. Typically, nanofiltration processes operate at 85 to 95 percent recovery, so for a 12-MGD WTP, the concentrate stream would likely range from 0.6 to 2.1 MGD. North Carolina does not allow deep-well injection, so the most feasible option for discharge of the concentrate is to a wastewater collection system or directly to a WWTP. The preliminary opinion of cost summarized in Table 50 assumes the installation of a concentrate pump station and pipeline to discharge the concentrate at the West Brunswick Water Reclamation Facility (WRF) (approximately 72,000 LF away). The nanofiltration concentrate is proposed to be discharged at the *tail end* of the West Brunswick WRF so that upsizing of the WRF's treatment processes to accommodate the concentrate flow is minimized. Further evaluation of the concentrate water quality is necessary to confirm the concentrate discharge location at the WRF.

Table 50. Budgetary Capital Cost - 211 WTP (12 MGD Expansion)

		Quantity	Unit	Unit Cost	Preliminary Cost Opinion
Groundwater Wells (~225 ft depth)		30	EA	$960,000.00	$28,800,000.00
Wellfield Piping (raw water transmission)*		75,000	LF	$85.00	$6,375,000.00
12-MGD Nanofiltration Plant		1	EA	$31,000,000.00	$31,000,000.00
30-inch Water Main (211 WTP to Hwy 211/17 Intersection)		65,000	LF	$250.00	$16,250,000.00
Concentrate Pumping		1	EA	$300,000.00	$300,000.00
Concentrate Discharge Piping	0.6-2.1 mgd	72,000	LF	$150.00	$10,800,000.00
Improvements at West Brunswick Regional WRF		1	EA	$2,000,000.00	$2,000,000.00
Property Acquisition		1	EA	$300,000.00	$300,000.00
				Sub Total	$95,825,000.00
Mobilization/Demobilization				6%	$5,749,500.00
General Requirements				4%	$3,833,000.00
Bonds and Insurance				2.5%	$2,395,625.00
Contingency				20%	$19,165,000.00
Engineering, Permitting, Legal and Admin				15%	$14,373,750.00
* assume 2,500 LF between each well					
			Total		$141,341,875.00

O&M costs attributed to expanding the 211 WTP from 6 to 18 MGD with 12 MGD of nanofiltration treatment are based on O&M costs as documented in the *Technology and Cost Document for the Final Ground Water Rule* (USEPA, 2006) and increased by a factor of 1.2 to account for inflation using ENR's CCI for July 2006 (7721) and the March 2012 CCI (9267.57). Additionally, the cost includes O&M for a concentrate discharge pipeline to the West Brunswick WRF. On the basis of this information, the budgetary O&M costs for adding 12 MGD of nanofiltration treatment at the 211 WTP are approximately $2.3 million per year (Table 51).

Table 51. Budgetary Annual O&M Costs – 211 WTP (12 MGD Expansion)

Description	Budgetary O&M Costs – 211 WTP (12 MGD Expansion)
Chemicals	$136,800
Electricity	$468,000
Membrane and Filters Replacement	$415,200
Equipment	$49,200
Labor	$132,000
Concentrate Discharge	$936,000
Pipeline	$162,500
Total	$2,299,700

5.3.3.2 New Groundwater WTP

A new groundwater-source WTP in the western area of the County would use the Peedee aquifer, which is a freshwater source. The Peedee aquifer is present throughout coastal Brunswick County at depths between 30 and 170 feet below sea level (Harden et al. 2003). It comprises sand and clays in the confining beds and calcareous sandstone to sandy limestone in the transmissive beds. It has lower permeability but is much thicker than the Castle Hayne aquifer. In general, the transmissivity is comparable to or greater than that of the Castle Hayne aquifer. A conceptual cost estimate is provided for an exploratory well program and a production wellfield, summarized in Table 52.

On the basis of water quality data in the USGS report, *Hydrogeology and Ground-water Quality of Brunswick County, North Carolina* (Harden et al., 2003), the required level of treatment can range from lime softening to membrane softening or nanofiltration. Because of the potential variability of the groundwater quality and the potential for saltwater intrusion, a nanofiltration water treatment system is proposed, and the costs associated with a nanofiltration system are provided. As documented in the *Water Supply Master Plan* (Hazen & Sawyer, 2006), preliminary costs for a new 6-MGD nanofiltration WTP at the 211 WTP are approximately $14 million. This cost was increased by a factor of 1.2 to account for inflation using ENR's CCI for July 2006 (7721) and the March 2012 CCI (9267.57) and the preliminary cost is adjusted to account for a 12-MGD WTP.

The potential for saltwater intrusion must be evaluated as part of a qualitative evaluation of potential environmental impacts. If saltwater intrusion is determined to be an issue for this aquifer, it might not be feasible to proceed with plans to increase fresh groundwater withdrawals.

As with other proposed new WTPs on undeveloped sites, the construction costs and permitting activities would be higher than those associated with expanding existing facilities. Other significant cost elements are land acquisition and off-site distribution. Budgetary cost estimates are provided in Table 52. For this estimate, it was assumed that the concentrate discharge from a nanofiltration WTP would be delivered to a County WRF for disposal and that the groundwater WTP would be close to the WRF such that concentrate discharge pumping and piping costs are minimized. The West Brunswick Regional WRF is rated at 6 MGD and is the County's largest WRF. Because of its capacity and proximity to a large water distribution main (30-inch diameter), it could be considered as a potential location for a co-located groundwater WTP. Distribution system modeling is recommended to determine how 12 MGD of finished water delivered into the 30-inch water main near the West Brunswick Regional WRF (near the intersection of Highway 211 and Highway 17) would affect flow dynamics and distribution system water quality. Water main sizing upgrades might be necessary, but because of the proximity of this south-central location to the projected growth areas, the upgrades might be minimal and no distribution system upgrades are included in the conceptual costs of this alternative.

The County has indicated that a new WRF might be constructed farther west and south of the West Brunswick Regional WRF, on property that the County purchased in the past few years. This WRF would be closer to the areas of population growth. Similar to the discussion above, a new WTP could be co-located on that property to reduce the amount of discharge piping necessary to dispose of the nanofiltration concentrate.

Table 52. Budgetary Capital Cost - New Groundwater WTP (12 MGD)

		Quantity	Unit	Unit Cost	Preliminary Cost Opinion
Exploratory Well Program		1	EA	$2,000,000.00	$2,000,000.00
Groundwater Wells (~200 ft depth)		30	EA	$890,000.00	$26,700,000.00
Wellfield Piping (raw water transmission)*		75000	LF	$85.00	$6,375,000.00
12 MGD Nanofiltration Plant		1	EA	$31,000,000.00	$31,000,000.00
Concentrate Pumping		1	EA	$125,000.00	$125,000.00
Concentrate Discharge Piping	0.6-2.1 MGD	800	LF	$150.00	$120,000.00
Improvements at West Brunswick Regional WRF		1	EA	$2,000,000.00	$2,000,000.00
Property Acquisition		1	EA	$200,000.00	$200,000.00
				Sub Total	$68,520,000.00
Mobilization/Demobilization				6%	$4,111,200.00
General Requirements				4%	$2,740,800.00
Bonds and Insurance				2.5%	$1,713,000.00
Contingency				20%	$13,704,000.00
Engineering, Permitting, Legal and Admin				18%	$12,333,600.00
* assume 2,500 LF between each well					
			Total		$103,122,600.00

O&M costs attributed to a new 12-MGD groundwater nanofiltration WTP are based on O&M costs as documented in the *Technology and Cost Document for the Final Ground Water Rule* (USEPA 2006) and increased by a factor of 1.2 to account for inflation using ENR's CCI for July 2006 (7721) and the March 2012 CCI (9267.57). On the basis of this information, the budgetary O&M costs for a new 12-MGD nanofiltration treatment plant adjacent to a WRF are approximately $2.15 million per year (Table 53).

Table 53. Budgetary Annual O&M Costs – New Groundwater WTP (12 MGD)

Description	Budgetary O&M Costs - 12 MGD NF WTP
Chemicals	$136,800
Electricity	$468,000
Membrane and Filters Replacement	$415,200
Equipment	$49,200
Labor	$132,000
Concentrate Discharge	$936,000
Total	$2,137,200

Further consideration of this alternative would require a groundwater quality and quantity evaluation, which would be included in an exploratory well program. Additionally, confirmation that a water treatment process waste stream could be discharged to and treated by the West Brunswick Regional WRF or another WRF would be necessary. Also, the development of a new raw water source would need to be evaluated to determine if any conflict exists with the County's contract with LCFWSA.

5.3.4 Seawater Desalination WTP

The County is adjacent to the ICWW and Atlantic Ocean, which has a virtually unlimited quantity of water available for treatment. A new WTP could be in the County's service area where the population growth is occurring. For the purposes of this evaluation, the Holden Beach area is the area of consideration because it is centrally located along the coastal area of the County. Historically, seawater desalination has proven to be cost-prohibitive compared to treating other sources of raw water. A conceptual level cost evaluation was completed for the treatment facilities, intake structures and raw water mains, distribution mains and site work associated with a new desalination facility. Costs are also included for a distribution system blending water analysis to determine if there are any projected effects on the water quality as the treated seawater mixes with the treated surface water and groundwater from the existing treatment plants.

Disposal of concentrate or brine is typically a costly component for a seawater desalination plant. Because North Carolina does not allow deep injection wells, the most feasible option for concentrate management is to return the concentrate to the ICWW. Water quality modeling of the brine discharge and its effect on the ICWW would need to be performed as part of permitting the facility. Seawater desalination also requires additional environmental permitting for both withdrawal of water and concentrate disposal. It is anticipated that the conceptual costs as provided below in Table 54 preclude this alternative from further consideration. These budgetary capital costs were developed using Tetra Tech's historical cost database.

Table 54. Budgetary Capital Cost - Seawater Desalination WTP (12 MGD)

	Quantity	Unit	Unit Cost	Preliminary Cost Opinion
Withdrawal System	1	EA	$3,000,000.00	$3,000,000.00
Seawater Desalination WTP (12 MGD)	1	EA	$190,000,000.00	$190,000,000.00
Brine Discharge	1	EA	$6,000,000.00	$6,000,000.00
30-inch Water Main (Holden Beach area to 30-inch tie-in along Main Steet in Shallote)	45,000	LF	$250.00	$11,250,000.00
Property Acquisition	1	EA	$1,800,000.00	$1,800,000.00
			Sub Total	$212,050,000.00
Mobilization/Demobilization			6%	$12,723,000.00
General Requirements			4%	$8,482,000.00
Bonds and Insurance			2.5%	$5,301,250.00
Contingency			20%	$42,410,000.00
Engineering, Permitting, Legal and Admin			25%	$53,012,500.00
		Total		$333,978,750.00

Seawater desalination's O&M costs are very high, primarily because of the power costs associated with operating the treatment processes, particularly operating the high-pressure feed pumps for the reverse osmosis treatment process. The budgetary costs for this water supply option are shown below and are expected to be at least $12.1 million per year (Table 55).

Table 55. Budgetary Annual O&M Costs – Seawater Desalination WTP (12 MGD)

Description	Seawater Desalination WTP (12 MGD)
Seawater Desalination WTP	$12,000,000.00
Pipeline	$112,500.00
Total	$12,112,500.00

5.4 OTHER OPTIONS FOR REDUCING THE IBT

5.4.1 Surface Water Storage

Two options for storing surface water from the Cape Fear River are being evaluated. One option is a surface water off-line storage reservoir, and the other option is an ASR system. The first ASR system in North Carolina was built by Greenville Utilities Commission and began operation in 2010. The Cape Fear Public Utility Authority (CFPUA) is beginning an ASR Well Testing Program in 2012 at its elevated tank site on Westbrook Avenue in Wilmington. Results from this study will be included in a pending study by the County of whether ASR at the County's 211 plant could result a reduction in supply from surface water withdrawal from the Cape Fear River to meet potable water demands during the dry season and during peak demand events such as the July 4th holiday.

5.4.2 Water Conservation and Reuse

The County's water conservation program is described in detail in Section 7. Further development of water conservation programs in the County is expected to reduce the *per capita* demand for potable water in the service area, although no specific *per capita* demand targets have been set. Although water conservation alone would not be sufficient to offset future water demands and alleviate the need for an IBT, *per capita* water demand would be evaluated annually and used to project future flows as a part of the County's capital planning processes. Likewise, although the reuse of reclaimed wastewater in the Shallotte IBT River Basin will help to offset potable demands and minimize IBTs from the Cape Fear IBT River Basin, consumptive reuse in the Shallotte IBT River Basin would still count toward the proposed IBT. The County's current and future planned water reuse are discussed in Section 1.4.

5.4.3 Return of Wastewater to Source Basin

Treated wastewater in the Shallotte IBT River Basin can be returned to the Cape Fear IBT River Basin for discharge or land application, or as reclaimed water for a variety of residential, commercial and industrial uses. As discussed in Section 1.5, four of the County's six existing municipal WWTPs (representing approximately 89 percent of permitted wastewater treatment capacity) produce reuse quality effluents. Several options exist for returning wastewater from the Shallotte to the Cape Fear IBT River Basins:

1) Pumping treated effluent from the West Regional plant to the Cape Fear IBT River Basin for discharge, land application, or reuse. The West Regional Plant already has a 6.0-MGD capacity (half of the proposed IBT) and is expandable to 12 MGD.
2) Pumping raw sewage from the Shallotte IBT River Basin to an expanded Northeast Regional plant (or one of the other plants that discharges in the Cape Fear IBT River Basin).
3) Building a new treatment plant or multiple decentralized plants in or closer to the Cape Fear IBT River Basin to treat wastewater from Shallotte IBT River Basin for dispersal in the Cape Fear IBT River Basin.

Although each option listed above has merit, it is believed that option #1, pumping treated effluent from the West Regional plant to the Cape Fear IBT River Basin would be the least costly option because a significant portion of the treatment capacity is already installed. Conveyance costs are presumed to be the same order of magnitude for all the options listed. Because option #1 is likely to be least costly, it will be used to provide a baseline cost estimate for the *return of wastewater to source basin* management options.

As indicated, the West Regional plant already has 6 MGD of treatment, storage, and spray irrigation capacity, and plans are to eventually upgrade to the full proposed IBT flow of 12 MGD. Accordingly, treatment costs are not included as a line item for the cost estimates in Table 56 and Table 57 (capital costs) and Table 58 (annual O&M costs).

Because approval for a new, major discharge to the lower Cape Fear River is likely to be subject to significant permitting obstacles, only land application is considered in this option. On the basis of NRCS soil data for the County, it appears that the Cape Fear IBT River Basin features several areas with Baymeade and Kureb soil series, which are well-drained, sandy soils and are generally suitable for land application. However, without more detailed investigation, it is unclear whether these areas would be available for purchase by the County for effluent dispersal. Assuming that land is available, several options could be considered for land application. Two options have been considered for this option: traditional spray irrigation and rapid infiltration.

The spray irrigation and rapid infiltration options would both require similar transfer pumping and piping (to convey treated effluent from the West Regional plant to the land application area) and distribution system pressurization pumping systems. Compared to rapid infiltration, traditional spray irrigation systems generally require substantial amounts of suitable land on which to apply effluent. Spray irrigation system also require relatively large storage reservoirs to hold treated effluent during wet or freezing periods. Although sizing of storage for spray irrigation systems is based on a site-specific water balance, the DWQ typically requires a minimum of 30 days of storage and, in fact, the existing spray irrigation system at the West Regional plant has 30 days of storage. Depending on soil and site characteristics, rapid infiltration systems (which are defined by DWQ for the Coastal Plain as sites receiving more than 1.75 inches of effluent per week) in the Coastal Plain are often loaded at rates of up to 5 gpd per square foot (gpd/sf) and sometimes up to 10 gpd/sf. Because of their high loading rate, rapid infiltration systems are more susceptible to subsurface constraints that limit the movement of water away from the site and toward a receptor (i.e., surface water). Although sites that are suitable for rapid infiltration typically do not require on-site effluent storage, on the basis of hydrogeologic investigations and modeling, rapid infiltration systems could require artificial drainage to ensure that the resulting groundwater mound that forms beneath the application area does not impede movement out of the infiltration area and that effluent does not surface downgradient.

The County uses a combination of traditional (i.e., slow rate) spray and drip irrigation and rapid infiltration, along with irrigation at golf courses to manage reclaimed water from the West Regional plant. Costs for the County's existing land application/reuse system, sized to manage 6.0 MGD of reclaimed water (in the Shallotte IBT River Basin), were about $21.5 million, for a unit cost of approximately $3.58/gpd land application capacity. As indicated in Table 56 and Table 57, land application in the Cape Fear IBT River Basin, not including transmission from the West Regional plant, was estimated to range between $10,631,250 for 100 percent rapid infiltration to $92,452,500 for 100 percent spray irrigation, with much of the cost difference attributable to land acquisition, site preparation and storage requirements. For comparison purposes, the unit costs of these options range from $0.89/gpd (rapid infiltration with gravity subsurface drainage) to $7.70/gpd (for slow rate spray irrigation). These budgetary capital costs were developed based on a variety of sources including RSMeans CostWorks® cost estimation tool using 2012Q1 data for Wilmington, North Carolina, EPA's 2006 update to *Land Treatment of Municipal Wastewater Effluents* guidance manual, the County's previous costs for the West Regional WWTP land application system and professional experience and judgment.

Note that the feasibility of both options is highly dependent on locating and acquiring suitable property of sufficient size and proximity in the Cape Fear IBT River Basin.

Table 56. Budgetary Capital Cost - 12 MGD Land Application in CFR Basin from West Regional WWTP (Rapid Infiltration sub-option)

Line Item	Quantity	Unit	Unit Cost	Extended Cost
Transmission (12 miles, 30-inch diameter pipe)	63,400	LF	$250.00	$15,850,000.00
Conveyance pumping station	1	EA	$2,000,000.00	$2,000,000.00
Pre-application treatment	N/A			
Subsurface drainage	1	EA	$500,000.00	$500,000.00
Spray irrigation pumping station	1	EA	$700,000.00	$700,000.00
Field preparation (60-acre rapid infiltration + 50% for buffers)	1	EA	$1,800,000.00	$1,800,000.00
Field distribution equipment (spray irrigation, installed)	60	acre	$40,000.00	$2,400,000.00
Land acquisition	90	acre	$15,000.00	$1,350,000.00
SUBTOTAL				$24,600,000.00
Mobilization/demobilization			6%	$1,476,000.00
General requirements			4%	$984,000.00
Bonds and Insurance			2.50%	$615,000.00
Contingency			20%	$4,920,000.00
Engineering, Permitting, Legal and Admin			25%	$6,150,000.00
		Total		$38,745,000.00

Table 57. Budgetary Capital Cost - 12 MGD Land Application in CFR Basin from West Regional WWTP (Spray Irrigation sub-option)

Line Item	Quantity	Unit	Unit Cost	Extended Cost
Transmission (12 miles, 30-inch diameter pipe)	63,400	LF	$250.00	$ 15,850,000.00
Conveyance pumping station	1	EA	$2,000,000.00	$ 2,000,000.00
Pre-application treatment	N/A			
Storage (360 MG, 12' liquid depth + 2' freeboard)	1	EA	$ 4,000,000.00	$ 4,000,000.00

Line Item	Quantity	Unit	Unit Cost	Extended Cost
Spray irrigation pumping station	1	EA	$ 700,000.00	$ 700,000.00
Field preparation (2,100-acre slow rate spray irrigation)	1	EA	$ 12,000,000.00	$ 12,000,000.00
Field distribution equipment (spray irrigation, installed)	2,100	acre	$ 5,000.00	$ 10,500,000.00
Land acquisition	2,100	acre	$ 15,000.00	$ 31,500,000.00
SUBTOTAL				$ 76,550,000.00
Mobilization/demobilization			6%	$ 4,593,000.00
General requirements			4%	$ 3,062,000.00
Bonds and Insurance			2.50%	$ 1,913,750.00
Contingency			20%	$ 15,310,000.00
Engineering, Permitting, Legal and Admin			25%	$ 19,137,500.00
			Total	$ 120,566,250.00

Under this option, it is assumed that the existing land application and reuse would be discontinued, or at least greatly decreased, in the Shallotte IBT River Basin and instead shifted to the Cape Fear IBT River Basin. Because the facilities being operated would be very similar to those in operation, there would be no additional O&M demands above those associated with the West Regional WWTP and land application system. Additional O&M demands associated with the new effluent pumping station and conveyance piping are summarized in Table 58.

Table 58. Budgetary Annual O&M Costs – Land Application in Cape Fear IBT River Basin Option

Description	Estimated Annual O&M Cost
Pumping Cost[1]	$623,000.00
Pipeline Maintenance	$159,000.00
Total	$782,000.00

Note:

[1] Assume 900-hp total, 85 percent pump efficiency, $0.09/kWhr

5.5 Summary of Alternatives

The preceding sections provide discussion of a number of alternatives including a No Additional IBT alternative. The No Additional IBT alternative is not recommended because the County has demonstrated the need for an expansion of its water treatment system; not doing so would compromise its ability to provide reliable, high-quality potable water to its customers, particularly those in the Shallotte IBT River Basin. Additional alternatives to the increase in IBT associated with Northwest WTP expansion are summarized in Table 59 including costs and qualitative assessments of permitting and potential environmental impacts. A rating of permitting difficulty reflects the general regulatory requirements, cost, and time involved in obtaining the necessary permits and approval. Technical difficulty is related to the planning, design, permitting, and construction effort to implement the project. For example, a project with low technical difficulty is expected to have the least amount of effort from conception to construction, whereas a project with high technical difficulty is expected to require considerable effort to implement.

Environmental impacts can be direct, secondary, and cumulative in nature. Direct impacts are those effects caused by a project that occur at the same time and place, and result from project construction and the project itself. Secondary and cumulative impacts, particularly growth-inducing effects, on natural resources occur later in time or farther removed in distance as a result of the project's construction and operation.

Additional IBT associated with an expansion of the Northwest WTP is recommended as the preferred alternative because of a lower cost (capital, O&M), low technical difficulty, an equivalent or lower level of permitting difficulty, a low level of direct impacts (e.g., new WTP alternatives would have additional construction impacts for a new site), and an equivalent level of secondary and cumulative impacts. Return of additional wastewater to the source would add a minimum of $39 million to the cost of the preferred alternative without significant benefit to the resource.

Table 59. Summary Water Supply Alternatives to Additional IBT

Alternative	Estimated Capital Construction Costs (Budgetary)	Estimated Annual O&M Costs	Technical Difficulty	Permitting Difficulty	Direct Environmental Impacts	Secondary and Cumulative Impacts
Additional IBT – (Associated w/ Northwest WTP Expansion)	$90.7M	$1.5M	Low	Medium	Low	Medium
Waccamaw Surface WTP	$163M	$3.4M	Medium	High	High	Medium
Expand 211 WTP	$141M	$2.3M	Medium	Medium	Low	Medium
New Groundwater WTP	$103M	$2.1M	Medium	Medium	Medium	Medium
Seawater Desalination Plant	$334M	$12M	High	High	Medium/High	Medium
Return of Additional Wastewater to Source Basins (includes cost to expand NW WTP)	Low End: $129M ($38.7M + $90.7M) High End: $212M ($121M + $90.7M)	$2.3M ($0.78M + $1.5M)	Medium	Medium	Medium	Medium

Combined with expansion of the Northwest WTP and associated increase in IBT, the County proposes to use a combination of alternatives to limit transfer of water. As indicated, water conservation and reuse are key elements of the County's current water management plan and they reduce demand and associated IBT. It is not known how changes to these programs would result in additional demand reduction and future water transfer. In addition, the County has reduced the need to transfer additional water by developing an interconnection and agreement to purchase water from the Little River Water and Sewerage Company for potable water service in the Waccamaw River subbasin. Finally, the County is planning a study of ASR storage at the 211 plant to reduce withdrawal of surface water during peak demand periods. The technical viability of this option is unknown.

The next section discusses in more detail the potential direct, secondary, and cumulative impacts of the preferred alternative.

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6 Predicted Environmental Effects

The preceding Sections 2 through 4 discuss the existing environmental characteristics or features of the source and receiving basins of the County IBT. Section 6 discusses the potential environmental effects or impacts of the preferred alternative (i.e., an increase in IBT) on these environmental features. The impacts are categorized as direct, secondary, and cumulative. NCDENR's recent guidance on State Environmental Policy Act (SEPA) documents and secondary/cumulative impacts (NCDENR, 2011b) defines each as follows:

- **Direct Impacts** are those effects caused by a project that occur at the same time and place. Direct impacts result from project construction and the project itself.
- **Secondary Impacts**, or indirect impacts, on natural resources occur later in time or farther removed in distance as a result of the project's construction and operation. These impacts can further be divided into two categories:
    - Encroachment-Alteration Effects: The physical presence of the project could affect the function of natural systems through a series of secondary effects.
    - Growth-Inducing Effects: The presence of a project could affect the pattern or density of development.
- **Cumulative Impacts** are those that result from the incremental effects of the original direct impact combined with the impacts of other past, present and reasonably foreseeable projects in the area.

6.1 SOURCE BASIN (CAPE FEAR)

6.1.1 Direct Impacts

Direct impacts associated with the Northwest WTP alternative include those related to withdrawal of water from the Cape Fear River above Lock and Dam #1. Direct impacts of the plant expansion such as those that could result from project construction would be reviewed as part of an EA prepared specifically for the plant expansion. The current environmental document is being prepared to support approval of an IBT certificate only and, therefore, does not involve any construction activities. *An environmental document for the plant expansion would be prepared separately and be reviewed through SEPA if an IBT certificate is approved.* Therefore, the following analysis focuses on the potential impacts of water withdrawal.

The LCFWSA supplies raw water to the Northwest WTP from an intake on the Cape Fear River above Lock and Dam #1. This low head dam causes the river to impound slightly behind it before spilling over and continuing down the river. The County is one of several LCFWSA customers receiving a portion of the withdrawal. A FONSI for expansion of the LCFWSA's intake to accommodate a 96-MGD withdrawal above Lock and Dam #1 was issued by NCDEH in 2009. The supporting environmental document (McKim and Creed, 2008) provided a comparison of cumulative water demand at this river location to the published 7Q10 flow and cites hydrology modeling conducted by NCDWR, which suggested sufficient water supply through 2050.

The new LCFWSA intake has now been constructed and is in operation. As discussed in McKim and Creed (2008), the three new intake screens manufactured by Johnson Screens are connected to a new 60 inch intake pipeline. The configuration of the new, additional intake is "identical in form and operation" to the existing intake pipe and no known impacts to aquatic species from the previous configuration have been reported according to the EA approved by NCDEH. Further from McKim and Creed (2008), the mesh size (slot size is approximately 0.118 inches) was designed to prevent entrainment of fish including eggs and larvae, and velocity through the intake screens will not exceed 0.5 feet per second.

The Cape Fear Basin Water Supply Plan (NCDWR, 2002) also suggests that a surrogate for safe yield at Lock and Dam #1 is 20 percent of the published 7Q10. However, rather than relying upon a safe yield value such as this, DWR requested during scoping that the County run the Cape Fear Hydrologic Model to determine whether any difficulties would exist in meeting future demands. Therefore, the following analysis builds on the previous modeling analysis by DWR and focuses on the direct impact of the County withdrawal and the cumulative impact of all existing and projected withdrawals at the dam, and whether water supply needs are met in the future.

6.1.1.1 Impacts Above Lock and Dam #1

6.1.1.1.1 Hydrology Analysis—Background

NCDWR (2008) undertook an investigation of surface water supplies in the Cape Fear, including increased withdrawals from behind Lock and Dam # 1, using a calibrated hydrology model through 2050 conditions. The Cape Fear Hydrologic Model[1] or CFHM (HydroLogics, 2006) is an implementation of OASIS (HydroLogics, 2009), which is a generalized mass balance model designed to assess the impacts of different water allocation policies and facilities over the historic record of inflows. It works on a daily timestep and is not designed for hydraulic flood routing, but it is applicable to drought management. The inflow data set is based on *unimpaired* gage flows and *impairments.* The unimpaired gage flows are the recorded gage flows corrected for human intervention or impairments. The impairments are modifications to the natural flows from reservoir storage, consumptive withdrawals, and discharges.

The existing CFHM is based on records from 46 streamflow gages, running from January 1930 to September 2004—many of which have missing data estimated. A total of 12 of the 46 gages require correction for impairment. Altogether, there are approximately 40 irrigation source nodes, 40+ municipal and industrial demand nodes, and 60+ discharge nodes in the model. The model also contains a series of operating rules. The original model data stopped in September 2004. The model has already been updated through water year 2005 (NCDWR, 2008), but not for subsequent years. DWR is leading a process to update the model, but, it was not available during preparation of this environmental document. Therefore, the existing model is being used to support the County's IBT request.

Previous analysis with a cumulative 2050 withdrawal from behind Lock and Dam #1 indicates that full demand at this model node was met (NCDWR, 2008). For this environmental document, results of this analysis are presented with data taken directly from the existing model and include updates to the County portion of the withdrawal that are based on revised demand data provided in Section 1.

The model's terminus is at Lock and Dam #1. Only one water intake is below Lock and Dam #1: International Paper. The industrial withdrawal is just downstream of the dam. Withdrawals for 2010 averaged 34.7 MGD (NCDWR, 2010); however, nearly all this water is discharged in close proximity of the withdrawal.

Changes in hydrology can affect habitat for aquatic species. Given the size of the withdrawals relative to the river's low flow regime and the tidal nature of the river below Lock and Dam #1, NCDWR deemed that a study of stream flow impacts on habitat and recreation downstream of the dam would not be needed (July 17, 2009 letter from NCDWR to Tetra Tech; contained within the scoping comments provided in

[1] NCDWR has begun updating the Cape Fear Hydrologic Model; however, this process is not complete. Therefore, the current version of the model was used for the analysis contained herein.

Appendix C). Cumulative withdrawals represent about 3% of mean river flow (5,063 cfs), 6% of median river flow (2,540 cfs), and 17% of 10th percentile river flow (969 cfs) based on the most recent USGS Water Data Report. The cumulative withdrawals incorporate all LCFWSA customers including Brunswick just above the Lock and Dam and are 164 cfs for the 2050 planning horizon.

6.1.1.1.2 Hydrology Analysis—Methods

The following hydrologic analysis explores three general scenarios derived from the CFHM: 2003, the baseline condition for the OASIS application, and 2030 and 2050, which are future projected conditions. The 2003 baseline scenario reflects the discharges and withdrawals (represented as monthly averages) that were reported for 2003 applied to the model's long-term simulation (1930–2005). Likewise, the 2030 and 2050 projected scenarios are the projected 2030 and 2050 withdrawals applied to the 76-year simulation. The CPFM has three model nodes to represent demands in the location immediately upstream of Lock & Dam 1. These model nodes and the downstream model junction where results are supplied are summarized in Table 60.

Table 60. Node Information from the Cape Fear Hydrologic Model

OASIS ID	Type	Comment
820	Junction	Cape Fear River mainstem junction upstream of Lock & Dam 1
821	Demand node	Bladen County withdrawal
823	Demand node	Wilmington (CFPUA) withdrawal
825	Demand node	LCFWSA withdrawal which consists of: • Brunswick County • Pender County • 2 industrial users

Since the previous CFHM analysis was conducted by NCDWR in the mid-2000s through about 2008, the County has revised its 2030 and 2050 water demand. Therefore, the previous withdrawal estimates have been replaced with the revised values by adjusting data from Node 825, which represents the LCFWSA demand (excluding CFPUA, which has its own node (823) in the model, collocated with LCFWSA). Note that CFPUA is a customer of LCFWSA but the flows are divided in the model.

The average withdrawals for the County are provided in Table 61. The 2003 daily withdrawal values provided by the County were processed into monthly values. Data from the County's 2008 Local Water Supply Plan (LWSP) was used as a monthly template for 2030 and 2050 flows. The resulting monthly series for each of the analysis years are shown in Figure 37.

Table 61. Brunswick County Average Daily Withdrawal (via LCFWSA) from the Cape Fear River

Year	Comment	Withdrawal (cfs)	Withdrawal (MGD)
2003	Withdrawal obtained from Brunswick County	11.3	7.30
2030	Previous withdrawal estimate from CFHM	24.7	15.96
2030	Revised withdrawal estimate	23.4	15.13
2050	Previous withdrawal estimate from CFHM	35.1	22.70

Year	Comment	Withdrawal (cfs)	Withdrawal (MGD)
2050	Revised withdrawal estimate	33.6	21.73

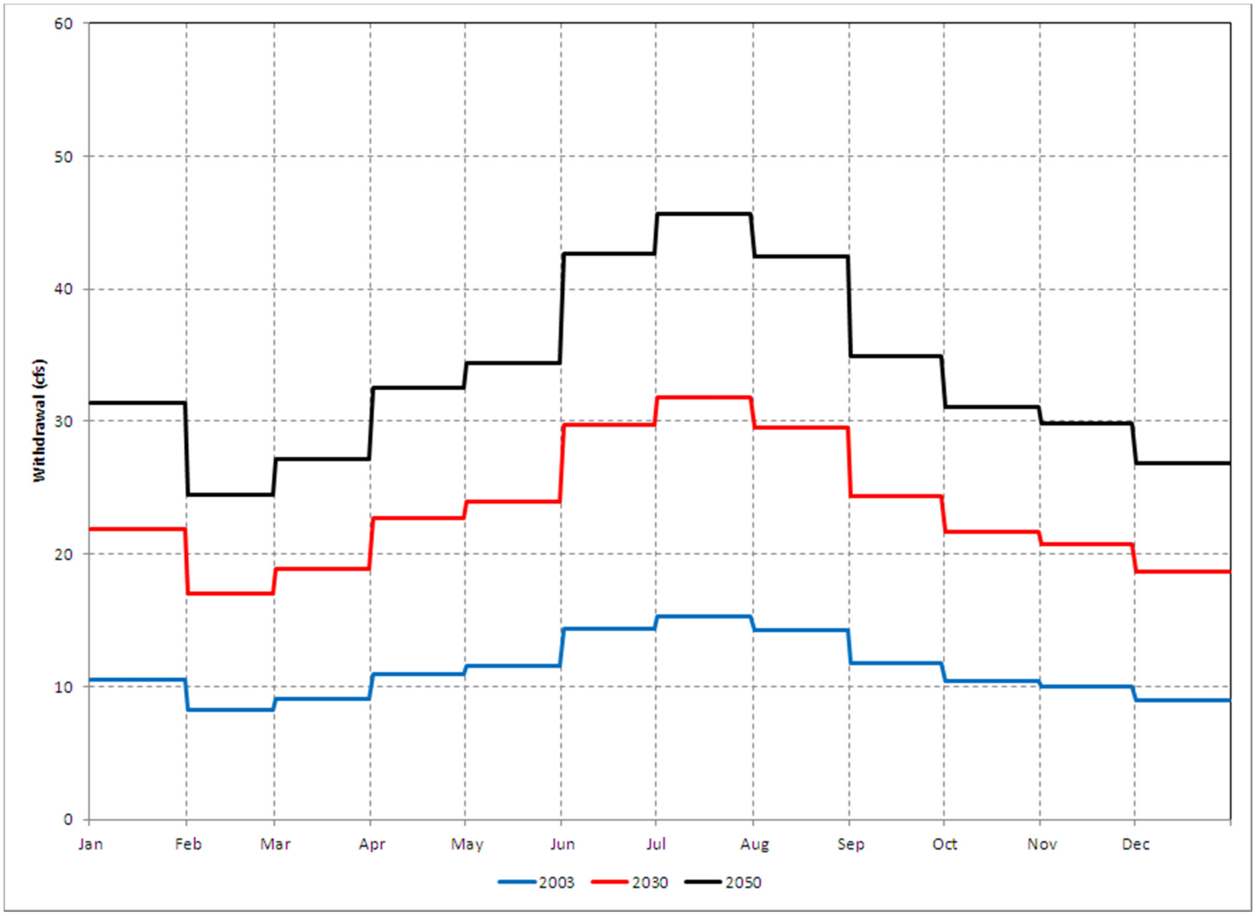

Figure 37. Brunswick County NWTP Average Monthly Withdrawal (cfs) Series Used for Each Scenario

6.1.1.1.3 Hydrology Analysis—Results

The simulated daily flow series at model junction 820 is plotted using a flow duration curve with and without additional Brunswick County withdrawal (beyond 2003). The curve shows the amount of time flows at a certain level are exceeded. For example, the lowest flow simulated would be exceeded 100 percent of the time. Results in Figure 38 (2003), Figure 39 (2030) and Figure 40 (2050) focus on low flow periods where the greatest impact would be expected to occur (full flow duration curves are provided in Appendix J).

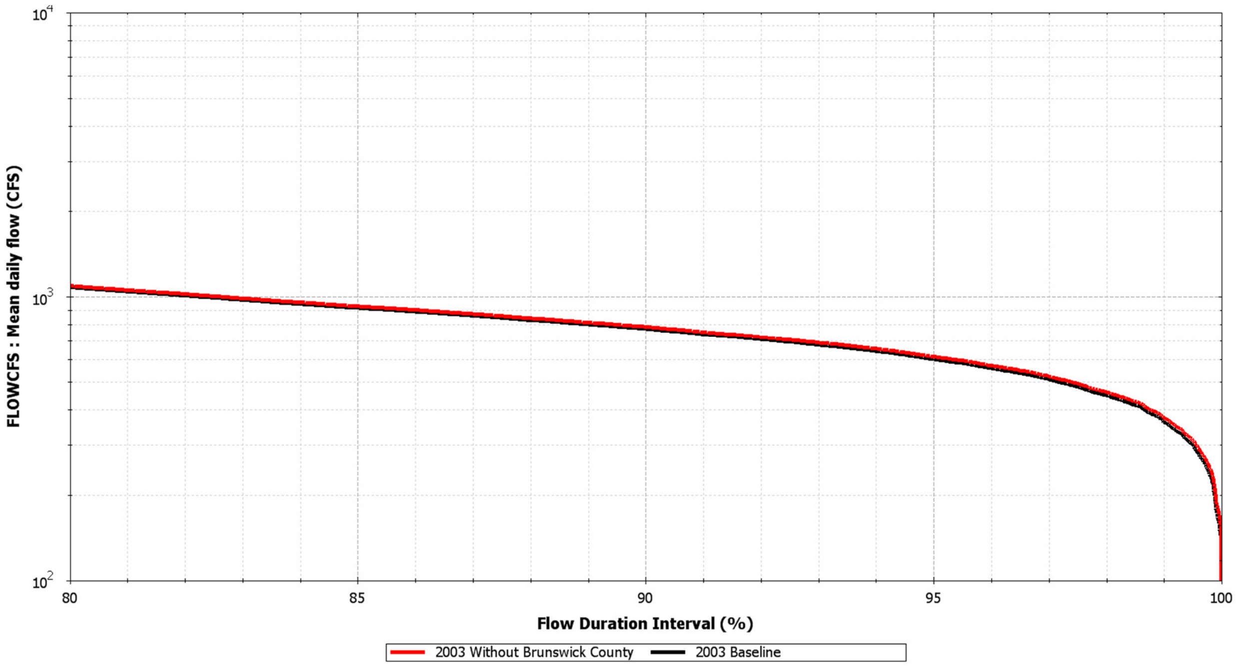

Figure 38. Flow Duration Curve of 2003 Simulated Flow at Lock and Dam #1 With (Black) and Without (Red) Additional Brunswick County Withdrawal (Focused on Low Flow)

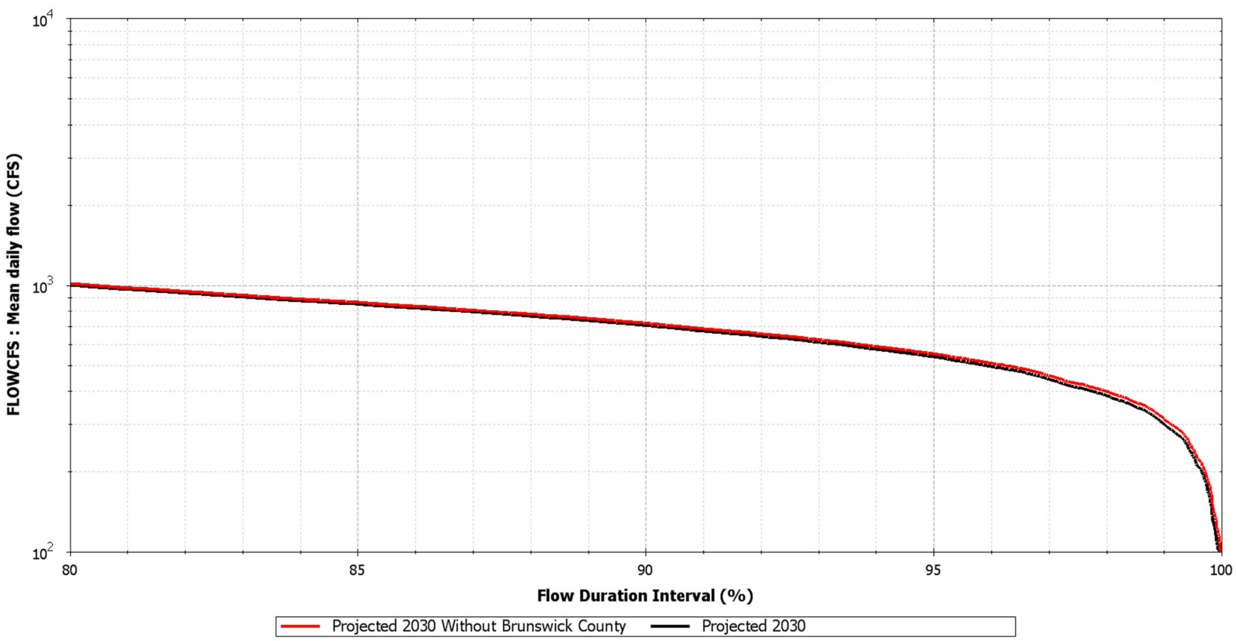

Figure 39. Flow Duration Curve of 2030 Simulated Flow at Lock and Dam #1 With (Black) and Without (Red) Additional Brunswick County Withdrawal (Focused on Low Flow)

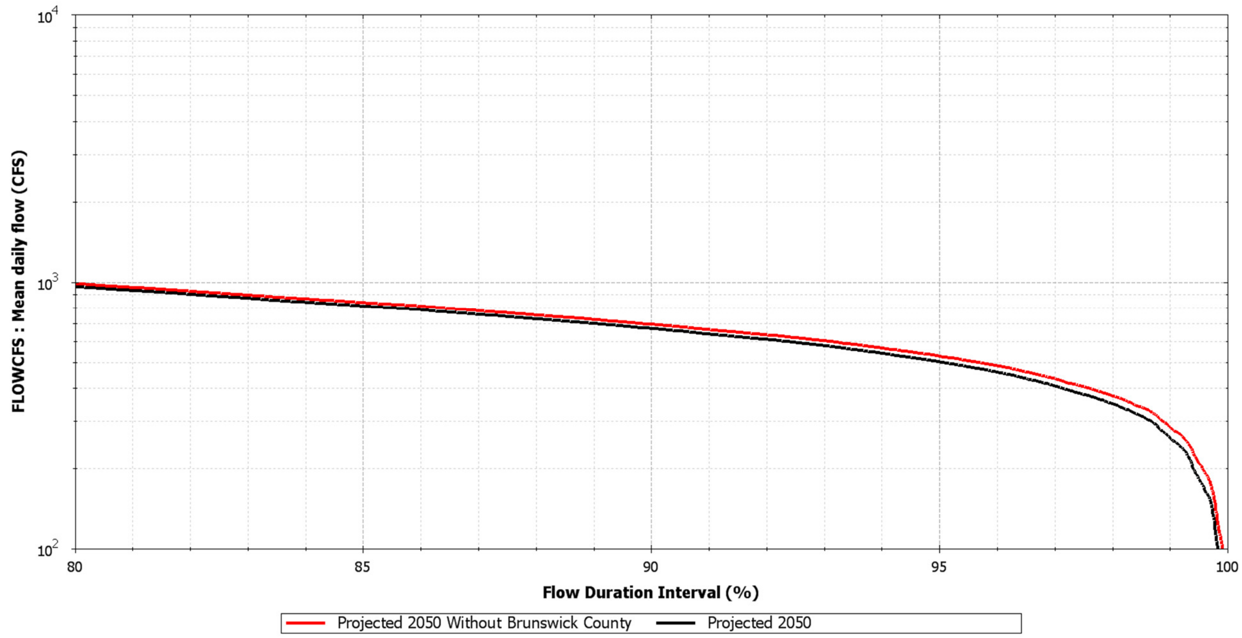

Figure 40. Flow Duration Curve of 2050 Simulated Flow at Lock and Dam #1 With (Black) and Without (Red) Additional Brunswick County Withdrawal (Focused on Low Flow)

Comparison of the incremental increase in the projected withdrawals with and without the additional County withdrawal is shown in Table 62 and Table 63, respectively. The percent difference from the incremental increase at some of the lowest flows is 3 to 5 percent (for flows exceeded 95% of the time).

Table 62. Incremental Impact of Brunswick Withdrawal for 2030 Scenario on Stream Flow

Flow Statistic	Description	Simulated Flow with 2030 Cumulative Withdrawals Except for Brunswick County at 2003 Withdrawal (cfs)	Simulated Flow with 2030 Cumulative Withdrawals (cfs)	Percent Difference Due to Increase in Brunswick County Withdrawal (2003 to 2030)
5th Percentile	Flow exceeded 95% of time	549.52	535.83	-2.5%
10th Percentile	Flow exceeded 90% of time	715.30	701.95	-1.9%
50th Percentile	Median Flow	2,874.81	2,861.76	-0.45%
Mean	Average Flow	5,194.38	5,182.21	-0.23%

Table 63. Incremental Impact of Brunswick Withdrawal for 2050 Scenario on Stream Flow

Flow Statistic	Description	Simulated Flow with 2050 Cumulative Withdrawals Except for Brunswick County at 2003 Withdrawal (cfs)	Simulated Flow with 2050 Cumulative Withdrawals (cfs)	Percent Difference Due to Increase in Brunswick County Withdrawal (2003 to 2050)
5th Percentile	Flow exceeded 95% of time	525.30	499.10	-5.0%
10th Percentile	Flow exceeded 90% of time	690.97	667.20	-3.4%
50th Percentile	Median Flow	2,807.42	2,784.97	-0.80%
Mean	Average Flow	5,130.55	5,108.16	-0.44%

An additional 2050 scenario, representing a potential maximum withdrawal, was used to further assess impacts of water withdrawal. This scenario uses the 2050 demands as described previously but assigns maximum daily flow values for the duration of the month of July rather than average monthly values. July is the month of maximum demand based on consistent historical patterns. The July daily maximum withdrawal just above model junction 820 was based on the 2011 LWSP for LCFWSA. This value is assumed to incorporate all demands at this point in the river (i.e., LCFWSA including Brunswick County, Wilmington or CFPUA, and Bladen County) and assumes a value of 106 MGD or 164 cfs, the reported surface supply in the LWSP. This withdrawal value is also equal to the LCFWSA annual demand of 88.627 MGD for 2050 multiplied by the July peaking factor from 2011 (equal to 1.192), and is only slightly greater that the unadjusted average July withdrawals (149 cfs or 96 MGD) in the base 2050 scenario.

Results comparing the 2050 average scenario and maximum withdrawal scenario are shown graphically in Figure 41. Table 64 shows a minor departure between 2050 average and maximum scenarios with differences of about one percent or less.

Note that while these results represent the impacts of cumulative withdrawal at Lock and Dam #1, a vast majority of the water that is withdrawn remains in the source basin.

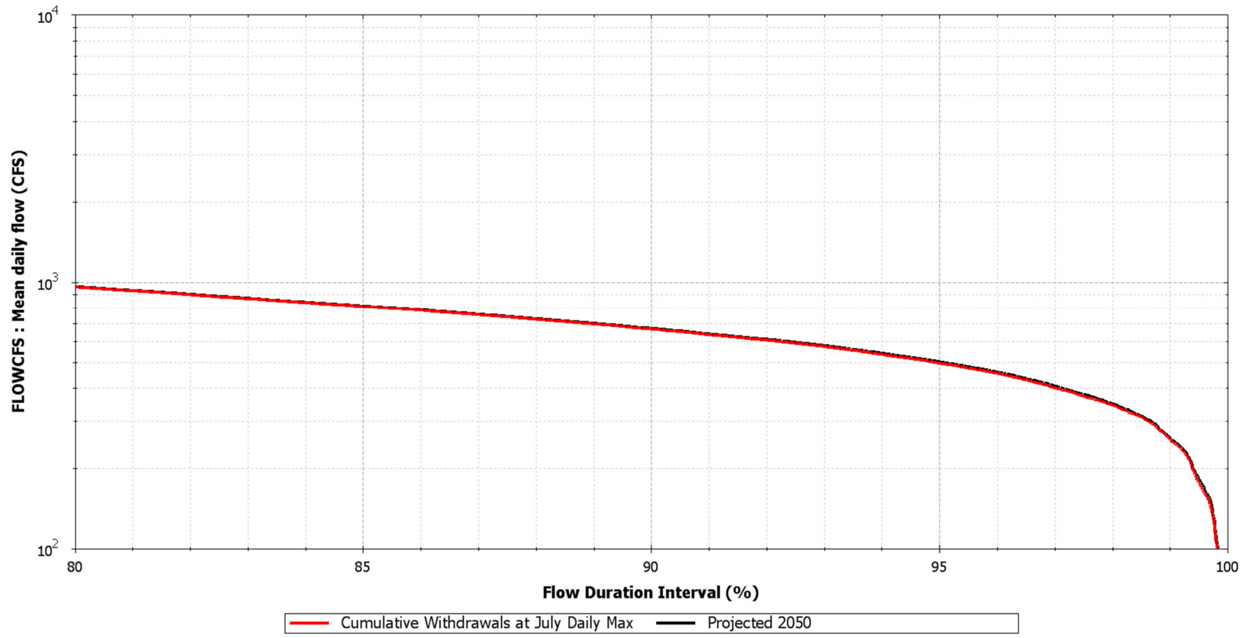

Figure 41. Flow Duration Curve of 2050 Simulated Flow at Lock and Dam #1 With Daily Maximum Values Applied for the Month of July Only (Focused on Low Flow)

Table 64. Incremental Impact of Cumulative Withdrawal for July at Daily Maximum for 2050 Scenario on Simulated Flow at Lock and Dam #1

Flow Statistic	Description	Simulated Flow with 2050 ***Monthly Average*** Withdrawals (cfs)	Simulated Flow with 2050 ***July Daily Maximum*** Withdrawals (cfs)	Percent Difference (2050)
5th Percentile	Flow exceeded 95% of time	499.10	493.85	-1.1%
10th Percentile	Flow exceeded 90% of time	667.20	663.48	-0.6%
50th Percentile	Median Flow	2,784.97	2,783.72	-0.04%
Mean	Average Flow	5,108.16	5,105.81	-0.05%

An unimpaired scenario run was performed by NCDWR (2008) representing hypothetical conditions with all discharges, withdrawals, and impoundments in the basin removed. A comparison by NCDWR (2008) showed that under all three demand scenarios, the simulated flows for the scenarios were higher during low flow periods than the unimpaired scenario because of regulation from Jordan Lake.

The preceding analysis does not change NCDWR's (2008) conclusion that full demand for all withdrawals at Lock and Dam #1 would be met through 2050 because the revisions to Brunswick demand are minor and the maximum withdrawal scenario differs little from the average day scenario. In addition, the increase from the Brunswick County withdrawal would be small, and predicted flows passing over the dam at the 95th percentile flow exceedence (i.e., a fairly low flow) in 2050 remain substantial at nearly 500 cfs. Accordingly, the direct impact of the County withdrawal on water supply would not be significant.

6.1.1.1.4 Water Quality Analysis—Results

Water withdrawals could also degrade water quality conditions in the pool behind Lock and Dam #1. While this section of the Cape Fear River is not listed as impaired on the 303(d) list, NCDWQ requested an evaluation of dissolved oxygen, algal dynamics, and pH in this reach. Downstream of Lock and Dam #1, however, the Cape Fear River Estuary is on the 303(d) list of impaired waters for dissolved oxygen and has been the subject of recent study. The potential impacts on water quality upstream and downstream of the dam are discussed in the sections that follow.

A USGS observation station (02105769) and a North Carolina Ambient Monitoring System station (B8350000) were used to investigate possible relationships of flow or water temperature with response variables of dissolved oxygen, pH, and chlorophyll *a*. Several statistical regressions were applied to the data by varying the independent and dependent variables. Insufficient observed data exist for chlorophyll *a* to construct a statistical relationship, so this parameter was removed from consideration (six total observations).

The critical period of interest for the response variables is during the summer (June, July, and August) when withdrawals are typically near the annual maximum, stream flow is generally low, and water temperature is high. Data associated with flows above 5,000 cfs were removed as the relationship of dissolved oxygen to flow appears to change at high flow. On a given sample date, only the surface observations (generally 0.1 meter below the surface) were retained because vertical differences were negligible. The resulting data set included 31 days of observed data over the period from June 26, 1997, through August 12, 2010, with which to investigate relationships.

The range of variables used for correlation analysis is shown in Table 65. Flow was evaluated both with and without a logarithmic transformation. A correlation matrix (Table 66) indicates that dissolved oxygen is weakly correlated (i.e., values closer to 0) to flow and temperature, whereas pH shows more correlation to flow. As dissolved oxygen has essentially zero correlation with untransformed flow, only the natural logarithm of flow was retained for further analysis.

Table 65. Water Quality Variables at Lock and Dam 1, June – August at Flows < 5,000 cfs

	Flow (cfs)	ln (Flow (cfs))	Water Temperature (°C)	Dissolved Oxygen (mg/L)	pH
Minimum	526	6.27	24.20	5.30	5.90
1st Quartile	1,044	6.95	27.55	6.10	6.60
Median	1,270	7.15	28.30	6.40	6.80
Mean	1,535	7.22	28.32	6.49	6.84
3rd Quartile	1,780	7.48	29.15	6.95	7.00
Maximum	4,040	8.30	31.40	7.80	8.10

Table 66. Correlation Matrix for Water Quality Variables

	Flow (cfs)	ln (Flow (cfs))	Water Temperature (°C)	Dissolved Oxygen (mg/L)	pH
Flow (cfs)	1.00	0.96	-0.72	0.00	-0.31
ln Flow (cfs)	0.96	1.00	-0.65	-0.03	-0.43
Water Temperature (°C)	-0.72	-0.65	1.00	0.05	-0.01
Dissolved oxygen (mg/L)	0.00	-0.03	0.05	1.00	-0.27
pH	-0.31	-0.43	-0.01	-0.27	1.00

A predictive model of pH can be formulated as pH = 15.676 -0.141 (Water Temperature) – 0.67 (ln(Flow)), with adjusted R^2 = 0.2807 and probability value of 0.004 (Table 67). All model coefficients are significantly different from zero.

Table 67. Predictive Models for pH

Model	Intercept	Coefficients on: Water Temperature	ln (Flow)	Water Temperature x ln (Flow)	Adjusted R^2	Probability value
PH-1	15.676	-0.141	-0.67	-	0.2807	0.004

Analyses of the data show that neither flow nor water temperature nor their combination provides statistically significant explanatory models of observed dissolved oxygen (Table 68). All attempts resulted in adjusted R^2 values less than zero and the lowest probability value is 0.49 (typically a value of less than 0.05 is required for model significance). In addition, the 95 percent confidence interval on the coefficient on flow is not significantly different from zero.

Table 68. Predictive Models for Dissolved Oxygen

Model	Intercept	Coefficients on: Water Temperature	ln (Flow)	Water Temperature x ln (Flow)	Adjusted R^2	Probability value
DO-1	5.716	0.024	0.014	-	-0.0687	0.965
DO-2	6.739		-0.035		-0.0338	0.889
DO-3	5.899	0.021			-0.0319	0.790
DO-4	-39.48	1.65	6.062	-0.218	-0.0178	0.497

The statistical models tell us that the variability in observed dissolved oxygen is primarily due to factors other than flow and temperature. Nonetheless, the coefficients obtained in a least squares fit provide a best unbiased estimate of the partial contribution of these factors to dissolved oxygen. Therefore, estimates can be made of the potential impact of additional water withdrawal using the three models that represent the effect of flow on dissolved oxygen, as well as the model for pH. The analysis focuses on July, a critical period, when the maximum monthly withdrawals typically occur and at mean water temperature of 28.3 °C.

Permitted facilities associated with withdrawal at Lock and Dam #1 include the Northwest WTP (24 MGD), CFPUA's Sweeney WTP (35 MGD), Pender County (2 MGD; expandable to 6 MGD), along with two small industrial users supplied by LCFWSA (~2.6 MGD). For 2011, the max day withdrawal for the County is taken directly from Northwest WTP records. To arrive at the cumulative withdrawal, maximum day values from CFPUA and LCFWSA were combined for a value of 51.13 MGD (41.5 plus 9.63) as provided in their respective LWSPs. The basis for the 2050 cumulative, maximum withdrawal of 106 MGD was discussed previously in Section 6.1.1.1.3. Table 69 provides a summary of these withdrawals.

Table 69. Maximum Brunswick County and LCFWSA Withdrawals for Water Quality Analysis

Year	Brunswick County Withdrawal (MGD)	Brunswick County Withdrawal (cfs)	Cumulative Withdrawal (MGD)	Cumulative Withdrawal (cfs)
2011	21.3	33.0	51.1	79.1
2050	38.8 [1]	60.5	106	164

[1] Based on the proposed treatment capacity of 36 MGD finished water for the Northwest WTP plus additional raw water that is withdrawn from the river for backwash, clarifier blowdowns, and process water is not included. This water is discharged back to the Cape Fear source basin via NPDES permit.

To evaluate dissolved oxygen and pH response for an extreme case, the 7Q10 is used. USGS published a previous estimate for the Cape Fear River at Lock and Dam #1 in 2001: 825 cfs or 533 MGD using data reflecting the period of regulation from Jordan Lake, 1982-1997 (Weaver and Pope, 2001). USGS was contacted for an updated 7Q10, and provided a *provisional* value of 500 cfs (323 mgd) using data for 1982–2009 climatic years. The decrease can be attributed to, "a combination of the recent droughts on flows in the Cape Fear River and the regulated flow conditions from Jordan Lake during this period," according to USGS (personal communication; see Appendix I).

6.1.1.1.5 Water Quality Analysis—Results

The 2011 maximum cumulative withdrawal (i.e., Brunswick plus others) at Lock and Dam #1 was 79.1 cfs, and the potential 2050 maximum cumulative withdrawal is 164 cfs, resulting in an increase in max of withdrawal of 85 cfs. The resulting predicted changes in dissolved oxygen when applied to the provisional 7Q10 flow are shown in Table 70. Two of the models predict increased dissolved oxygen as a result of the increased withdrawal, but none of the changes are significant.

Table 70. Predicted Dissolved Oxygen (mg/L) Response Maximum Withdrawal at Lock and Dam #1

Model	Predicted Dissolved Oxygen with 2011 Maximum Cumulative Withdrawal	Predicted Dissolved Oxygen with 2050 Maximum Cumulative Withdrawal	Change in Dissolved Oxygen	Percent Change
DO-1	6.4827	6.4801	-0.0026	-0.04%
DO-2	6.5215	6.5280	0.0065	0.10%
DO-4	6.5535	6.5743	0.0208	0.32%

The regression model for pH predicts an increase in pH from 7.519 to 7.644 under these 2050 7Q10 low flow conditions equal to a 1.66 percent change (Table 71).

Table 71. Predicted pH (s.u.) Response to Increase in Maximum Withdrawal at Lock and Dam #1

Model	Predicted pH with 2011 Maximum Cumulative Withdrawal	Predicted pH with 2050 Maximum Cumulative Withdrawal	Change in pH	Percent Change
PH-1	7.5191	7.6438	0.1247	1.66%

In sum, both the dissolved oxygen and pH changes are predicted to be minimal and insignificant, and further modeling analysis is not warranted.

6.1.1.2 New Fish Passage Structure at Lock and Dam #1

A new fish passage structure (FPS) at Lock and Dam #1 on the Cape Fear River was completed in November 2012 by the US Army Corps of Engineers. The Basis of Design report provided the design, associated analyses (e.g., hydrologic and hydraulic analysis), and the biological rationale for the project (US Army Corps of Engineers, 2010). The rock arch rapids design is a type of rock ramp that provides fish passage over low-head dams by emulation of natural rapids and facilitation of fish hydrodynamics. The FPS alternative was chosen over others including removal of the dam in part due to the need to protect the water supply intake structures located just upstream (e.g., LCFWSA intake).

The FPS is designed to increase fish passage and increase spawning opportunities for anadromous fish. Spawning migration in the Atlantic coastal region occurs primarily during periods of increased but moderate river flow and temperature such as late winter and spring (NOAA, 2013). The design of the FPS accounts for flows during this period including an assumed “spawning flow” of 5,000 cfs, a flow level near the mean flow for the river (5,063 cfs based on 1982-2012), and typical spring flows during March and April which are somewhat greater (i.e., up to about 9,000 cfs; US Army Corps of Engineers, 2010). Maximum, cumulative withdrawals for 2050 (164 cfs; incorporates all LCFWSA customers including Brunswick) just above the FPS represent 2 to 3 percent of these flow values. Maximum withdrawal is more likely to occur in the summer given seasonal water use patterns; therefore, water withdrawals from the river during the spawning migration would represent an even smaller proportion of flow (as would considering only Brunswick’s portion). As such the impact of withdrawals on FPS function would be insignificant.

6.1.1.3 Impacts Below Lock and Dam #1

The section of the Lower Cape Fear River Estuary (LCFRE) from upstream of Toomers Creek to a line across the river between Lilliput Creek and Snows Cut has been on North Carolina's 303(d) list as impaired for dissolved oxygen since 1998. In 2006 the DWQ added pH as impaired for this segment, and in 2008 DWQ added copper and turbidity to the listing. Emphasis by DWQ has been on developing a better understanding of loads and processes influencing dissolved oxygen.

Since the original listing for dissolved oxygen, many technical studies of the LCFRE have been conducted by DWQ, the Lower Cape Fear River Program, other agencies and academic researchers, and consultants. As a result, an extensive technical foundation of knowledge on the LCFRE has been created including information on physical, chemical, and biological features and processes. Monitoring programs have provided insight regarding ambient conditions over many years on water quality, benthos and fish. The Lower Cape Fear River Program has conducted monitoring in coordination with DWQ since 1995, and a considerable amount of data is available before that. Extensive data have been collected by the Middle Cape Fear River Basin Association upstream of Lock and Dam #1 since mid-1998. Additionally, sophisticated hydrodynamic modeling tools have been developed for the entire estuary and the portion of the river up to Lock and Dam #1.

An application of the three-dimensional water quality model Environmental Fluid Dynamics Code (EFDC) was developed for the LCFRE by the University of North Carolina-Charlotte for DWQ (Bowen et al. 2009). The model was used to investigate the effects of various organic matter and ammonia load reduction scenarios, both point and nonpoint source, on the dissolved oxygen concentrations in the estuary. The model region included the tidally affected portions of the Cape Fear (i.e., portion below Lock & Dam 1), Black, and Northeast Cape Fear rivers near Wilmington, North Carolina, and extended south to the mouth of the Cape Fear River near Southport, North Carolina.

The 21 state variable EFDC water quality model included multiple dissolved and particulate organic carbon constituents, and organic and inorganic nutrients, dissolved oxygen, and three phytoplankton constituents. To adequately characterize the various organic matter decomposition rates of the riverine and wastewater inputs, both labile and refractory dissolved organic matter constituents were used. The water quality model considered inputs from the three riverine sources at the model boundaries, 20 wastewater point source inputs in the estuary, and 14 additional point sources that simulated other freshwater inputs to the estuary from tidal creeks and wetlands. Over the 3-year period (2002–2005) for which the freshwater and point source loadings were developed, approximately 10 percent of the organic matter loading and 50 percent of the ammonia loading to the estuary came from the 20 wastewater point sources that discharge directly to the estuary (Bowen et al. 2009).

The calibrated model achieved an excellent fit to observed data (more than 5200 measurements at 18 estuary sites) for complex estuary models. Bowen et al. (2009) report that the mean model error was less than 0.01 mg/L, and the root mean square error was 0.92 mg/L, which corresponds to 13.8 percent of the mean value. DWQ found the calibrated model to be suitable for conducting scenario tests on the effect of changes in organic matter and ammonia loadings on the dissolved oxygen concentrations in the estuary.

A number of scenarios were examined by Bowen and DWQ to test the sensitivity of dissolved oxygen to reductions in point and nonpoint source loads of oxygen-demanding pollutants. With all point sources eliminated, the 10th percentile dissolved oxygen concentration increased by approximately 0.3 mg/L, from 4.3 to 4.5 mg/L. Nonpoint source loading reductions of 30 percent, 50 percent, or 70 percent were assumed for the three river inputs (Cape Fear, Black, and Northeast Cape Fear), and from the 14 creeks and wetland inputs in the estuary. Despite these large reductions, dissolved oxygen concentrations increased by only 0.2, 0.3, and 0.4 mg/L, respectively, from 4.3 to either 4.5, 4.6 or 4.7 mg/L. On the basis of the modeling results, DWQ has temporarily suspended its development of a TMDL for oxygen-demanding loads while it considers the relative impact of natural and anthropogenic sources on the water quality in the LCFRE.

The studies by Bowen et al. (2009) and Hamrick et al. (2001) show that during low-flow summer conditions, hydrology and pollutant transport are dominated by tidal exchange with the ocean. The EFDC model uses a historical period of flow at its upper boundary (i.e., Lock and Dam #1) that reflects flows above 20 cms (~700 cfs). The withdrawal associated the proposed flow transfer for the County corresponds to 60 cfs (39 mgd), which represents approximately 9 percent of the lowest model flows entering the LCFRE. Because tidal flow dominates pollutant fate and transport during the lowest flow periods and transfer of flow would actually remove some pollutants from entering the LCFRE, the IBT would not be expected to have a noticeable effect on water quality in the river below Lock & Dam #1.

6.1.2 Secondary and Cumulative Impacts

The proposal involves a certificate from the EMC to transfer additional water across the basin divide. Therefore, secondary and cumulative impacts are relevant to the receiving basin only.

6.2 RECEIVING BASIN #1 (WACCAMAW)

6.2.1 Direct Impacts

The proposal does not involve additional water transfer to the Waccamaw IBT River Basin. Therefore, no direct impacts would occur as a result of the IBT certificate.

6.2.2 Secondary and Cumulative Impacts

The proposal does not involve additional water transfer to the Waccamaw IBT River Basin. Therefore, no secondary and cumulative impacts would occur as a result of the IBT certificate.

6.3 RECEIVING BASIN #2 (SHALLOTTE)

6.3.1 Direct Impacts

For the Northwest WTP expansion alternative, there would be no direct effects on the Shallotte IBT River Basin associated with the transfer of water. Any direct impacts associated with construction of the WTP improvements and transmission line upgrades would be reviewed under an environmental document prepared under SEPA specifically for these projects as required by statute and regulation.

6.3.2 Secondary and Cumulative Impacts

Secondary and cumulative impacts for the project are those that could be derived from potential growth inducement in the receiving river basin. The additional water supply is considered a factor in facilitating growth. If not managed properly, additional urbanization of the service area could degrade water resources, aquatic and wildlife habitat and resources, and other environmental features discussed in Sections 2 through 4 because of increased stormwater runoff, erosion and sedimentation, and other consequences of land development. A cumulative impact is derived from the combination of water supply, construction of new or expanded utilities (e.g., water and sewer), and transportation projects. Note that there is another category of secondary impacts, encroachment-alteration effects. These are minimized because they involve the physical presence of the project, and this proposal does not involve construction of physical structures. However, encroachment-alteration effects on habitat for example could result from new development in general. These types of effects are combined with growth inducement effects in general for purpose of the discussion that follows.

Table 72 provides a summary of the potential secondary and cumulative impacts on environmental features of the Shallotte IBT River Basin that are described in Section 4. Many of these potential impacts are associated with future growth projections described in the County's future land use (Figure 19 and Table 28). Growth is expected to primarily occur as low- and medium-density residential uses, with an increase of three to four fold in area relative to existing land use (Table 27).

Table 72. Summary of Potential Secondary and Cumulative Impacts (Shallotte Study Area)

Environmental Feature	Potential Secondary and Cumulative Impacts
Topography, Geology, and Floodplains	Grading of sites could disturb natural topography; development of sites and associated utilities could occur in floodplains if not prohibited; natural riparian buffers could be disturbed if not prohibited.
Soils	Soils could be compacted during development resulting in reduced infiltration of water; soils most suitable for agricultural lands could be developed to residential, commercial, or other uses precluding continued cultivation.
Land Use	Changes in land use from natural, vegetated covers to developed uses; existing developed land could be converted to more intense land uses; the introduction of incompatible land uses to adjacent, existing land use could occur without proper land use planning.
Forest Resources	A large portion of the watershed is forested, most of which is loblolly-shortleaf pine. Some forested land would be converted to developed land uses. Significant forest lands, including commercial forest tracts, would be expected to remain. Many of these are unsuitable or not preferred for development (e.g., wetlands, in northern portions of the County).
Prime or Unique Agricultural Land	Approximately 36 percent of the area has been classified as important or prime farmland; however, more than a quarter is already developed. Agricultural lands could be converted into residential, commercial, or other uses precluding continued cultivation.
Public Lands and Scenic, Recreational, and State Natural Areas	There are several areas as described in Table 29, the largest of which is the Green Swamp Preserve. New development and population growth could put pressure on public, scenic, recreational lands, and state natural areas if not properly managed.
Areas of archaeological or Historic Value	There are no known areas of archaeological or historic significance.
Surface Water Resources	Increases in pollutants and degradation of water quality from stormwater runoff from impervious surfaces and developed pervious areas because of new development. Increases in the volume and rate of stormwater runoff could affect stream channel geomorphology and aquatic habitat. Increases in flooding. Exacerbation of existing water quality impairments such as shellfish harvesting issues.
Groundwater Resources	Additional use of pesticides, fertilizers, and other substances could leach to groundwater; additional septic tanks could increase nutrient export to groundwater; reduced infiltration of water because of impervious surfaces and soil compaction.
Wetlands	More than 40 percent of the study area is mapped as wetland according to NC-CREWS, though not all these areas would be considered jurisdictional. Filling, draining, or increase in pollutant runoff into wetlands from land development.

Environmental Feature	Potential Secondary and Cumulative Impacts
Aquatic and Wildlife Habitat and Resources	There are a number of SNHAs, important bird areas, unique wetlands (e.g., Carolina bays), fish nursery areas, shellfish growing areas, and rare and protected species as described in Section 3.6. Fragmentation, degradation, or loss of sensitive and nonsensitive aquatic and terrestrial species and their habitats from effects associated with land development.
Air Quality	No air quality concerns are in the Shallotte study area. Additional emissions affecting air quality could occur as a result of new industry and additional automobile use.
Noise Levels	Noise levels could increase because of construction projects and a general increase in population.
Introduction of Toxic Substances	The use of toxic substances could increase because of general increases in development and human activity.

Mitigation measures aimed at offsetting potential secondary and cumulative impacts include government policies and programs. Section 7 provides a summary of local, state, and federal regulations and programs related to development for the communities that would be obtaining water through the proposed action and are in the receiving basin. An evaluation of the degree of protection provided by these regulations and programs is provided.

7 Mitigation Measures

While increased water supply typically stimulates increases in population and corresponding land use change and development in the Shallotte River Basin, government policies can provide mitigation for potential *secondary and cumulative impacts* from these changes. Regulations and programs related to development and its potential impacts are summarized below for the communities that would be obtaining water through the proposed action and are in the receiving basin. Existing state regulations are discussed first as they apply to all jurisdictions. Then, additional local regulations and programs are discussed.

7.1 State Regulations

7.1.1 Land Use Planning and Environmental Resource Protection Initiatives

The North Carolina CAMA has significant influence on land use planning and coastal resource protection in the Shallotte IBT River Basin. The purpose of CAMA is to protect coastal resources, both water and land, from irreversible damage and to preserve the economic, aesthetic, and ecological benefits that these resources provide. CAMA contains two major provisions: (1) land use planning required for 20 CAMA-designated counties, and (2) designation of Areas of Environmental Concern and accompanying development requirements.

Regarding the first major provision, CAMA requires that each of the 20 designated coastal counties develop a land use plan following a common format and list of considerations. The land use plans are intended to reflect the goals and objectives of the local government, including growth management, protection of productive resources (i.e., farmland, forest resources, fisheries), and preferred types of economic development, natural resource protection, and storm hazard mitigation. To obtain approval, projects that require a CAMA permit must be consistent with the local land use plan.

Under the second major provision, CAMA regulates development in coastal areas designated as Areas of Environmental Concern, which generally encompass the following areas (NCDCM, 2008):

- In or on navigable waters within the 20 CAMA counties (which include the County);
- On a marsh or wetland;
- Within 75 feet of the mean high water line along an estuarine shoreline;
- Near the ocean beach;
- Near an inlet;
- Within 30 feet of the normal high water level of areas designated as inland fishing waters by the N.C. Marine Fisheries Commission; and
- Near a public water supply.

The CAMA rules (15A NCAC 07H .0101) provide detailed definitions for Areas of Environmental Concern and specific guidelines for development in Areas of Environmental Concern. For example, for Areas of Environmental Concern defined in the estuarine system, only water dependent uses are permitted. Within these uses, the rules specify siting and design guidelines (e.g., location of marinas in non-wetland areas or in deep waters and avoidance of shellfish resources, submerged aquatic vegetation, or wetland habitats). For some Areas of Environmental Concern, if a proposed development does not meet the CAMA rules, the project can be approved if the public benefits outweigh the long-term impacts, no reasonable alternate site exists, and the project mitigates for the adverse impacts through all reasonable means.

7.1.2 Riparian Buffers

Vegetated buffers along waterbodies are required through the 20 Coastal Counties Stormwater Law (Session Law 2008-211), described in further detail in Section 7.1.4.

7.1.3 Erosion and Sedimentation Control

North Carolina Department of Land Resources (DLR) administers sediment and erosion (S&E) control requirements for the state. DLR maintains a manual of S&E practices and periodically updates it.

Land-disturbing activities equal to or greater than 1 acre require a sedimentation and erosion control plan, and this plan must be submitted to DLR for approval. Any land-disturbing activity is required by state law to comply with sedimentation and erosion control practices, but the requirements are not enforced unless a citizen reports the noncompliant site to DLR.

DLR encourages local governments to enact S&E control ordinances to provide further protection. Local ordinances cannot be less stringent than the state requirements, but they can require more stringent standards. Some local governments require S&E plans for smaller areas of disturbance compared to the state including several local governments in the Shallotte IBT River Basin (discussed further in Section 7.2.4).

7.1.4 Stormwater Programs

The state stormwater requirements that apply to the Shallotte IBT River Basin are the 20 Coastal Counties Stormwater Law and the NPDES Phase II Stormwater Rules. These stormwater requirements are described below.

Coastal Counties Stormwater Law

The 20 Coastal Counties Stormwater Law (Session Law 2008-211) established stringent stormwater regulations that apply to the 20 state-designated coastal counties, which include the County. The law outlines the following stormwater requirements applicable to jurisdictions in the Shallotte IBT River Basin. These requirements apply to any development that disturbs one or more acres of land, any nonresidential development that will add more than 10,000 square feet of built upon area, or any development that would otherwise require a S&E control plan.

Development Near Class SA Waters

Class SA waters are designated by NCDENR as tidal salt waters that are used for commercial shellfishing or marketing purposes (Figure 42). The Coastal Counties Stormwater Law prohibits new points of stormwater discharge to Class SA waters or an increase in the volume of stormwater flow through or capacity of existing conveyances that drain to Class SA waters. In addition, the law outlines the following requirements that vary by development density:

- High density projects (greater than 12 percent built upon area)
    - Stormwater runoff from built upon areas flows into and through wetlands at a non-erosive velocity;
    - Control and treat the runoff from all surfaces for the greater of (1) one and one-half inches of rainfall, or (2) the difference between predevelopment and postdevelopment for the one-year, 24-hour storm.

- Additional runoff not addressed with the above requirement must be routed through a vegetative filter with a minimum length of 50 feet from the mean high water level of the Class SA water.
- Preserve or establish vegetative buffers with widths of 50 feet for new development and 30 feet for redevelopment, measured from waterbodies as specified in Session Law 2008-211.

- Low density projects (12 percent or less built upon area).
    - Vegetative conveyances must be used primarily to transport stormwater runoff.
    - Preserve or establish vegetative buffers with widths of 50 feet for new development and 30 feet for redevelopment, measured from waterbodies as specified in Session Law 2008-211.

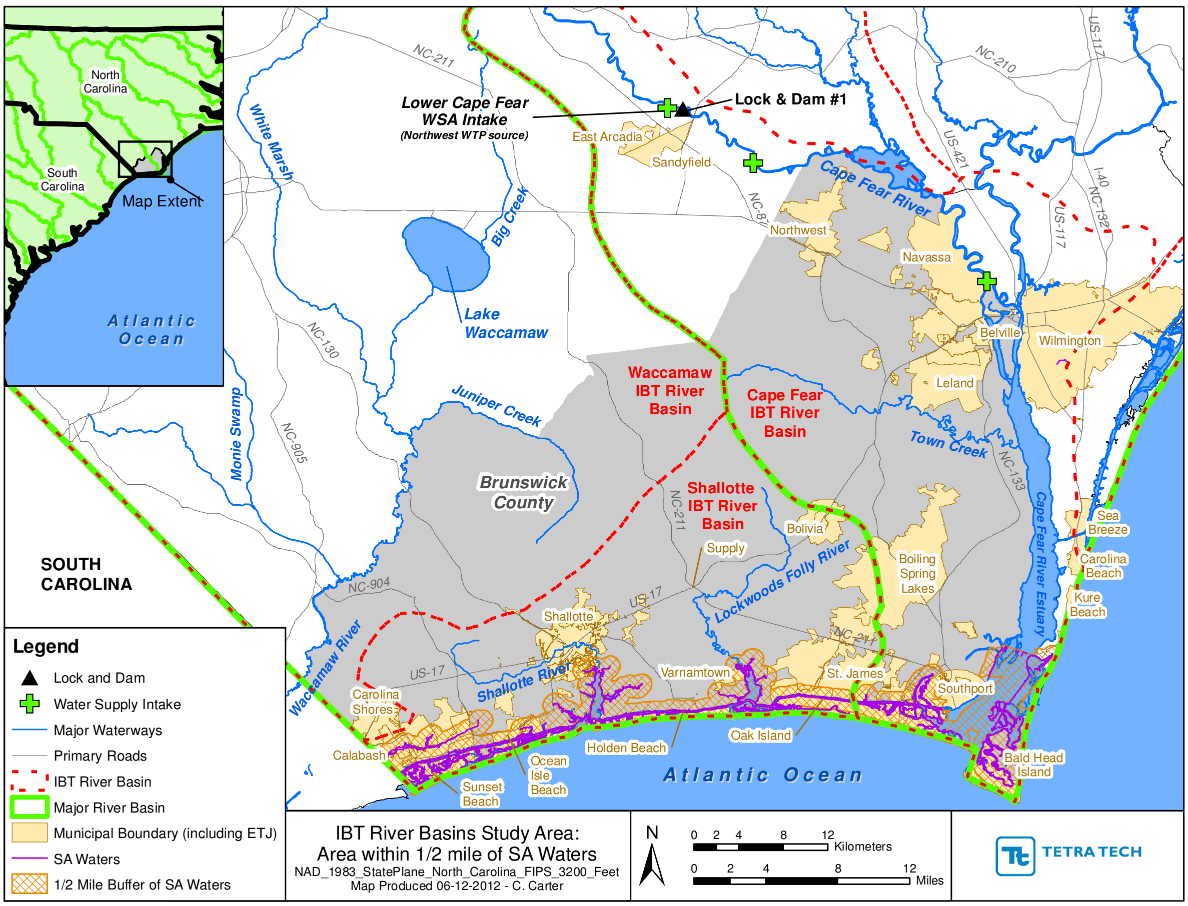

Figure 42. Class SA Waters as Designated by NCDENR

Other Coastal Development.

Coastal development not within or near SA waters but in the Shallotte IBT River Basin is subject to the following stormwater requirements:

- High density projects (greater than 24 percent built upon area)

- Stormwater runoff from built upon areas flows into and through wetlands at a non-erosive velocity;
- Control and treat the runoff from all surfaces for one and one-half inches of rainfall; and
- Preserve or establish vegetative buffers with widths of 50 feet for new development and 30 feet for redevelopment, measured from waterbodies as specified in Session Law 2008-211.

- Low density projects (24 percent or less built upon area).
    - Vegetative conveyances must be used primarily to transport stormwater runoff.
    - Preserve or establish vegetative buffers with widths of 50 feet for new development and 30 feet for redevelopment, measured from waterbodies as specified in Session Law 2008-211.

Under both SA and non-SA requirements, minor variances for the vegetative buffer requirements could be granted. The 20 Coastal Counties Stormwater Law also contains specific requirements for the type of structural stormwater controls used.

NPDES Phase II Stormwater Rules

Local governments designated as having municipal separate stormwater systems (MS4s) are subject to the post-construction requirements established by the North Carolina NPDES Phase II stormwater rules. Per Session Law 2006-246, the Phase II rules apply to jurisdictions beyond designated MS4s, including designated municipal spheres of influence (MSI) and counties designated as *tipped* where 75 percent or more of the County is covered by a stormwater program and the County has a 10-year growth rate equal or greater than the average state growth rate over the same period. Oak Island is the only MS4 in the Shallotte IBT River Basin. Minimum requirements for stormwater management in the Phase II jurisdictions are (Session Law 2006-246):

- For all development that disturbs 1 acre or more and has greater than 24 percent built-upon area:
    - Control and treat runoff from the first one inch of rain.
    - Draw down the water quality treatment volume no faster than 48 hrs, but no slower than 120 hrs.
    - Discharge the storage volume at a rate equal to or less than the predevelopment discharge rate for the 1-year, 24-hour storm.
    - Remove an 85 percent average annual amount of Total Suspended Solids.
- For all development that disturbs 1 acre or more:
    - Locate all built-upon areas at least 30 feet landward of all perennial and intermittent surface waters.
- Low-density projects (less than or equal to 24 percent built-upon area) must use vegetated conveyances to the maximum extent practicable to transport stormwater runoff from the project. Onsite stormwater treatment devices such as infiltration areas, bioretention areas, and level spreaders may also be used as added controls for stormwater runoff.

Although the volume treatment requirements for high-density projects are more protective under the Coastal Stormwater rules, the Phase II requirements mandate peak control requirements, which provide for further protection from stormwater impacts. Jurisdictions that are Phase II communities must comply with both the State Stormwater rules as well as the Phase II requirements. Some jurisdictions could have more stringent stormwater requirements than the minimum Phase II requirements. Additional local regulations are described in the local jurisdiction sections.

7.2 Local Jurisdictions

The majority of land in the Shallotte IBT River Basin is in the unincorporated area of the County, subject to its jurisdiction. However, a relatively large urbanized area is in the jurisdiction of 11 incorporated municipalities: the City of Boiling Spring Lakes, the Town of Bolivia, the Town of Calabash, the Town of Carolina Shores, the Town of Holden Beach, the Town of Oak Island, the Town of Ocean Isle beach, the Town of Shallotte, the Town of St. James, the Town of Sunset Beach, and the Town of Varnamtown. Depending on the municipality and particular regulation, some County regulations apply to both incorporated and unincorporated areas. Local regulations and policies, and the specific linkages between county and municipalities, are explained in the following sections.

7.2.1 Land Use Planning and Environmental Resource Protection Initiatives

The County and all municipalities in the County are required to develop land use plans under CAMA (see Section 7.1.1). The County CAMA Core Land Use plan was originally completed in 2007 with most recent amendments in 2011 (Holland Consulting Planners, Inc. 2007a). This plan is available online at http://www.brunswickcountync.gov/Departments/LandDevelopment/Planning/LandUsePlan.aspx. Municipalities had the option of participating in the County's land use plan or developing their own, and the following municipalities in the Shallotte IBT River Basin participated: Boiling Spring Lakes, Bolivia, Sunset Beach, and St. James. The County's plan analyzed existing and emerging conditions including population, housing, the economy, climate, water supply, flood hazards, and other conditions relating to human or natural systems. Existing land use and community facilities were described and catalogued in detail, and the future land use plan was designed to address projected growth in population and increased demands for services including, for example, infrastructure, water supply, and wastewater services. The plan applies smart growth principles and contains specific implementation actions relating to zoning, public access, land use compatibility, natural resources conservation, stormwater control, natural hazard areas, water quality, and cultural, historical, and scenic areas.

The development of the County's future land use map (Figure 19) was based on maintaining consistency with the County's existing districts, paths, urban nodes, landmarks, and other features. The future land use map also considered existing public facility plans, development constraints, and existing zoning patterns.

The CAMA Land Use Plans for the other jurisdictions in the Shallotte IBT River Basin are similar in scope to the Brunswick plan. CAMA Land Use Plans are certified by the state. Because of its small size and low rate of recent growth, Varnamtown was not required to develop a full CAMA Land Use Plan and instead was allowed to develop a less comprehensive *work plan* to fulfill the requirement.

The following jurisdictions have other plans relating to comprehensive planning, visioning, or protection of environmental resources:

- Brunswick County:
    - Brunswick Tomorrow Comprehensive Plan (formed to develop a 20 year vision for Brunswick County) - http://www.brunsco.net/Departments/LandDevelopment/Planning/BrunswickTomorrow.aspx
    - Brunswick County Comprehensive Parks and Recreation Master Plan— http://www.brunsco.net/portals/0/parksandrec/master%20plan.pdf
- Town of Oak Island:

  - Parks and Recreation Comprehensive Master Plan http://www.oakislandnc.com/Packet_Many/Pres1B.pdf
  - Urban and Community Forestry Plan http://www.oakislandnc.com/Adobe_Files/UrbanForestry.pdf
  - Green Project http://www.oakislandnc.com/Adobe_Files/Green_Project.pdf
- Town of Shallotte:
  - Downtown Shallotte Vision Plan http://shallotte.govoffice.com/index.asp?Type=B_BASIC&SEC={2C66DBB5-2D46-4C5F-9878-5D03F16BD16E}

7.2.2 Zoning

The County and all incorporated municipalities in the Shallotte IBT River Basin have zoning ordinances established. The County regulates development through its Unified Development Ordinance (UDO), which includes its zoning regulations. The goals of the UDO include, for example, the following (Brunswick County, 2011):

- Preserving the overall quality of life for residents and visitors
- Protecting the character of established residential neighborhoods
- Maintaining orderly and compatible land-use and development patterns
- Lessening congestion in the streets and accommodate the use of alternatives to the private automobile including public transportation, and pedestrian and bicycle facilities
- Ensuring adequate light, air, privacy, and access to property
- Encouraging environmentally responsible development practices
- Promoting rehabilitation and reuse of older buildings
- Maintaining a range of housing choices and options
- Accommodating growth and development that complies with the preceding stated purposes

The County UDO, its application, and future amendments consider recommendations from the County's planning documents, including the Brunswick Tomorrow Comprehensive Plan, CAMA Land Use Plan, thoroughfare plan, collector street plan, neighborhood plans, small area plans, community facilities plan, capital improvement program, economic development strategies, housing assistance plan, and parks and recreation master plan.

The County UDO establishes 11 zoning districts (Figure 43), which include five residential districts, three commercial districts, two industrial districts, and one military installation district. Development is controlled through requirements specified for each district, which include density restrictions, minimum lot sizes, and other dimensional requirements. A majority of the County unincorporated area with the Shallotte IBT River Basin is in the residential zoning districts, which have the following density requirements (number in parentheses accounts for lot dimensions with water and wastewater):

- Rural Residential (RR): 2.2 (2.9) units per acre
- Low-Density Residential (R-7500): 2.9 (5.8) units per acre
- Medium-Density Residential (R-6000): 4.4 (7.3) units per acre
- Medium-Density Site Built Residential (SBR-6000): 4.4 (7.3) units per acre

- Multifamily Residential (MR-3200): 6.2 (13.6) units per acre

The above density requirements apply to conventional development. Higher densities may be allowed under the density bonus provisions of the UDO, which provide incentives for affordable housing or public facilities.

The County nonresidential zoning districts in the Shallotte IBT River Basin are

- Commercial-Low Density (CLD)
- Neighborhood Commercial (NC)
- Commercial-Intensive (CI)
- Industrial-General (IG)
- Military Installation (MI)
- Conservation and Protection (CP)

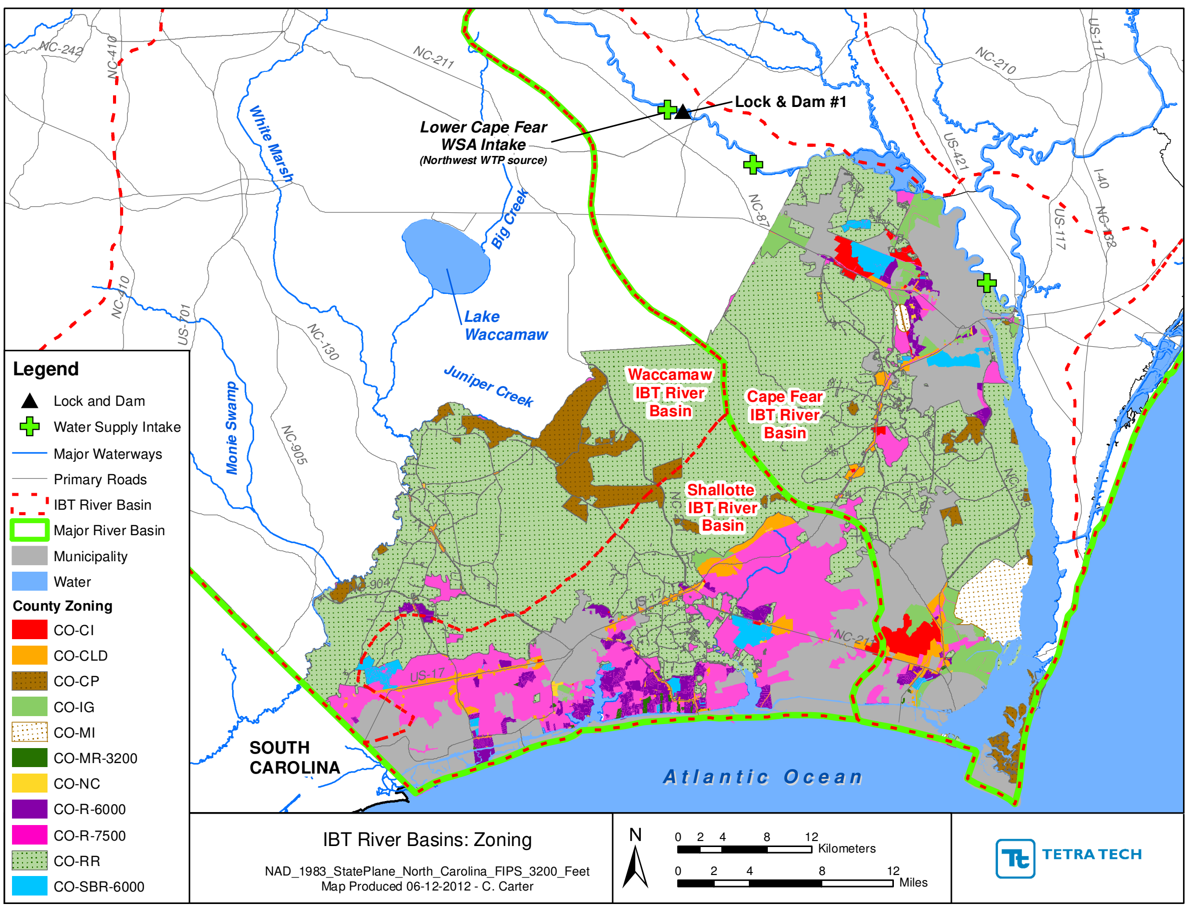

Figure 43. Brunswick County Zoning Districts

Overlay districts are also established in the County UDO to support specific public policy objectives. The relevant overlay districts in the Shallotte IBT River Basin are defined as follows:

- Economic Development (ED)
  - Provide opportunities for a broad range of agricultural industry, light and heavy manufacturing, office, institutional and research uses with no adverse impacts beyond the space occupied by the use.
- Corridor Development Standards 1 and 2 (CDS-1 and CDS-2)
  - Ensures that lands adjacent to major transportation corridors be developed to promote appropriate land use, maintain the scenic natural beauty of the area, and support the public health and welfare.
  - Promotes the safe and efficient movement of traffic by encouraging development which reduces or eliminates commercial strip development, excessive driveway cuts, visual clutter and poor site layout.
- Viewshed Protection (VS)
  - Protects and enhances the scenic character of the County's riparian areas and waterways and ensure the preservation of views from within these scenic areas as well as views of these areas from adjacent lands.
- Water Quality Protection (WQP)
  - Protects water quality in specific waterbodies through regulations.

The overlay districts that have been mapped in the Shallotte IBT River Basin are shown in Figure 44. In addition to the overlay districts shown in the figure, the Water Quality Protection Overlay District applies to parcels greater than or equal to one acre extending 575 feet landward of the mean high water line of those waters south from a line extending from Genoes Point to Mullet Creek, to and across the Intracoastal Waterway to Sheep Island. These regulations are intended to protect the water quality of shellfish beds in the Lockwood Folly River. The following standards apply to any development on this land:

- Limit the built upon impervious area to no more than 25 percent of the lot
- Provide a buffer zone of at least 30 feet from any wetland or water line
- Limit any structures to being at least 75 feet from the mean high water line
- Comply with any additional standards imposed by state or federal regulations

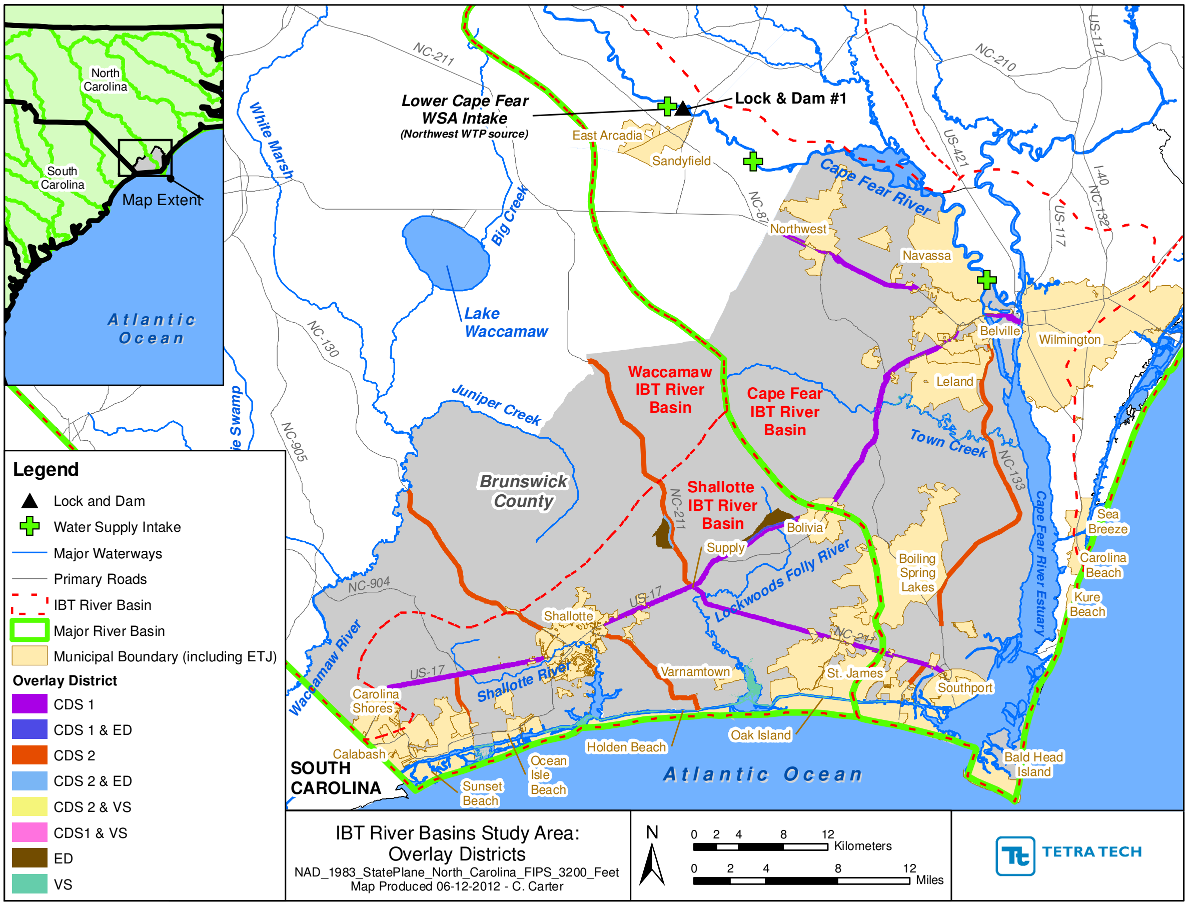

Figure 44. Brunswick County Overlay Districts

7.2.3 Riparian Buffers

As discussed in Section 7.1.4, the State Coastal Stormwater Law requires vegetative buffers, typically 50 feet, along waterbodies. The County Stormwater Management Manual (described in more detail in Section 7.2.5) requires, for all future development, a 30-foot riparian buffer to be maintained on all sides of intermittent and perennial streams and other waterbodies in the County's jurisdiction. This is consistent and not more stringent than the State Coastal Stormwater Law. The municipalities that are not under the County's stormwater regulations also require 30-foot riparian buffers and do not have more stringent regulations compared to the state requirements.

7.2.4 Erosion and Sedimentation Control

The minimum state requirements for erosion and sediment control apply to all land disturbance greater than one acre in the Shallotte IBT River Basin. These requirements are enforced by three DLR district inspectors. The County unincorporated area and the municipalities under its stormwater ordinance (Bolivia, Sunset Beach, Boiling Spring Lakes, and St. James) are also subject to the County's erosion and sedimentation control requirements for development with *less than* 1 acre disturbance. Although protective of additional development area, the County's requirements are not more stringent than the state's requirements and involve basic controls like silt fencing and the prevention of erosion onto neighboring properties. Town ordinances for Holden Beach and Calabash also contain erosion and sediment control provisions in their ordinances to protect neighboring properties from erosion caused by land disturbance and development less than one acre. The remaining municipalities (Carolina Shores, Oak Island, Ocean Isle, Shallotte, and Varnamtown) do not have more stringent soil and erosion control compared to the state requirements.

7.2.5 Stormwater Programs

As discussed in Section 7.1.4, all jurisdictions in the Shallotte IBT River Basin are subject to the State Coastal Stormwater Law. Oak Island, the only MS4 designated in the basin, is subject to additional requirements under the North Carolina NPDES Phase II Stormwater rules, as outlined in Section 7.1.4. The County is listed on the NCDENR website as a *tipped* county; however, the County obtained an exemption from Phase II requirements.

The County maintains a stormwater ordinances and stormwater management plan and has agreements with the following Shallotte IBT River Basin municipalities to enforce stormwater management under its ordinance: Bolivia, Sunset Beach, Boiling Spring Lakes, and St. James. The remaining Shallotte IBT River Basin municipalities are responsible for enforcing stormwater regulations and have separate stormwater ordinances.

The County Stormwater Ordinance outlines general requirements and provisions for inspection, monitoring, and enforcement (Chapter 1-13, Article VI of County ordinances). The ordinance refers to the County's *Stormwater Management Manual* for specific stormwater control and treatment requirements. The manual requires that all developments obtaining a stormwater permit control stormwater runoff to achieve (Brunswick County, 2002)

- No more than a 5 percent net increase in the peak discharge from the predevelopment conditions for the 10-year, 24-hour storm.
- No net increase in the peak discharge from the predevelopment conditions for the 1-year, 24-hour storm (applies to new development only; in practice, developers may be allowed a 5 percent net increase).

New nonresidential development of any size must obtain a stormwater permit and comply with the regulations in the stormwater manual (Coastal rules are limited to greater than 10,000 square feet of built upon area). The above requirements provide additional protection from stormwater impacts compared to the State Coastal Stormwater Law.

The Oak Island Stormwater Ordinance closely follows the state model ordinance for Phase II stormwater requirements and is generally not more stringent than the minimum state requirements outlined in Section 7.1.4 (State Coastal Stormwater Law). However, the Oak Island administrative manual for the stormwater ordinance contains requirements for development that would otherwise be exempt from the state standards. Specifically, development that does not require a state stormwater permit must control and treat the runoff from all surfaces generated by 1.5 inches of rainfall or less from all impervious surfaces on site. The Oak Island manual outlines specific control and treatment techniques depending on site-specific conditions (Town of Oak Island, No Date).

Although Oak Island is the only Phase II MS4 community in the Shallotte IBT River Basin, several other municipalities have more stringent stormwater requirements compared to the State Coastal Stormwater Law. Ocean Isle requires that all development, regardless of size, match the flow rate and timing of the predevelopment 10-year, 24-hour storm event. Control systems must be infiltration practices and must also control the runoff from all surfaces generated by the first 1.5 inches of rainfall (Article III of Oak Island Stormwater Ordinance). Similarly, Calabash requires a stormwater permit for development that is one acre or less (otherwise exempt from state standards) and an engineered plan for all commercial development and residential development that is greater than 25 percent impervious surface (Calabash Stormwater Ordinance). Holden Beach also requires stormwater control for development disturbing one acre or less. For stormwater runoff directed toward a public street, Holden Beach requires the control the first 1.5 inches of rainfall from impervious surfaces during a 24-hour period within parcel boundaries (Holden Beach Stormwater Ordinance).

The Shallotte Stormwater Ordinance and Stormwater Management Manual follows the County's respective documents closely, although no net increase in peak discharge (as opposed to the County's 5 percent increase) for the 10-year, 24-hour storm is allowed, and no more than a 5 percent increase in this event peak discharge is allowed only if: 1) overall impervious surface is less than fifteen percent, 2) the remaining pervious areas are used to convey and control runoff, and 3) it is demonstrated that no damage to public or private properties and to the quality of public waters would occur from this increase (Town of Shallotte, 2012).

The remaining municipalities (Carolina Shores and Varnamtown) do not have a separate stormwater ordinances. These towns rely on state enforcement of the Coastal Stormwater Law.

Low Impact Development (LID) is a stormwater management design technique that seeks to minimize the stormwater impacts from development by mimicking the natural, predevelopment hydrologic regime. The use of LID strategies is encouraged through a number of policies and programs throughout the Shallotte IBT River Basin. The Brunswick *Stormwater Management Manual* (Brunswick County, 2002) encourages developers to use these techniques and the County *LID Guidance Manual* (Brunswick County, 2008) provides guidance on LID practices. The Lower Cape Fear Stewardship Development Award Program recognizes development projects that protect, conserve, or improve natural resources; developers receiving these awards gain a number of promotional advantages for their project (Lower Cape Fear Stewardship Development Award Program, 2011).

7.2.6 Floodplain Development Regulations

Local governments are required to develop hazard mitigations plans and regulations to participate in the National Flood Insurance Program and receive funding from the Federal Emergency Management Agency (FEMA) disaster assistance. North Carolina maintains a model ordinance for coastal communities that represents the minimum federal and state requirements for floodplain regulations and includes options for more stringent requirements.

The County and all incorporated municipalities in the Shallotte IBT River Basin have floodplain ordinances and hazard mitigation plans. Many of the floodplain ordinances are closely based on the state's model ordinance, and those that differ include more stringent regulations. The ordinances define the base flood elevation and special flood hazard areas according to federal and state requirements (NCDEM, 2007):

- Base flood—the flood having a one percent chance of being equaled or exceeded in any given year.
- Base flood elevation (BFE)—a determination of the water surface elevations of the base flood as published in the flood insurance study. When the BFE has not been provided in a *special flood hazard area*, it may be obtained from engineering studies available from a federal or state or other source using FEMA approved engineering methodologies. This elevation, when combined with the *freeboard*, establishes the *regulatory flood protection elevation*.
- Special flood hazard area (SFHA)—the land in the floodplain subject to a one percent or greater chance of being flooded in any given year, as determined in section 18-546.

The Oak Island Flood Damage Prevention Ordinance is an example of a coastal community with significant waterfront, which is representative of the majority of municipalities in the Shallotte IBT River Basin. The Oak Island ordinance contains a number of permit requirements, consistent with the state model ordinance, that are enacted to prevent loss of life and damage to buildings either along the waterfront or inland but within flood hazard areas. These permit requirements include, for example, the following requirements for building in special flood hazard areas (Oak Island Flood Damage Prevention Ordinance):

- All new construction and substantial improvements shall be designed (or modified) and adequately anchored to prevent flotation, collapse, and lateral movement of the structure.
- All new construction and substantial improvements shall be constructed with materials and utility equipment resistant to flood damage.
- All new construction and substantial improvements shall be constructed by methods and practices that minimize flood damages.
- All new and replacement water supply systems shall be designed to minimize or eliminate infiltration of floodwaters into the system.
- New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of floodwaters into the systems and discharges from the systems into flood waters.
- On-site waste disposal systems shall be located and constructed to avoid impairment to them or contamination from them during flooding.

The ordinance also includes general standards that apply to all construction within flood hazard areas, which include (Oak Island Flood Damage Prevention Ordinance):

- New construction and substantial improvement of any residential, commercial, industrial, or other non-residential structure (including manufactured homes) shall have the reference level, including basement, elevated no lower than the regulatory flood protection elevation.
- For location where a base flood elevation has been determined but a floodway or non-encroachment area have not been designated, no encroachments, including fill, new construction, substantial improvements, or other development, shall be permitted unless certification with supporting technical data by a registered professional engineer is provided demonstrating that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the community.

The ordinance contains many detailed standards for buildings that are intended to minimize damage to structures during flooding events. The ordinance also specifies more stringent standards for the Coastal High Hazard Area, which is associated with high-velocity waters from storm surges or seismic activity.

Several of the Shallotte IBT River Basin Hazard Mitigation Plans are available online and are referenced below:

- Boiling Spring Lakes Hazard Mitigation Plan - http://www.brunswickcountync.gov/Portals/0/bcfiles/Brunswick_County_HM_Plan_DRAFT_102009.pdf
- Brunswick County Hazard Mitigation Plan (Includes the participating jurisdictions of Boiling Spring Lakes, Bolivia, Calabash, St. James, Shallotte, and Varnamtown) http://www.brunsco.net/Departments/LandDevelopment/Planning/HazardMitigationPlan.aspx
- Holden Beach Hazard Mitigation Plan (Different from Brunswick Co.) http://hbtownhall.com/pdf/HBHMP_Final.pdf
- Shallotte Hazard Mitigation Plan

- http://shallotte.govoffice.com/index.asp?Type=B_BASIC&SEC={B6EA86F1-929C-4877-B572-5C4D4440EDE4}
- Sunset Beach Hazard Mitigation Plan
- http://www.sunsetbeachnc.gov/index.asp?Type=B_BASIC&SEC={22DB6684-79F9-4310-8AD6-1C165DDDD2ED}

7.2.7 Water Use Restrictions

The County has the authority to impose water restrictions if a public water supply shortage occurs. All water customers, including the municipalities in the Shallotte IBT River Basin, are subject to the water use restrictions. The water use restrictions are organized in states, with Stage 1 being voluntary and Stages 2 and 3 being mandatory. The stages are defined as follows (Chapter 1-13, Article V of County ordinances):

1) Stage 1—Water conservation alert. A Stage 1 water shortage emergency may be declared in the event of an immediate water shortage, as so declared by state and/or local officials, or when there are three (3) consecutive days when water demand exceeds eighty (80) percent of the water production capacity. Water production capacity shall be defined as the maximum volume of water that meets or exceeds state and federal standards that the water treatment process can produce during a twenty-four (24) hour period. Water production capacity can vary depending on system component reliability and/or raw water conditions. During a declared Stage 1 water shortage emergency the following voluntary water conservation practices shall be encouraged:
    a. Inspect and repair all faulty and defective parts of faucets and toilets.
    b. Use shower for bathing rather than bathtub and limit shower to no more than five (5) minutes.
    c. Do not leave faucets running while shaving, brushing teeth, rising or preparing food.
    d. Limit the use of clothes washers and dishwashers and when used, operate fully loaded. Operate dishwashers after the peak demand hours of 6:00 p.m. to 10:00 p.m.
    e. Limit lawn watering to that necessary for plant survival. Water lawns before the peak demand hours of 6:00 a.m. to 10:00 a.m.
    f. Water shrubbery the minimum required. Water shrubbery before the peak demand hours of 6:00 a.m. to 10:00 a.m.
    g. Limit vehicle washing to a minimum.
    h. Do not wash down outside areas such as sidewalks, driveways, patios, etc.
    i. Install water saving showerheads and other water conservation devices.
    j. Use disposable and biodegradable dishes where possible.
    k. Install water saving devices in toilets such as early closing flappers.
    l. Limit hours of water cooled air conditioners.
    m. Do not fill swimming or wading pools.
2) Stage 2—Water shortage warning. A Stage 2 water shortage emergency may be declared in the event of an immediate water shortage, as so declared by state and/or local officials, or when there are two (2) consecutive days when water demand exceeds ninety (90) percent of the water production capacity. Water production capacity shall be defined as the maximum volume of water

that meets or exceeds state and federal standards that the water treatment process can produce during a twenty-four (24) hour period. Water production capacity can vary depending on system component reliability and/or raw water conditions. During a declared Stage 2 water shortage emergency the following activities shall be prohibited:

a. Watering lawns, grass, shrubbery, trees, flower and vegetable gardens except by hand held hoses, container, or drip irrigation system. A person who regularly sells plants will be permitted to use water on their commercial stock. A golf course may water their greens. State and county licensed landscape contractors may water any plants by hand held hose or drip irrigation under a written warranty.

b. Filling swimming or wading pools, either newly constructed or previously drained. Make up water for pools in operation will be allowed.

c. Using water-cooled air conditioners or other equipment, in which cooling water is not recycled, unless there are health or safety concerns.

d. Washing any type of mobile equipment including cars, trucks, trailers, boats or airplanes. Any persons involved in a business of washing motor vehicles may continue to operate.

e. Washing outside surfaces such as streets, driveways, service station aprons, parking lots or patios.

f. Washing the exterior of office buildings, homes or apartments.

g. Using water for any ornamental fountain, pool, pond, etc., unless recycled.

h. Serving drinking water in food establishments such as restaurants or cafeterias, unless requested to do so by a customer.

i. Using water from a public or private fire hydrant for any reason other than to suppress a fire or other public emergency or as authorized by director or his authorized representative.

j. Using water to control or compact dust.

k. Intentionally wasting water.

l. Commercial and industrial water customers shall achieve mandatory reductions in water usage through whatever means are available. A minimum reduction of twenty (20) percent shall be the target, however a greater target reduction percentage may be required depending on the severity of the water shortage emergency. Compliance with the reduction target shall be determined by the director or his authorized representative. Variances to the target reduction may be granted by director or his authorized representative to designated public health facilities.

3) Stage 3—Water shortage danger. A Stage 3 water shortage emergencies may be declared in the event of an immediate water shortage, as so declared by state and/or local officials, or when there is one (1) day when water demand exceeds one-hundred (100) percent of the water production capacity. Water production capacity shall be defined as the maximum volume of water that meets or exceeds state and federal standards that the water treatment process can produce during a twenty-four (24) hour period. Water production capacity can vary depending on system component reliability and/or raw water conditions. During a declared Stage 3 water shortage emergency the following activities shall be prohibited, in addition to activities prohibited under Stage 2:

a. Watering lawns, grass, shrubbery, trees, and flowers.

b. Washing motor vehicles at commercial car wash establishments.

c. Watering any vegetable garden except by hand held hose, container, or drip irrigation.

d. Commercial and industrial water customers shall achieve mandatory reductions in water usage through whatever means are available. A minimum reduction of fifty (50) percent shall be the target, however a greater target reduction percentage may be required depending on the severity of the water emergency. Compliance with the reduction target shall be determined by the director or his authorized representative. Variances to the target reduction may be granted by the director or his authorized representative to designated public health facilities.

e. In the event that the prohibition of the activities listed above is not sufficient to maintain an adequate supply of water for fire protection, all use of water for purposes other than maintenance of public health and safety shall be prohibited. Residential water use shall be limited to the amount necessary to sustain life through drinking, food preparation and personal hygiene.

7.2.8 Other Water Conservation

Additional water conservation programs in place such as pricing signals and customer are discussed in Section 1.4.

7.2.9 Water Reuse

A robust reuse program is in place as discussed in Section 1.4.

7.3 Mitigative Analysis

Table 73 summarizes the programs discussed in the preceding sections according to the environmental feature categories that they address with respect to potential secondary and cumulative impacts. Additional information on the potential impacts was provided in Section 6 and in Table 72.

Table 73. Programs to Address Secondary and Cumulative Impacts

Environmental Features Potentially Impacted by Secondary and Cumulative Impacts	Existing Programs to Mitigate Impacts in the Shallotte IBT River Basin
1. Topography, Geology, and Floodplains	Floodplain development ordinances and local hazard mitigation plans
2. Soils	Local and state erosion and sedimentation control programs; 20 Coastal Counties Stormwater Law, Phase II stormwater regulations, additional local stormwater regulations; Brunswick County Voluntary Agricultural District
3. Land Use	CAMA land use plans; UDO; zoning ordinances and overlay districts; comprehensive and/or vision plans
4. Forest Resources	CAMA land use plans; UDO; zoning ordinances and overlay districts; Oak Island Urban and Community Forestry Plan; Significant forest lands, including commercial forest tracts, are expected to remain. Many of these are unsuitable or not preferred for development (e.g. wetlands, located in northern portions of the County, etc.).

Environmental Features Potentially Impacted by Secondary and Cumulative Impacts	Existing Programs to Mitigate Impacts in the Shallotte IBT River Basin
5. Prime or Unique Agricultural Land	CAMA land use plans; UDO; zoning ordinances and overlay districts; Brunswick County Voluntary Agricultural District
6. Public Lands and Scenic, Recreational, and State Natural Areas	Impacts to these lands are not expected to occur at a significant level.
7. Areas of archaeological or Historic Value	N/A
8. Surface Water Resources	20 Coastal Counties Stormwater Law, Phase II stormwater regulations, additional local stormwater regulations, Lockwoods Folly River Local Watershed Plan, Lockwoods Folly River TMDL, state and local stormwater manuals, Brunswick County LID Guidance Manual; water conservation and drought management programs; water reuse program; NPDES and Nondischarge permitting; State and local department of environmental health regulations regarding onsite wastewater systems; Section 401 and 404 permitting; Water Quality Protection Overlay District; riparian buffers
9. Groundwater Resources	Same as #8
10. Wetlands	CAMA land use plans; Section 401 and 404 permitting; Water Quality Protection Overlay District, riparian buffers
11. Aquatic and Wildlife Habitat and Resources	Same as #8 and #10 above; federal programs such as the Endangered Species Act (ESA) of 1973; other state conservation programs
12. Air Quality	Air quality impacts are not expected to occur at a significant level. All applicable state and federal permitting requirements will apply to any new development.
13. Noise Levels	Noise impacts are not expected to occur at a significant level. All applicable state and federal permitting requirements will apply to any new development.
14. Introduction of Toxic Substances	Same as #8

Table 74 evaluates the protection from future development impacts provided by existing policies and regulations for each jurisdiction in the Shallotte IBT River Basin. Three ratings are used. The solid circle indicates the highest level of protection provided, defined as *Well Addressed by Current Regulations and Policies.* The partially solid circle indicates that a jurisdiction provides a moderate amount of protection, but opportunities for enhancement are available and other jurisdictions in the basin provide more protective measures. The empty circle indicates that policy or regulations in a jurisdiction need improvement to protect from impacts of future development. None of the jurisdictions received this latter rating. All jurisdictions have policies that are at least on par with other North Carolina jurisdictions of their size, and the state land use planning and stormwater regulations have provided a robust baseline for protection measures across all jurisdictions. Therefore, these measures will mitigate secondary and cumulative impacts from the proposal to a level of insignificance.

Despite this conclusion, a few opportunities for enhancement are noted in Table 74 and could be considered by the communities of the Shallotte IBT River Basin in the future. S&E control is not regulated for development less than one acre in the jurisdictions of Carolina Shores, Oak Island, Ocean Isle, Shallotte, and Varnamtown. These jurisdictions represent a small portion of the overall IBT Basin, and the impact from this gap should be small. However, such a regulation could provide additional protection on a site-specific basis and is recommended for consideration. Similarly, Carolina Shores and Varnumtown do not require stormwater regulation for development of one acre or less, which is considered a minor gap on a basinwide scale but potentially useful at the site-scale.

While the state and local regulations provide a substantial level of protection from effects on future development, additional protection opportunities exist across all jurisdictions. LID and similar strategies are encouraged within the basin, but barriers to implementing these strategies might exist in ordinances or codes. Revision of ordinances to remove these barriers would allow for more feasible applications of LID to further protect water quality, wildlife habitat, and other natural resources. The County LID Manual represents a good step in this direction.

Table 74. Evaluation of Mitigative Measures

Jurisdiction	Land Use Planning and Environmental Resource Protection Initiatives	Zoning	Riparian Buffers	Erosion and Sedimentation Control	Stormwater Regulations	Floodplain Development Regulations	Water Shortage Response
City of Boiling Spring Lakes	●	●	●	●	●	●	●
Town of Bolivia	●	●	●	●	●	●	●
Brunswick County	●	●	●	●	●	●	●
Town of Calabash	●	●	●	●	●	●	●
Town of Carolina Shores	●	●	●	⦿	⦿	●	●
Town of Holden Beach	●	●	●	●	●	●	●
Town of Oak Island	●	●	●	⦿	●	●	●
Town of Ocean Isle Beach	●	●	●	⦿	●	●	●
Town of Shallotte	●	●	●	⦿	●	●	●
Town of St. James	●	●	●	●	●	●	●
Town of Sunset Beach	●	●	●	●	●	●	●
Town of Varnamtown	●	●	●	⦿	⦿	●	●

● Well Addressed by Current Regulations and Policies
⦿ Opportunities for Enhancement
○ Needs Improvement

Several communities in the basin have developed plans that focus on natural resource protection, and more focused planning efforts in the basin could improve this protection. The existing environment section (Section 3) identifies several resource areas that could be addressed through a more comprehensive planning process. These considerations would include the protection of

- Rare forest communities, including Longleaf-Slash Pine and hardwood-dominated communities
- Soils that provide good infiltration and ground water recharge
- Prime farmland
- Exceptional wetland functions

Development planning should consider opportunities to preserve these features in the basin, either through conservation design for individual developments or in jurisdiction-wide, open-space preservation plans.

A final and important consideration for future development is the extensive shellfish water impairments in the area. The Coastal Stormwater Law will likely provide substantial protection against degradation from future development. However, communities draining directly to these waters could provide additional consideration of water quality impacts in their ordinances similar to the County water quality zoning overlay that protects the Lockwood Folly River shellfish beds. Implementation of the Lockwoods Folly River Local Watershed Plan and fecal coliform TMDL would also contribute to the restoration of these waters.

8 Summary

To meet future demand for water, the County is considering expansion of its Northwest WTP. The expansion of the Northwest WTP is expected to trigger the need for an IBT certificate from the EMC because a portion of the additional water would be distributed from its source in the Cape Fear IBT River Basin to customers in the Shallotte IBT River Basin. The County has prepared this EA to support a request for an IBT certificate, pursuant to the procedures and standards set out in IBT statute, G.S.§143-215.22I effective July 1, 2007 as specified in Session Law 2010-155. A summary of the alternatives considered to IBT, the potential impacts, and mitigation to reduce the potential impacts to an insignificant level is provided below.

8.1 Alternatives to IBT

An increase in IBT associated with an expansion of the Northwest WTP was compared to several alternatives that do not require an IBT or combinations of alternatives that could limit the quantity of the IBT. The full list of alternatives is as follows:

1) No Additional IBT (over the grandfathered amount)
2) Additional IBT - Expand Northwest WTP
3) Waccamaw Surface WTP
4) Expand 211 WTP
5) New Groundwater WTP
6) Seawater Desalination Plant
7) Return of Additional Wastewater to Source Basin
8) Water Conservation and Reuse
9) Surface Water Storage

Factors considered during alternatives analyses included the technical viability of the option, the constructability of the alternative, potential environmental impacts, technical difficulty, permitting issues, and estimates of probable costs, both construction costs and O&M.

The No Additional IBT alternative (#1) was not recommended because the County has demonstrated the need for an expansion of its water treatment system, and not doing so would compromise its ability to provide reliable, high-quality potable water to its customers in the future, particularly in the Shallotte IBT River Basin. Compared to alternatives #3 through #6 in the list above, additional IBT associated with an expansion of the Northwest WTP (#2, qualified below) is recommended as the preferred alternative because of a lower cost (capital, O&M), an equivalent or lower level of permitting difficulty, a low level of direct impacts (e.g., new WTP alternatives would have additional construction impacts for a new site), and an equivalent level of secondary and cumulative impacts in the Shallotte IBT River Basin. Return of additional wastewater to the source basin (alternative #7 above) would add more than 40 percent to the cost of the preferred alternative without significant benefit to the resource.

Combined with additional IBT associated with the expansion of the Northwest WTP (alternative #2), the County proposes to use a combination of alternatives (#8 and #9) to limit transfer of water. Water conservation and reuse are key elements of the County’s current water management plan, and they already reduce water demand and any associated IBT of water. It is not known how changes to these programs would result in additional demand reduction and future water transfer. In addition, BDPU has reduced the need to transfer additional water by developing an interconnection and agreement to purchase water from the Little River Water and Sewerage Company for future potable water service in the Waccamaw River IBT River Basin. Finally, the County is planning a study of ASR storage at the 211 WTP to reduce withdrawal of surface water during peak demand periods. The technical viability of this option is unknown.

8.2 Environmental Impacts

The potential direct, secondary, and cumulative impacts of the preferred alternative were analyzed in more detail for this EA. The proposal does not involve additional water transfer to the Waccamaw IBT River Basin. Therefore, no direct, secondary, or cumulative impacts would occur as a result of the IBT certificate. Further, no direct impacts on the Shallotte IBT River Basin would be associated with approval of an IBT certificate. The current environmental document has been prepared to support approval of an IBT certificate only and, therefore, does not involve any construction activities. Any direct impacts associated with construction of the WTP improvements in the source basin, and transmission line upgrades in the source and receiving basin would be reviewed under an environmental document prepared under SEPA specifically for these projects as required by statute and regulation. An EA for the plant expansion and associated improvements as described would be prepared and be reviewed as required by SEPA only if an IBT certificate is approved. Therefore, the potential direct impacts of concern for the IBT approval would be for the withdrawal of water from the Cape Fear River. Potential secondary and cumulative impacts would be relevant to the Shallotte receiving basin only.

8.2.1 Direct Impacts in the Cape Fear IBT River Basin

Direct impacts associated with an expansion of the Northwest WTP include those related to withdrawal of water from the Cape Fear River above Lock and Dam #1. An analysis using NCDWR's existing hydrology model for the Cape Fear (CFHM) was conducted to determine the County's impact on water availability and whether water demands are met for all users in the future. The results showed that the incremental impact of the increase in the County water withdrawals from 2003 conditions to 2050 at low flows in the river is less than or equal to 5 percent. Predicted flows passing over the dam at the 95th percentile flow exeedence (i.e., a fairly low flow) in 2050 would remain substantial at nearly 500 cfs. In addition, the analysis did not change NCDWR's (2008) previous conclusion that full demand for all withdrawals at Lock and Dam #1 are met through 2050. Accordingly, the direct impacts of the County withdrawal on water supply would not be significant.

An analysis of the potential impacts of water withdrawal on water quality above and below the dam was also conducted. Above the dam, the analysis involved correlation and regression using observed data: flow, temperature, dissolved oxygen, and pH. To evaluate dissolved oxygen and pH response for an extreme case, the analysis focused on July, a critical period, when the maximum monthly withdrawals typically occur and at mean water temperature of 28.3°C, used the provisional 7Q10 flow, and the 2050 max withdrawal for all users at the dam. Dissolved oxygen was predicted to change less than 1 percent as a result of the increased withdrawal. The regression model for pH predicted a small increase in pH equal to approximately 1.7 percent. Therefore, both the dissolved oxygen and pH changes are predicted to be minimal and insignificant.

Below the dam, the section of the LCFRE from upstream of Toomers Creek to a line across the river between Lilliput Creek and Snows Cut has been on North Carolina's 303(d) list as impaired for dissolved oxygen. Since the original listing for dissolved oxygen, many technical studies of the LCFRE have been conducted including a sophisticated hydrodynamic model (EFDC). Results of the modeling study showed that the river and estuary were relatively insensitive to reductions in point and nonpoint source loads of oxygen demanding pollutants. During low-flow summer conditions, hydrology and pollutant transport are dominated by tidal exchange with the ocean. Because of that and the transfer of flow would actually remove some pollutants from entering the LCFRE, the IBT would not be expected to have a noticeable impact on water quality in the river below Lock & Dam #1.

8.2.2 Secondary and Cumulative Impacts in the Shallotte IBT River Basin

Secondary and cumulative impacts for the project are those that could be derived from potential growth inducement in the Shallotte IBT River Basin. The additional water supply is considered a factor in facilitating growth. Future growth in the County is expected to primarily occur as low- and medium-density residential uses. If not managed properly, additional urbanization of the service area has the potential to cause significant impacts that degrade water resources, aquatic and wildlife habitat and resources, and other environmental features due to increased stormwater runoff, erosion and sedimentation, and other consequences of land development. A cumulative impact is derived from the combination of water supply, construction of new or expanded utilities (e.g., water and sewer), and transportation projects.

8.3 MITIGATION MEASURES

While increased water supply can stimulate increases in population and corresponding land use change and development in the Shallotte IBT River Basin, government policies applicable to the service area provide considerable mitigation for potential secondary and cumulative impacts from these changes. Regulations and programs related to development and its potential impacts are summarized for this EA. In addition to other planning and environmental policies of jurisdictions in the Shallotte IBT River Basin, land use planning and stormwater regulations are some of the most robust in the state because of requirements of CAMA and the recently enhanced State Coastal Stormwater Law.

8.4 SUMMARY OF ENVIRONMENTAL IMPACTS

In summary, the request for an IBT certificate to increase water transfer of 7.8 MGD over the grandfathered amount (10.5 MGD) from the Cape Fear IBT River Basin to the Shallotte IBT River Basin would not be expected to result in any significant environmental impacts. Therefore, the long-term productivity and sustainability of the source and receiving basin are not compromised. Further, there would be no significant environmental changes that are irreversible or irretrievable.

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Abbreviations and Acronyms

ASR	Aquifer Storage and Recovery
BCPU	Brunswick County Public Utilities
BFE	base flood elevation
CAMA	Coastal Area Management Act
CCI	Construction Cost Index
CFHM	Cape Fear Hydrologic Model
CFPUA	Cape Fear Public Utility Authority
DAQ	Division of Air Quality
DCM	Division of Coastal Management
DLR	Department of Land Resources
DWQ	Division of Water Quality
EA	Environmental Assessment
EFDC	Environmental Fluid Dynamics Code
EMC	Environmental Management Commission
ENR	*Engineering News-Record*
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
EVT	existing vegetation type
FEMA	Federal Emergency Management Agency
FIA	Forest Inventory and Analysis
FONSI	Finding of No Significant Impact
G.S.	General Statute
GIS	geographic information system
gpd	gallons per day
HGM	hydrogeomorphic
HSG	hydrologic soil group
IBA	Important Bird Area
IBT	interbasin transfer
km	kilometer
ICWW	Intracoastal Waterway
LCFRE	Lower Cape Fear River Estuary
LCFWSA	Lower Cape Fear Water and Sewer Authority
LID	low impact development

LMCOS	lands managed for conservation and open space
LWSP	Local Water Supply Plan
mg/L	milligram per liter
MGD	million gallons per day
MS4	municipal separate stormwater system
MSI	municipal spheres of influence
NCCGIA	North Carolina Center for Geographic Information and Analysis
NC-CREWS	North Carolina Coastal Region Evaluation of Wetland Significance
NCDENR	North Carolina Department of Environment and Natural Resources
NCDWR	North Carolina Division of Water Resources
NCNHP	North Carolina Natural Heritage Program
NHP	Natural Heritage Program
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity unit
O&M	operation and maintenance
ORW	outstanding resource water
PER	Preliminary Engineering Report
RSAC	Remote Sensing Applications Center
SEPA	State Environmental Policy Act
SFHA	special flood hazard area
SGA	shellfish growing area
SNHA	Significant Natural Heritage Area
TMDL	total maximum daily load
UDO	Unified Development Ordinance
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WRF	water reclamation facility
WS/TS	*Water Supply/Treatment Study*
WTP	water treatment plant
WWTP	wastewater treatment plant

List of Appendices

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Appendix A Grandfathered IBT

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NCDENR
North Carolina Department of Environment and Natural Resources
Division of Water Resources

Michael F. Easley, Governor

William G. Ross Jr., Secretary
John Morris, Director

April 25, 2008

Jerry W. Pierce, P.E.
Director of Public Utilities
Brunswick County Public Utilities
20 Referendum Drive NE, Building G
Bolivia, NC 27422

RE: Brunswick County Interbasin Transfer Grandfathered Capacity Determination

Dear Mr. Pierce,

This letter is to inform you that the Division of Water Resources has determined that **Brunswick County has a grandfathered interbasin transfer capacity of 10.5 million gallons per day** (mgd) to transfer water from the Cape Fear River Basin (2-3) to the Shallotte (9-4) and Waccamaw (9-3) River Basins. We base our determination on G.S. §143-215.22L(b) and Administrative Code T15A:02G.0401(d), and that on July 1, 1993, Brunswick County was limited by infrastructure to transfer 10.5 mgd between the source and receiving basins.

The grandfathered interbasin transfer capacity is the maximum amount of surface water that may be transferred from one river basin to another without requiring an interbasin transfer (IBT) certificate approved by the Environmental Management Commission (EMC).

The water balance tables that you submitted dated April 10, 2008 project that the maximum day IBT by Brunswick County may reach 10.5 mgd in the year 2012. Therefore, since the process can require three years or more to complete, the Division recommends that the County now begin the process of petitioning the Environmental Management Commission for an interbasin transfer certificate.

The North Carolina IBT statute was revised in 2007. The new statute in §143-215.22L(c) explains that applicants for an IBT certificate must prepare a Notice of Intent to File a Petition describing the IBT request in non-technical terms. Within 90 days of filing the Notice of Intent, public meetings must be held upstream and downstream of the proposed withdrawal point in the source basin, and also in the receiving basin. Notice of the meetings must be sent to an extensive list of parties listed in the statute, both in North Carolina and South Carolina. One of the purposes of the meetings will be to receive public input on alternatives and issues that should be addressed in the environmental document to be developed.

The revised IBT law also says that in order to sell IBT water to another public water system, there must be an interlocal agreement or other regional water supply arrangement between the selling and purchasing water systems and all participants in the agreement or arrangement must be co-applicants for the IBT certificate. All co-applicants for the certificate are subject to all the terms, conditions, and limitations made applicable to the lead or primary applicant.

Please contact me with any questions at 919-715-0389 or Phil.Fragapane@ncmail.net .

Regards,

Phil Fragapane

Phil Fragapane, PE
River Basin Management Section

cc: Tom Fransen, Linwood Peele, John Morris, NCDWR
Todd Kennedy, Tetratech

Appendix B Notice of Intent

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BRUNSWICK COUNTY ADMINISTRATION

BRUNSWICK COUNTY GOVERNMENT CENTER
DAVID R. SANDIFER COUNTY ADMINISTRATION BUILDING
30 GOVERNMENT CENTER DRIVE, N.E.
BOLIVIA, NORTH CAROLINA 28422

MAILING ADDRESS:

POST OFFICE BOX 249
BOLIVIA, NORTH CAROLINA 28422

TELEPHONE
(910) 253-2000
(800) 442-7033

FAX
(910) 253-2022

February 17, 2009

Mr. Stephen Smith, Chairman
North Carolina Environmental Management Commission
1617 Mail Service Center
Raleigh, NC 27699-1617

Subject: Notice of Intent to File a Petition for an Interbasin Transfer Certificate
Pursuant to G.S. § 143-215.22L(c)

Dear Mr. Smith:

Brunswick County, among the fastest growing counties in the state, provides water to more than 30,000 retail customers and 11 wholesale customers. Future demand for water has prompted a proposal to expand the County's Northwest Water Treatment Plant (WTP). In conjunction with this proposed expansion, future increases in the transfer of water from the Northwest WTP's source, the Cape Fear River, to customers in the adjacent Lumber Major River Basin, are expected to trigger the need for an interbasin transfer (IBT) certificate from the North Carolina Environmental Management Commission (EMC) under the Regulation of Surface Water Transfers Act.

The County has two water treatment plants: the Northwest WTP, located near Northwest and supplied by water from the Cape Fear River, and the 211 WTP, located near St. James and supplied by 15 groundwater wells into the Castle Hayne Aquifer (Figure 1). The Lower Cape Fear Water and Sewer Authority supplies raw water to the Northwest WTP from an intake on the Cape Fear River above Lock and Dam 1. The Northwest WTP and 211 WTP have permitted capacities of 24 million gallons per day (MGD) and 6 MGD, respectively. The Northwest WTP is now approaching 80 percent capacity on peak days. To meet future water demand, the County is proposing to expand the Northwest WTP from 24 MGD to 36 MGD.

The expansion of the Northwest WTP is expected to trigger the need for an IBT certificate since a portion of the surface water treated at the Northwest WTP in the Cape Fear River Basin, as defined by G.S. § 143-215.22G, is distributed to customers in the Shallotte River Basin and the Waccamaw River Basin, both of which are located in the Lumber Major River Basin. Waters located in the Lumber Major River Basin (except for the Lockwoods Folly and

Shallotte Rivers), including the Waccamaw River, are tributaries of the Pee Dee River, which flows to Winyah Bay in South Carolina. The Shallotte River and Lockwoods Folly River are also considered part of the Lumber Major River Basin and flow directly into the Atlantic Ocean.

Under the grandfather provision of the Regulation of Surface Water Transfers Act, Brunswick County may transfer up to 10.44 MGD from one designated river basin to another without an IBT certificate. Based on water demand projections, it is expected that the County's grandfathered transfer capacity will be exceeded during the year 2012 and therefore require an IBT certificate. At that time, 9.68 MGD and 0.76 MGD are expected to be transferred to the Shallotte River Basin and Waccamaw River Basin, respectively, and not returned to the source river basin. The County is requesting an IBT certificate from the EMC for a maximum transfer of 18.35 MGD to the Shallotte River Basin and a maximum transfer of 0.94 MGD to the Waccamaw River Basin based on projections through 2040.

Therefore, as a duly authorized official and on behalf of Brunswick County and its co-applicants, the towns of Oak Island, Shallotte, Holden Beach, and Ocean Isle Beach, I hereby file this Notice of Intent to File a Petition for an Interbasin Transfer Certificate Pursuant to § 143-215.22L(c). As required by law, we intend to provide public notice and hold four public meetings within 90 days of issuing this Notice of Intent to provide information to interested parties and the public regarding the nature and extent of the proposed transfer and to receive comment on the scope of the Environmental Impact Statement.

Sincerely,

William M. Sue
Chairman
Brunswick County Board of Commissioners

Enclosures

cc: Tom Reeder, Director, NC Division of Water Resources
Jerry Pierce, Director of Public Utilities, Brunswick County

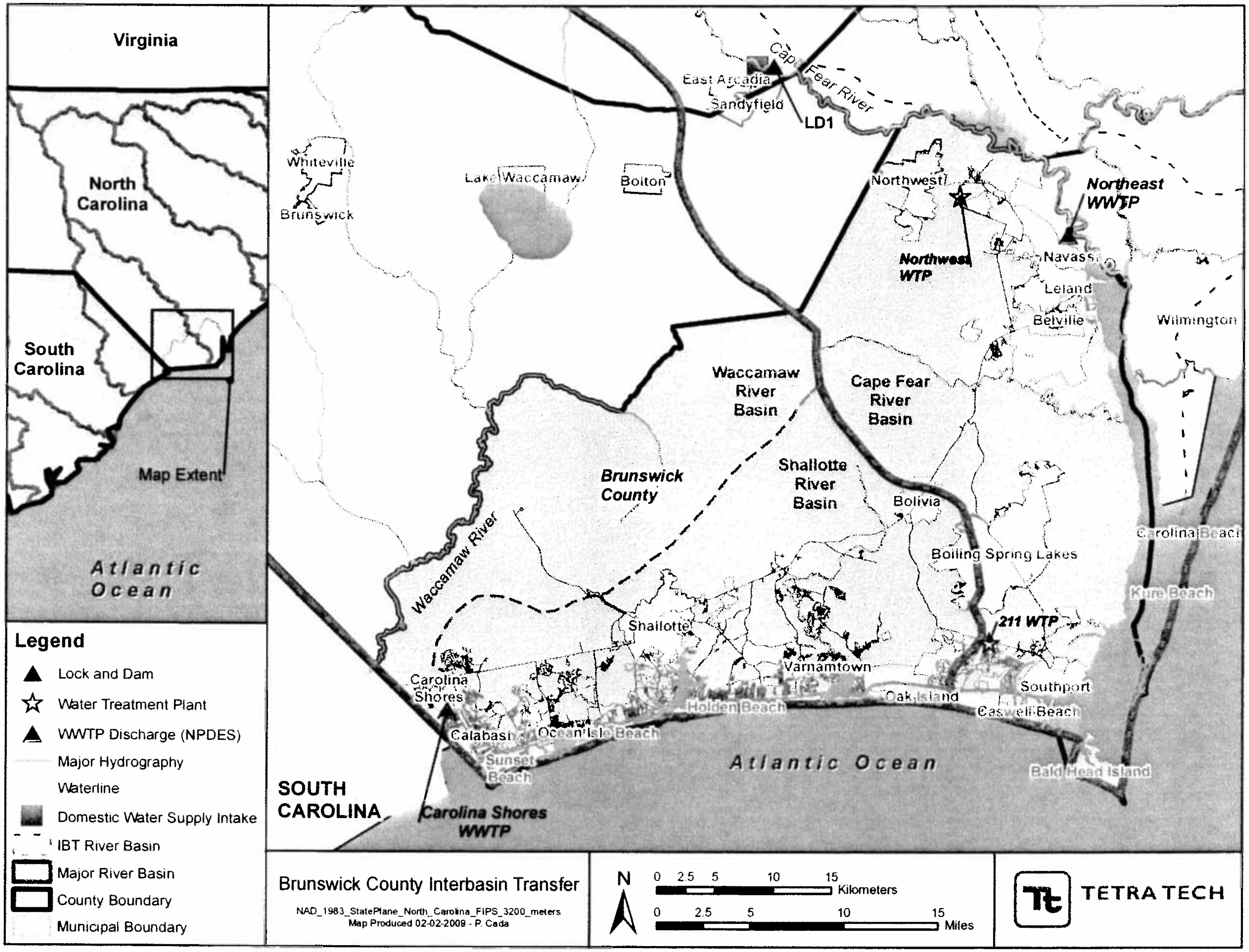
Virginia
North Carolina
South Carolina
Map Extent
Atlantic Ocean
Legend
Lock and Dam
Water Treatment Plant
WWTP Discharge (NPDES)
Major Hydrography
Waterline
Domestic Water Supply Intake
IBT River Basin
Major River Basin
County Boundary
Municipal Boundary
East Arcadia
Sandyfield
Cape Fear River
LD1
Whiteville
Brunswick
Lake Waccamaw
Bolton
Northwest
Northwest WTP
Northeast WWTP
Navassa
Leland
Belville
Wilmington
Waccamaw River Basin
Cape Fear River Basin
Brunswick County
Shallotte River Basin
Bolivia
Waccamaw River
Boiling Spring Lakes
Carolina Beach
Kure Beach
211 WTP
Shallotte
Varnamtown
Carolina Shores
Southport
Oak Island
Caswell Beach
Holden Beach
Calabash
Ocean Isle Beach
Sunset Beach
Atlantic Ocean
Bald Head Island
SOUTH CAROLINA
Carolina Shores WWTP
Brunswick County Interbasin Transfer
NAD_1983_StatePlane_North_Carolina_FIPS_3200_meters
Map Produced 02-02-2009 - P. Cada
N
0 2.5 5 10 15 Kilometers
0 2.5 5 10 15 Miles
TETRA TECH

Figure 1.

Contact Information

Primary Applicant

County of Brunswick Public Utilities Department
Jerry Pierce, P.E.
P.O. Box 249
Bolivia, North Carolina 28422
(910) 253-2657

Co-Applicants

Town of Oak Island
Jerry A. Walters
Town Manager
4601 East Oak Island Drive
Oak Island, NC 28465
(910) 278-5011

Town of Shallotte
Paul Sabiston
Town Administrator
P. O. Box 2287
Shallotte, NC 28459
(910) 754-4032

Town of Holden Beach
David Hewett
Town Manager
P. O. Box 449
Supply, NC 28462
(910) 842-6488

Town of Ocean Isle Beach
Daisy Ivey
Town Administrator
3 West Third Street
Ocean Isle Beach, NC 28469
(910) 579-2166

Appendix C Scoping

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NCDENR
North Carolina Department of Environment and Natural Resources
Division of Water Resources

Beverly Eaves Perdue, Governor

Dee Freeman, Secretary
Thomas A. Reeder, Director

February 23, 2009

J. Todd Kennedy, QEP
Tetra-Tech
P.O. Box 14409
Research Triangle Park, North Carolina 27709

Subject: IBT Notification Requirements
Brunswick County Water System
Cape Fear River Basin

Dear Mr. Kennedy:

On February 17, 2009, Brunswick County submitted to the Environmental Management Commission a Notice of Intent to request an Interbasin Transfer (IBT) Certificate. In accordance with North Carolina General Statutes §143-215.22L(c), Brunswick County is required to hold several public meetings and provide notice of these meetings to the public through the North Carolina Register, local newspapers, and targeted mailings to affected parties. To assist the County with the required notifications, The Division of Water Resources was able to provide the following information:

- ✓ List of NC counties that are at least partially located within the source (Cape Fear 2-3) and receiving basins (Shallotte 9-4, Waccamaw 9-3) [required by §143-215.22L(c)(2)(a),(c),(e)].
- ✓ List of NC counties where the Cape Fear River Basin has been identified as a future source of water in a local water supply plan [required by §143-215.22L(c)(2)(d)].
- ✓ List of NC public water supply systems that withdraw surface water from the Cape Fear River Basin [required by §143-215.22L(c)(3)c)].
- ✓ List of persons in NC who have registered a water withdrawal or transfer from the Cape Fear River Basin [required by §143-215.22L(c)(3)(e)].
- ✓ List of persons in NC who hold a certificate for transfer from the Cape Fear River Basin [required by §143-215.22L(c)(3)(f)].

- ✓ List of persons in NC who hold an NPDES wastewater discharge permit for a discharge of 100,000 gallons per day or more to the surface waters of the Cape Fear River Basin [required by §143-215.22L(c)(3)(g)].

- ✓ §143-215.22L(c)(3)(h) requires that all persons who have submitted a written request be notified of information pertaining to IBTs. All persons who have notified DWR that they would like to receive information pertaining to IBT issues can be reached using our mailing list. Please send one electronic copy of the public notice to wac@lists.ncmail.net. This mailing list is maintained by DWR.

The information that has been provided fully meets the requirements of the abovementioned subsections, as these regulations apply to individuals and entities located in North Carolina. Additional information required G.S. §143-215.22L(c) but not specifically mentioned by subsection, above, has not been provided by the Division. It is Brunswick County's responsibility to collect additional information from the state of South Carolina and other affected parties, as defined by the statutes.

If you have any questions or need additional information, please contact Toya Fields at (919) 715-0389 or toya.fields@ncmail.net.

Sincerely,

LeToya D. Fields
River Basin Management Section

Cc (via email):
Tom Fransen, DWR
Steven Reed, DWR
Jerry Pierce, P.E. Director of Public Utilities, Brunswick County

Brunswick County Public Utilities
BRUNSWICK COUNTY GOVERNMENT COMPLEX

20 Referendum Drive NE
Building G
Bolivia, North Carolina 28422

Mailing Address
Post Office Box 249
Bolivia, North Carolina, 28422

Telephone
(910) 253-2657
Fax
(910) 253-4304

March 3, 2009

Brunswick County Proposed Interbasin Transfer

Notice of Public Meetings

April 16, 2009, 6:00 PM
Brunswick County Commissioners Chambers
Brunswick County Government Center
David R. Sandifer Administration Building
30 Government Center Drive NE, Bolivia, NC

April 21, 2009, 6:00 PM
Leland Town Hall
102 Town Hall Drive, Leland, NC

April 23, 2009, 6:00 PM
Carolina Shores Commissioners Chambers
Carolina Shores Town Hall
200 Persimmon Road, Carolina Shores, NC

April 28, 2009, 6:00 PM
Elizabethtown Council Chambers
Elizabethtown Town Hall
805 West Broad Street, Elizabethtown, NC

Brunswick County and the towns of Oak Island, Shallotte, Holden Beach, and Ocean Isle Beach will hold four public meetings in cooperation with the North Carolina Division of Water Resources to receive comments on their request for an interbasin transfer (IBT) from the Cape Fear River Basin to the Waccamaw River Basin and Shallotte River Basin.

Notice of these meetings is given in accordance with N.C. General Statute § 143-215.22L. The purpose of the meeting is to provide information to interested parties and the public regarding the nature and extent of the proposed transfer and to receive comment on the scope of the required environmental document. The first public meeting will begin at 6:00 p.m. on April 16, 2009, at the Brunswick County Government Center in Bolivia, NC. Three additional meetings will be held: April 21 at the Leland Town Hall, April 23 at the Carolina Shores Town Hall, and April 28 at the Elizabethtown Town Hall. At each of the meetings, a brief presentation will be made followed by an opportunity to provide oral comments. Representatives from the County and the Division of Water Resources will be in attendance.

Brunswick County, among the fastest growing counties in the state, provides water to more than 30,000 retail customers and 11 wholesale customers. Future demand for water has prompted a proposal to expand the County's Northwest Water Treatment Plant (WTP). In conjunction with this proposed expansion, future increases in the transfer of water from the Northwest WTP's source, the Cape Fear River, to customers in the adjacent Lumber Major River Basin, are expected to trigger the need for an IBT certificate from the North Carolina Environmental Management Commission (EMC) under the Regulation of Surface Water Transfers Act.

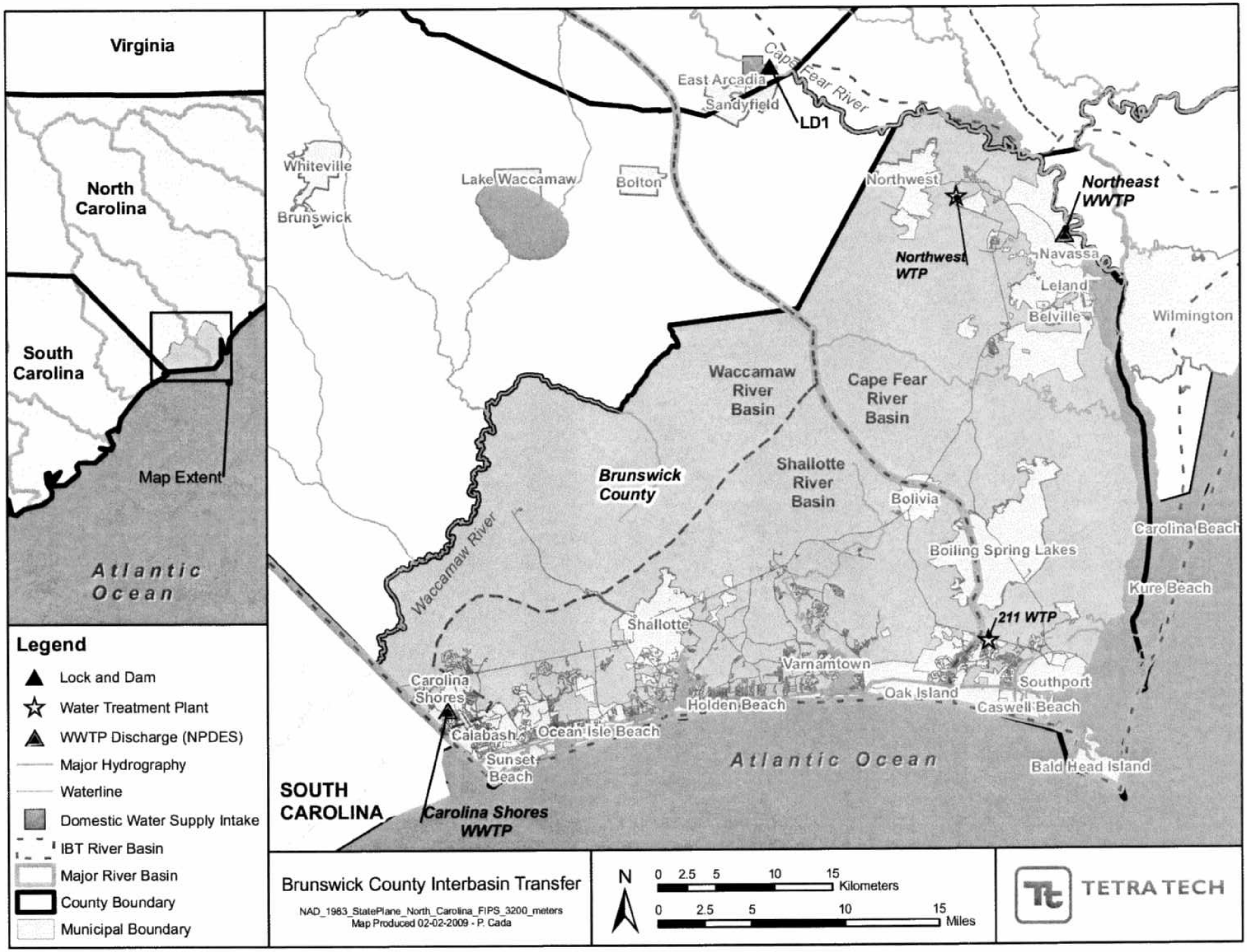
The County has two water treatment plants: the Northwest WTP, located near Northwest and supplied by water from the Cape Fear River, and the 211 WTP, located near St. James and supplied by 15 groundwater wells into the Castle Hayne Aquifer. The Lower Cape Fear Water and Sewer Authority (LCFWSA) supplies raw water to the Northwest WTP from an intake on the Cape Fear River above Lock and Dam 1. The Northwest WTP and 211 WTP have permitted capacities of 24 million gallons per day (MGD) and 6 MGD, respectively. The Northwest WTP is now approaching 80 percent capacity on peak days. To meet future water demand, the County is proposing to expand the Northwest WTP from 24 MGD to 36 MGD.

The expansion of the Northwest WTP is expected to trigger the need for an IBT certificate since a portion of the surface water treated at the Northwest WTP in the Cape Fear River Basin, as defined by G.S. § 143-215.22G, is distributed to customers in the Shallotte River Basin and the Waccamaw River Basin, both of which are located in the Lumber Major River Basin. Waters located in the Lumber Major River Basin (except for the Lockwoods Folly and Shallotte Rivers), including the Waccamaw River, are tributaries of the Pee Dee River, which flows to Winyah Bay in South Carolina. The Shallotte River and Lockwoods Folly River are also considered part of the Lumber Major River Basin and flow directly into the Atlantic Ocean.

Under the grandfather provision of the Regulation of Surface Water Transfers Act, Brunswick County may transfer up to 10.44 MGD from one designated river basin to another without an IBT certificate. Based on water demand projections, it is expected that the County's grandfathered transfer capacity will be exceeded during the year 2012 and therefore require an IBT certificate. At that time, 9.68 MGD and 0.76 MGD are expected to be transferred to the Shallotte River Basin and Waccamaw River Basin, respectively, and not returned to the source river basin. The County is requesting an IBT certificate from the EMC for a maximum transfer of 18.35 MGD to the Shallotte River Basin and a maximum transfer of 0.94 MGD to the Waccamaw River Basin based on projections through 2040.

The purpose of this announcement is to encourage those interested in this matter to provide comments and to comply with statutory notice requirements. You may attend either of the public meetings and make relevant oral comments and/or submit written comments. All statements made at the meeting will be audio recorded. However, written submissions of oral comments at the hearings are kindly requested. The meeting conveners may limit the length of oral presentations if many people want to speak.

If you are unable to attend, written comments can be mailed to Brunswick County Public Utilities Department, Attn. Jerry Pierce, P.E., P. O. Box 249, Bolivia, NC 28422 or emailed to jpierce@brunsco.net. Comments on the alternatives and issues that should be addressed in the environmental document required by the governing statute are requested. Oral, mailed, and emailed comments will be given equal consideration. Comments will be accepted up to 30 days following the last public meeting. Interested parties will also have future opportunities to provide comments during the IBT request process.


Virginia
North Carolina
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Map Extent
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Water Treatment Plant
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IBT River Basin
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Brunswick
Lake Waccamaw
Bolton
East Arcadia
Sandyfield
Cape Fear River
LD1
Northwest
Northwest WTP
Northeast WWTP
Navassa
Leland
Belville
Wilmington
Waccamaw River Basin
Cape Fear River Basin
Shallotte River Basin
Brunswick County
Bolivia
Boiling Spring Lakes
Waccamaw River
Carolina Beach
Kure Beach
211 WTP
Shallotte
Varnamtown
Southport
Oak Island
Caswell Beach
Holden Beach
Carolina Shores
Calabash
Ocean Isle Beach
Sunset Beach
Atlantic Ocean
Bald Head Island
SOUTH CAROLINA
Carolina Shores WWTP
Brunswick County Interbasin Transfer
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Resolution in Support of Brunswick County's and Co-Applicants' Environmental Impact Statement
And
Interbasin Transfer Permit Petitions to the North Carolina Environmental Management Commission

Whereas, Brunswick County and the towns of Oak Island, Shallotte, Holden Beach and Ocean Isle are preparing an Environment Impact Statement to support the submission of an Interbasin Transfer (IBT) Permit Petition to the North Carolina Environmental Management Commission (EMC) in order to expand the capacity of Brunswick County Northwest Water Treatment Plant; and

Whereas, Brunswick County has been among the fastest growing counties in the State of North Carolina and provides a treated water supply to more than 30,000 retail customers and 11 wholesale customers; and

Whereas, Brunswick County's Northwest Water Treatment Plant currently rated at 24 Million Gallons per Day (MGD) has exceeded its peak of 80% capacity during recent summer months and future demand studies indicate a capacity need of 36 MGD which has resulted in a proposal to expand the capacity of the plant; and

Whereas, the surface water source for the Northwest Water Treatment Plant is the Cape Fear River, behind Lock and Dam #1 in Bladen County and in conjunction with this proposed expansion future increases in the transfer of water from the Cape Fear River basin to customers in the adjacent Lumber Major River Basin are expected to trigger the need for an IBT certificate from the North Carolina Environmental Management Commission under the Regulation of Surface Water Transfers Act; and

Whereas, currently, under the grandfather provisions of the Regulation of Surface Water Transfers Act, Brunswick County may transfer up to 10,440,000 MGD from one designated river basin to another without an IBT certificate; however, with the expanded capacity of the water treatment plant, the County is requesting an IBT certificate from the EMC for a maximum transfer of 18,350,000 MGD to the Shallotte River Basin and a maximum transfer of 940,000 MGD to the Waccamaw River Basin based upon projections through 2040; and

Whereas, there are no municipal surface water treatment plants below Lock and Dam #1 withdrawing water from the Cape Fear River and the discharges to the

Shallotte River Basin and the Lockwood Folly River flows directly into the Atlantic Ocean.

Now Therefore Be It Resolved, that the Chairman and the Board of Directors for the Lower Cape Fear Water and Sewer Authority do hereby support the County of Brunswick and the towns of Oak Island, Shallotte, Holden Beach and Ocean Isle in the submittal of an Environmental Impact Statement and IBT permit petition to the North Carolina Environmental Management Commission.

Adopted this 11th day of May, 2009

Al J. Leonard, Chairman

Larry Smith, Secretary

May 22, 2008

Brunswick County Public Utilities Department
Attn. Mr. Jerry Pierce, P.E.
P.O. Box 249
Bolivia, NC 28422

Re: Comments from Cape Fear River Watch regarding the Brunswick County Proposed Interbasin Transfer

Dear Mr. Pierce,

Cape Fear River Watch (CFRW) has reviewed the Public Notice (PN) released by the Brunswick County Public Utilities regarding the proposed interbasin transfer (IBT) from the Cape Fear River Basin to the Waccamaw River Basin and Shallotte River Basin.

CFRW is an established non-profit environmental organization with a mission: To Protect and Improve the Water Quality of the Lower Cape Fear River Basin through Education, Advocacy and Action. With this mission in mind, CFRW will respectfully submits the following comments based on review of the PN:

- Based on information provided in the PN, Brunswick County is requesting an IBT certificate from the Environmental Management Commission (EMC) for a maximum transfer of 18.35 million gallons per day (MGD) from the Cape Fear River Basin to the Shallotte River Basin and a maximum transfer of 0.94 MGD to the Waccamaw River Basin based on projections through 2040. This approximately doubles the current IBT of 10 MGD to Brunswick County. Such massive transfers of water between distinct river basins dramatically impact the ecology of the river system as well as the water supply and quality, particularly during low flow periods. This IBT will fundamentally and irreversibly alter natural water flows in the Lower Cape Fear River Basin which will potentially harm endangered, threatened, and sensitive species that depend on specific water flows. Specifically, a number of anadromous fish including the shortnose sturgeon, American shad, and striped bass utilize the Cape Fear River as their spawning grounds. These fish currently face tremendous challenges reaching their spawning areas up river due to the presence of three lock and dam structures. Reducing the water level even further through this IBT will significantly reduce the potential for these important fish species to successfully reproduce due to their inability to navigate above Lock and Dam #1. And very importantly, low flow periods will be exacerbated by increased withdrawal and more and longer periods of salt water intrusion up to Lock and Dam #1 may further impact the freshwater wetlands adjacent to the CFR.

- The proposed IBT will affect the Lower Cape Fear River Basin's ability to assimilate pollutants by permanently lowering the amount of flow. Clean water is an integral part of a healthy riverine ecosystem. Water quality monitoring conducted by the University of North Carolina at Wilmington between 1996 and 2007 has shown that 13% and 14% of the parameters resulted in “poor” and “fair” classifications, respectively. Very large amounts treated sewage and other discharges occur in the lower basin. Reducing the flow in the Cape Fear River will undoubtedly degrade the state of water quality resulting in additional threats to the fish and other fauna which utilize the river. There is no proposal to reduce pollutant loadings, which are at or near the assimilative capacity of the river at this time, concomitant with the increased IBT and with future increased withdrawal by Wilmington. The assimilative capacity of the river below the intake for the proposed withdrawals would necessarily decline.

- The United States Geologic Survey (USGS) monitors flow rates within the Cape Fear River. At a monitoring station located at Lock and Dam #1 in Kelly, NC, the flow varied between above 20,000 ft^3/sec to approx. 600 ft^3/sec in between May 1, 2008 and April 30, 2009 (Figure 1). This translates to 12.9 billion gallons per day to 387 million gallons per day. NC has experienced two severe droughts in recent years (2002 and 2007). During times of drought, these volumes decrease significantly. In October 2007, only 273 ft^3/sec, or 176 MGD was measured from this monitoring station. The proposed volume of water to be transferred to the Shallotte and Waccamaw River Basins would therefore equate to nearly 11% of the entire flow of the Cape Fear River during low flow conditions. Planning must consider the possibility of recurring drought conditions.

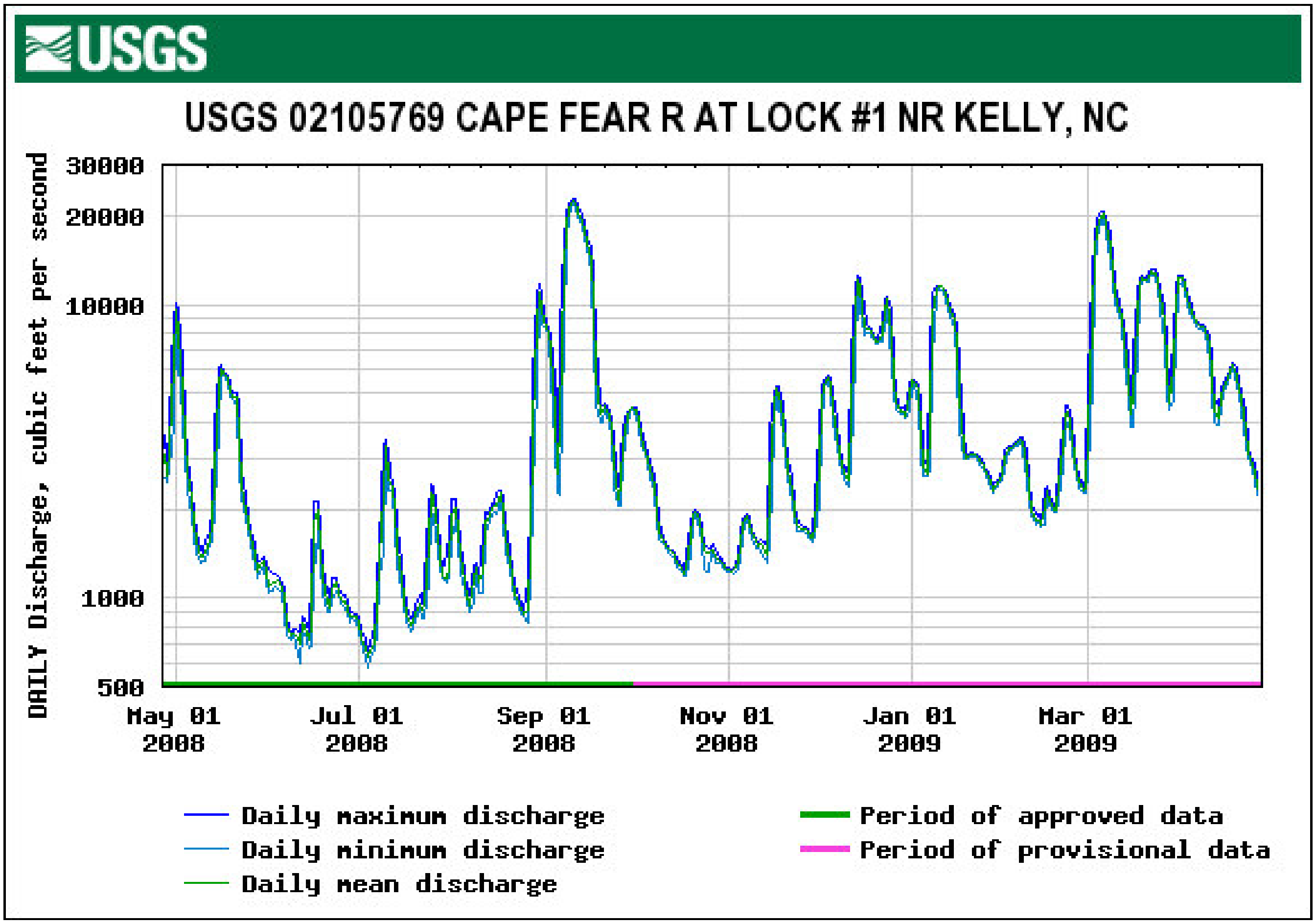

Figure 1: Flow Rates within the Cape Fear River at Lock and Dam #1

- Currently, the City of Wilmington's withdrawal rate is approximately18 MGD for drinking water. It is projected that by the year 2030, this volume will increase to 31 MGD. Combining the volume being requested by Brunswick County and the projected volume the City of Wilmington will require, over 50 MGD will be withdrawn from the river to supply drinking water alone. This would be 28% of the CFR flow at the low water level stated above. CFRW highly recommends that the EIS should include stipulations that limit the takings of water from the Cape Fear River for IBT purposes during low flow conditions. Furthermore, CFRW strongly recommends that the EIS incorporates information regarding all existing permitted extractors of water from the Cape Fear River as well as any permitted IBTs. The cumulative impacts of these extractions should be addressed in detail and the studies should include the assimilative capacity of the river for waste discharges.

- The Local Water Supply Plans issued by the North Carolina Division of Water Resources (NCDWR) are currently being developed. These plans should provide for the latest forecasts of water supply and demand, which are essential in the context of recent low flow conditions during droughts and the increasing demands for surface water.

- It has been demonstrated that IBTs can increase the potential for flooding in the receiving basin by bringing in more water than the basin is naturally able to accommodate. An additional 18.35 MGD released into the Shallotte River Basin will increase the threat of flooding upon the populated lands within Brunswick County.

- The request for an IBT certificate from the EMC should only be evaluated following the submittal of the final EIS to ensure all environmental issues are fully addressed. The project alternatives discussed in the EIS should be evaluated primarily on their environmental impact. Cost should not be used as evaluation criteria.

- CFRW encourages communities to engage in best management practices (BMPs) to reduce the need for high levels of water withdrawals or IBTs from our fragile riverine ecosystems. Along with BMPs, CFRW would encourage Brunswick County to explore “smart growth” initiatives to ensure that the projected population increases within the county are viable considering the environmental constraints. These alternatives, if implemented, may reduce the need for the environmentally damaging proposed IBT. Water conservation measures, particularly under declared drought conditions, should be prepared for implementation by all water withdrawers. Preparation for implementing such measures is not now adequate.

Thank you for your time and consideration of these comments. CFRW appreciates the opportunity to continue to participate in the discussions and developments of this IBT. Please feel free to contact me anytime regarding these comments or any other issue pertaining to the proposed IBT.

Sincerely,

Doug Springer – Cape Fear Riverkeeper and Executive Director of Cape Fear Riverwatch

Jane Hartley – President of Cape Fear Riverwatch

and the Executive Board of Cape Fear Riverwatch

May 26, 2008

Brunswick County Public Utilities Department
Attn. Mr. Jerry Pierce, P.E.
P.O. Box 249
Bolivia, NC 28422

Re: Comments regarding the Brunswick County Proposed Interbasin Transfer

Dear Mr. Pierce,

Thank you for this opportunity to comment on Public Notice (PN) released by the Brunswick County Public Utilities regarding the proposed interbasin transfer (IBT) from the Cape Fear River Basin to the Waccamaw River Basin and Shallotte River Basin. As a citizen of Brunswick county I am very concerned about this proposal.

North Carolina has just cleared from drought status, and it is anticipated that this environmental condition may become more frequent which combined with population growth will continue to strain all water resources. To not plan aggressively now for future demands is ludicrous and costs will certainly rise in the future, so waiting till later to fix infrastructure will not save anyone. The proposal I heard came across as the "cheap fix" not a long term solution and is environmentally questionable.

- I submit that Brunswick county encourage all communities to engage in best management practices (BMPs) to reduce the need for high levels of water withdrawals or IBTs from our fragile riverine ecosystems. This effort should include educational programs and handouts to homeowners and businesses.
- Along with BMPs, Brunswick County must explore "smart growth" initiatives to ensure that the projected population increases within the county are viable considering the environmental constraints. These alternatives, if implemented, may reduce the need for the environmentally damaging proposed IBT.
- Water conservation measures, particularly under declared drought conditions, should be prepared for implementation by all water withdrawers and required in all new developments as a stipulation for approval. Cisterns, rain barrels, permeable parking lots/driveways and low impact development to save wetlands and trees are a few ideas that can be encouraged or required.
- Saline plants should be aggressively explored in the lower reaches of the county already facing shortages. Preparation for implementing such measures is not now adequate.

Thank you for your consideration of my comments.

Sincerely,

Jane M. Hartley

From: Beth Eckert [mailto:Beth.Eckert@cfpua.org]
Sent: Thursday, June 04, 2009 11:06 AM
To: jpierce@brunsco.net
Subject: Brunswick County Public Utilities Department Interbasin Transfer Permit

Dear Mr. Pierce,

Thank you for the opportunity to comment on the proposed Interbasin Transfer Permit. I understand that I am little late with our comments but I appreciate you agreeing to submit them on to y our consultant. CFPUA's comments are as follows:

CFPUA's concerns as a user of the Cape Fear River are about fair allocation of water from this limited resource. In particular, CFPUA does not want this IBT process for Brunswick County to supersede a fair allocation of water rights from the Cape Fear River.

Demand information and alternatives were not presented in any detail. CFPUA requests and would expect the scoping process to carefully examine the cumulative water withdrawal impacts from all potential users into the future to determine the resource constraints.

Average and max day characteristics should be analyzed. What is Brunswick proposing to use from the River 30 years out? How does that compare to CFPUA's demands and the demands of the other entities that rely on the Cape Fear River. Do the potential future demands within the Cape Fear River Basin exceed available supply with a reasonable safety factor? Is this IBT establishing water rights that prevent a fair allocation of water from this limited resource within the Cape Fear River Basin itself?

Again, thank you for this opportunity and CFPUA looks forward to working through these and other issues with all of the stakeholders as the scoping process moves forward.

Sincerely,
Beth Eckert
Cape Fear Public Utility Authority
Environmental and Safety Management Director
910-332-6646
http://www.cfpua.org


Print this.... but only if you must

Public Meeting Oral Comment
Brunswick County Interbasin Transfer Public Meetings

April 21, 2009
Leland Town Hall
Leland NC

Doug Springer
Cape Fear River Watch

My name is Doug Springer and I'm the Cape Fear River keeper. I'm with Cape Fear River Watch and I'm definitely probably the least knowledgeable of all of you, so you all bear with me, you're the experts in this field…but as the river keeper I guess I just want to make a couple of more high level comments and then we will be submitting our scoping comments on this, but the basic position is that interbasin transfers should be of last resort. All other things should be considered. And right now we have such a great opportunity in cases like this where we can work together as a community to really look at this and see if we can actually look at some more creative alternatives. Four alternatives that I saw were not very creative. You know we're looking at historical growth it was pointed out and that's not really the case right now. We've actually been given a breather, but what we did see is the writing on the wall. We saw that starting to peak out just like we saw with our economy and some bad indicators there and we ignored them. Right now is a chance for us to go in and try to do some things in regards to conservation and some other practices and continue those, but also look at some other creative technical alternatives. You know do we need to look at actually coming down the river further and getting our water from there and actually looking to do some desalinization and things such as that in a cost effective way. So the bottom line is that right now there is no necessity for this. You can go back and use the numbers from '06 and those numbers, but right now there isn't a necessity. We're seeing water grabs all up and down the river. We just saw Smithfield Packing grab 30 mgd for a packing plant, we know there are going to be stiffer water allocation laws coming out over the next few years so everybody's really getting concerned about their local municipality and I understand that, you should be, you're really trying to look after the people, your kids basically, but I think we can be very smart and maybe use this as a real workshop and say, you know right now there isn't a necessity here. That's really very clear, even to the layman, if you look at those numbers. And let's really take the time to look at some alternatives and not get in a hurry about this. One of the things where I've seen the most litigation in NC is where we did rush the process and even with these public hearings where we say hey it's not important, not because of travel restrictions, not to have the right people here. That's a problem. You know, this is going to be a defining, water is going to define our future and to not have the right people here at this meeting other than the people such as ourselves sitting here and I actually have to kind of exclude myself because you are the experts, but not to have the people from Division of Water Resources here is actually a little bit of an insult to this process so I definitely think that should be a comment. So what I would say is from Cape Fear River Watch's perspective and mine is we're dealing with a very finite resource here – especially if you get up above Lock and

Dam #1 and look at the amount of water there, versus the amount of water which you really come down below it and you have the influx of water from the Black River and the Northeast Cape Fear and we really need to start looking at how do we really utilize that. Because that's the water that's actually flowing out of the ocean and may be a little bit more untouched and actually right now we've got enough water where we're not going to have this big impact on the ecology and our fisheries and things such as that. So the four alternatives that were put up there, I know they're very preliminary in nature, those are alternative of the past. We need to be much more creative as we work though this process. I think that's basically it unless you have any questions for me. Thank you.

Transcribed by:
Annette Pallone
Tetra Tech

North Carolina
Department of Administration

Beverly Eaves Perdue, Governor

Britt Cobb, Secretary

May 22, 2009

Mr. J. Todd Kennedy
Brunswick County
c/o Tetra Tech
P.O. Box 14409
Research Triangle, NC 27709

Re: SCH File # 09-E-4300-0295; SCOPING; Interbasin Transfer associated with expansion of Brunswick County's Northwest Water Treatment Plant

Dear Mr. Kennedy:

The above referenced environmental impact information has been reviewed through the State Clearinghouse under the provisions of the North Carolina Environmental Policy Act.

Attached to this letter are reviewer comments which identify issues to be addressed in the environmental review document. The appropriate document should be forwarded to the State Clearinghouse for compliance with State Environmental Policy Act. Should you have any questions, please do not hesitate to call me at 807-2425.

Sincerely,

Valerie McMillan (SJG)

Valerie W. McMillan, Director
State Environmental Review Clearinghouse

Attachments

cc: Region O

Mailing Address:
1301 Mail Service Center
Raleigh, NC 27699-1301

Telephone: (919)807-2425
Fax (919)733-9571
State Courier #51-01-00
e-mail valerie.w.mcmillan@doa.nc.gov

Location Address:
116 West Jones Street
Raleigh, North Carolina

NCDENR

North Carolina Department of Environment and Natural Resources

Beverly Eaves Perdue
Governor

Dee Freeman
Secretary

MAY 2009
RECEIVED
Secretary's Office
DOA

MEMORANDUM

TO: Valerie McMillan
State Clearinghouse

FROM: Melba McGee
Environmental Review Coordinator

RE: 09-0295 Scoping to Expand Brunswick County's Northwest Water Treatment Plant

DATE: May 20, 2009

The Department of Environment and Natural Resources has reviewed the proposed project. The attached comments are for the applicant's consideration. More specific comments will be provided during the environmental review process.

Thank you for the opportunity to respond. If during the preparation of the environmental document, additional information is needed, the applicant is encouraged to notify our respective divisions.

Attachments

1601 Mail Service Center, Raleigh, North Carolina 27699-1601
Phone: 919-733-4984 \ FAX: 919-715-3060 Internet: www.enr.state.nc.us

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Coastal Management

Beverly Eaves Perdue
Governor

James H. Gregson
Director

Dee Freeman
Secretary

May 4, 2009

Melba McGee
Environmental Coordinator
Office of Legislative & Intergovernmental Affairs
Department of Environment and Natural Resources
1601 Mail Service Center
Raleigh, NC 27699-1601

SUBJECT: Expansion of Brunswick County's Northwest Water Treatment Plant, Brunswick County, North Carolina (SCH#09-0295 and DCM#20090046)

Dear Ms. McGee:

Thank you for the opportunity to review the scoping request of Tetra Tech for the proposed plan of Brunswick County to expand its Northwest Water Treatment Plant in Brunswick County, North Carolina. The purpose of this review by the North Carolina Division of Coastal Management (DCM) is to identify the environmental and regulatory issues that the proposed environmental assessment (EA) ought to evaluate. Below are the comments of the North Carolina Division of Coastal Management.

- The environmental assessment will need to discuss the potential extent of DCM regulatory review.
    - Will the proposed project be receiving Federal assistance? A consistency submission to DCM will be required before the Federal assistance (funding) can be released to the project proponent.
    - If the proposed project would not require a CAMA permit then consistency review by DCM may be required should the proposed project require a Federal permit and/or license[1]. Please be aware that there are potentially two types of consistency reviews, one for the release of Federal assistance (funding) and the other for implementing the proposed project. These are separate types of reviews that may be combined into one consistency submission to DCM.
- Though not specifically required, we recommend that the EA evaluate, in the land-use section of the EA, the proposed project's conformance with the State's coastal

[1] There exists a potential that a proposed project that affects an AEC may not require a CAMA permit, but would still be reviewed by DCM under the consistency review process.

management program. Irrespective of any DCM regulatory review, the proposed project must be designed and implemented in conformance with the relevant enforceable policies of the State's coastal management plan since the proposed project is located in a coastal county.

- We recommend that wetland delineations be included in the draft EA.
- We recommend that the environmental assessment contain site-plan graphics showing wetlands that are in the vicinity of the proposed project. Furthermore, we recommend that the graphics distinguish between Section 404 wetlands and coastal wetlands.
- We recommend that the draft EA contain a section that reviews all required State permits and/or permissions that may be required for this proposed project.

Thank you for your consideration of the North Carolina Coastal Management Program.

Sincerely,

Stephen Rynas, AICP
Federal Consistency Coordinator
cc: Doug Huggett, Division of Coastal Management
Steve Everhart, Division of Coastal Management

MAY 13 2009

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL HEALTH

Project Number **09-0295**

County **Brunswick**

Inter-Agency Project Review Response

Project Name **Brunswick County**

Type of Project **Scoping - Proposal to expand Brunswick County's Northwest Water Treatment Plant.**

RECEIVED APR 24 2009

Comments provided by:

☐ Regional Program Person

☒ Regional Supervisor for Public Water Supply Section

☐ Central Office program person

Name **Debra Benoy-Wilmington RO** Date **04/22/2009**

Telephone number: ____________________

Program within Division of Environmental Health:

☐ Public Water Supply

☐ Other, Name of Program: ____________________

Response (check all applicable):

☐ No objection to project as proposed

☐ No comment

☐ Insufficient information to complete review

☐ Comments attached

☒ See comments below

The City of Wilmington has an intake downstream of the LCFWSA intake. City of Wilmington also gets water from LCFWSA at lock & dam 1. There is a new WTP being constructed at Tar Heel - upstream from this location and a new WTP has been proposed in Pender Co. which will receive it's water from LCFWSA at this location.

Return to:
Public Water Supply Section
Environmental Review Coordinator for the
Division of Environmental Health

MAY 1 3 2009

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES DIVISION OF ENVIRONMENTAL HEALTH

Project Number
09-0295
County
Brunswick

Inter-Agency Project Review Response

Project Name **Brunswick County**

Type of Project **Scoping - Proposal to expand Brunswick County's Northwest Water Treatment Plant.**

☐ The applicant should be advised that plans and specifications for all water system improvements must be approved by the Division of Environmental Health prior to the award of a contract or the initiation of construction (as required by 15A NCAC 18C .0300et. seq.). For information, contact the Public Water Supply Section, (919) 733-2321.

☐ This project will be classified as a non-community public water supply and must comply with state and federal drinking water monitoring requirements. For more information the applicant should contact the Public Water Supply Section, (919) 733-2321.

☐ If this project is constructed as proposed, we will recommend closure of _____ feet of adjacent waters to the harvest of shellfish. For information regarding the shellfish sanitation program, the applicant should contact the Shellfish Sanitation Section at (252) 726-6827.

☐ The soil disposal area(s) proposed for this project may produce a mosquito breeding problem. For information concerning appropriate mosquito control measures, the applicant should contact the Public Health Pest Management Section at (919) 733-6407.

☐ The applicant should be advised that prior to the removal or demolition of dilapidated structures, an extensive rodent control program may be necessary in order to prevent the migration of the rodents to adjacent areas. For information concerning rodent control, contact the local health department or the Public Health Pest Management Section at (919) 733-6407.

☐ The applicant should be advised to contact the local health department regarding their requirements for septic tank installations (as required under 15A NCAC 18A. 1900 et. sep.). For information concerning septic tank and other on-site waste disposal methods, contact the On-Site Wastewater Section at (919) 733-2895.

☐ The applicant should be advised to contact the local health department regarding the sanitary facilities required for this project.

☐ If existing water lines will be relocated during the construction, plans for the water line relocation must be submitted to the Division of Environmental Health, Public Water Supply Section, Technical Services Branch, 1634 Mail Service Center, Raleigh, North Carolina 27699-1634, (919) 733-2321.

☒ For Regional and Central Office comments, see the reverse side of this form.

Jim McRight	PWSS	04/22/2009
Reviewer	Section/Branch	Date

May 15, 2009

MEMORANDUM

TO: Melba McGee, Environmental Coordinator
Office of Legislative and Intergovernmental Affairs

FROM: Katie Armstrong, Natural Areas Specialist KA
NC Natural Heritage Program

SUBJECT: Scoping: Proposal to expand Brunswick County's Northwest Water Treatment Plant, requiring Interbasin Transfer certificate

REFERENCE: 09-0295

The proposed expansion of Brunswick County's Northwest Water Treatment Plant has the potential to impact Significant Natural Heritage Areas as well as rare and endangered species. A Significant Natural Heritage Area (SNHA) is an area of land or water identified by the NC Natural Heritage Program (NHP) as being important for protection of the State's biodiversity. SNHAs contain one or more Natural Heritage elements – high-quality or rare natural communities, rare species, and special animal habitats. The primary SNHAs that may be affected by impacts associated with the proposed project are the nationally significant Town Creek Aquatic Habitat and the state significant Lower Cape Fear Aquatic Habitat.

NHP is concerned about impacts to sensitive and rare species within the Cape Fear IBT River Basin. Direct, secondary, and cumulative impacts from the proposed project may affect the following aquatic species:

- shortnose sturgeon (*Acipenser brevirostrum*), federally and state listed as Endangered
- West Indian manatee (*Trichechus manatus*), federally and state listed as Endangered
- American alligator (*Alligator mississippiensis*), federally and state listed as Threatened
- Greenfield rams-horn (*Helisoma eucosmium*), Federal Species of Concern and state listed as Endangered
- magnificent rams-horn (*Planorbella magnifica*), Federal Species of Concern and state listed as Endangered
- Carolina pygmy sunfish (Elassoma boehlkei), Federal Species of Concern and state listed as Threatened
- eastern pondmussel (*Ligumia nasuta*), state listed as Threatened
- eastern creekshell (*Villosa delumbis*), state listed as Significantly Rare
- spotfin killifish (*Fundulus luciae*), state listed as Significantly Rare
- pod lance (*Elliptio folliculata*), state listed as Special Concern
- least killifish (*Heterandria formosa*), state listed as Special Concern
- Carolina diamondback terrapin (*Malaclemys terrapin centrata*), state listed as Special Concern

NHP anticipates that cumulative and secondary impacts of development resulting from the increased capacity of the water treatment plant and subsequent infrastructure, will result in many impacts to streams, including stream bank instability and other stream morphology changes, increased sediment loading, changes in substrate characteristics, modified aquatic food resources, changed stream temperatures, increased nutrient loading, increased toxicant loading, changed fish communities, and reduced complexity of benthic habitats. These anticipated changes are known threats to sensitive aquatic species. Secondary development that follows infrastructure projects causes the loss, degradation, and fragmentation of terrestrial habitats as well. In the preparation of the environmental impact statement, we direct the applicant to the NC Wildlife Resources Commission's (WRC) guidance document: http://www.ncwildlife.org/pg07_WildlifeSpeciesCon/pg7c3_impacts.pdf (published in August 2002).

Thank you for the opportunity to comment on this project. If you need additional information, please contact me at 919-715-7808 or katie.armstrong@ncdenr.gov.

cc: Sarah McRae, NCNHP

North Carolina Department of Cultural Resources
State Historic Preservation Office
Peter B. Sandbeck, Administrator

Beverly Eaves Perdue, Governor
Linda A. Carlisle, Secretary
Jeffrey J. Crow, Deputy Secretary

Office of Archives and History
Division of Historical Resources
David Brook, Director

May 19, 2009

Todd Kennedy
Tetra Tech
PO Box 14409
Research Triangle Park, NC 27709

Re: Brunswick County Interbasin Transfer, Brunswick County, ER 09-0947

Dear Mr. Kennedy:

We received notification of the proposed expansion of Brunswick County's Northwest Water Treatment Plant.

The topographic and hydrological situation makes it likely that portions of this project hold historic or prehistoric archaeological sites. Several different types of archaeological sites have been recorded within the general area, ranging from temporary hunting camps, to larger base camps, to more sedentary occupation sites. Several archaeological sites of the historic period are also recorded within the study area. As plans are available detailing the proposed action and reasonable alternatives, please forward them to us so that we may continue our review.

Our files are available for planning purposes in the initial stages of EIS preparation. Please do not hesitate to visit the Office of State Archaeology to review the archaeological site files and reports. An appointment can be arranged by telephoning 919-807-6556.

We have determined that the project as proposed will not have an effect on any historic structures.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, please contact Renee Gledhill-Earley, environmental review coordinator, at 919-807-6579. In all future communication concerning this project, please cite the above-referenced tracking number.

Sincerely,

Renee Gledhill-Earley

for Peter Sandbeck

cc: State Clearinghouse

NCDENR

North Carolina Department of Environment and Natural Resources

Division of Water Resources

Beverly Eaves Perdue Governor	Thomas A. Reeder Director	Dee Freeman Secretary

July 17, 2009

MEMORANDUM

To: J. Todd Kennedy
Tetra Tech

From: Toya Fields
Division of Water Resources

Subject: Brunswick County Public Utilities IBT – Draft EIS Scope

DWR has reviewed Tetra-Tech's 7/14 memo summarizing the July 6th scoping meeting with DWR, Tetra-tech and Brunswick county. These additional comments are provided in response to that letter and the Draft EIS Scope, provided on July 2, 2009.

General Comments

Both IBT and SEPA regulations require that the EA address very specific requirements. The requirements are as follows (taken from G.S. 113A-4 and 143-215.22L(d)):

1. A comprehensive analysis of the environmental impacts that would occur in the source and the receiving river basins if the petition for a certificate is granted;
2. Any significant adverse environmental effects which cannot be avoided;
3. A description of measures to mitigate any adverse impacts that may arise from the proposed interbasin transfer;
4. An evaluation of alternatives to the proposed interbasin transfer, including water supply sources that do not require an Interbasin transfer and use of water conservation measures.
5. The relationship between the short-term uses of the environment involved in the proposed action and the maintenance and enhancement of long-term productivity and;
6. Any irreversible and irretrievable environmental changes which would be involved in the proposed action should it be implemented.

Although it appears from the draft outline that Brunswick County intends to address many of these requirements, it would be helpful if subsections of the EIS were specifically devoted to summarizing these factors since these will be questions that the Division and the Commission will have to answer before a decision on the certificate can be made.

Furthermore, NC General Statutes require that the Petition for an IBT certificate meet additional requirements. These statutory requirements have been included below. Please keep in mind that the purpose of the EA is to serve as a support document for the IBT petition and Brunswick County should be prepared to address the following issues before any decision on the certificate can be made.

PETITION REQUIREMENTS
PROJECT OVERVIEW
✓ A description of any facilities used to transfer water (including the location and capacity of water intakes, pumps, pipelines, etc.) ✓ A description of all proposed consumptive and non-consumptive uses of the transferred water.
WATER QUALITY
✓ A summary of the water quality for both the source and receiving waterbodies, including any waters that are 303(d) listed for being impaired. ✓ Information on aquatic habitats for rare, threatened, and endangered species in both the source and receiving waterbodies.

✓	In-stream flow data for segments of the source and receiving waterbodies that may be affected by the transfer.
✓	A demonstration that the proposed transfer, if added to all other existing and planned transfers (or registered withdrawals) in the source river basin, would not reduce the amount of available water to a degree that would impair existing uses, pursuant to NC′s antidegradation policy. This demonstration should also include: • Existing and planned consumptive uses in the source river basin; • Existing and planned nonconsumptive uses in the source river basin; • A finding that the transfer would not result in a water level inadequate to support existing uses of the reservoir (if the proposed transfer would impact a reservoir in the source basin).
MITIGATION AND ANTIDEGRADATION	
✓	A description of water conservation measures in use by the applicant at the time of the petition and additional conservation measures that will be implemented if the certificate is granted.
✓	A description of existing and future water transfers (or withdrawals) from the source river basin that are either registered or included in a local water supply plan (LWSP).
WATER SUPPLY	
✓	A LWSP. If the plan is more than two years old, the petition should include an updated version.
✓	An assessment of the applicant's future water supply needs.
✓	A summary of present and future water supply needs, as identified in LWSPs, for public water systems within the source river basin. This analysis should include agricultural, recreational, and industrial uses, as well as electric power generation.
✓	A description of existing, planned, and potential sources of water within the receiving river basin that are a practicable alternative to the proposed transfer. This should include surface water impoundments, groundwater wells, reinjection storage, and purchases.
OTHER	
✓	Any other information deemed necessary by the Commission for review of the proposed water transfer. • A compliance and monitoring plan • Water balance table showing how increase in water use and transfer change over time.

Document Organization

DWR requests that portions of the EIS relating to environmental characteristics and predicted effects (section 3 of the draft outline) be organized by subbasin. The Division would also like to request that model discussions be included as appendices to the EIS.

Also, as stated in the July 14th memo, all data sources, including the LWSP should be as current as possible. IBT statutes specifically require that the LWSP submitted with the petition be less than two years old.

Alternatives Analysis

Although alternatives #3 and #4 will be excluded from further analysis due to the lack of viable surface water sources, the EIS should still contain sufficient justification for the exclusion of these alternatives.

The following alternatives should also be considered:

- NC G.S. §143-215.22L(d)(2) requires that water conservation measures be explored as an alternative to an IBT. The EIS should fully explore water efficiency, conservation, and reuse alternatives that would reduce or remove the need for an interbasin transfer. It may also be appropriate to include discussions of water conservation in the sections on needs analysis or impact mitigation.
- Combinations of viable alternatives (including conservation and reuse) that would reduce the interbasin transfer request.
- Return of wastewater to the source basin (to remove or reduce the need for an IBT).

Direct Impacts of Water Purchase

As part of the IBT process, Brunswick County Public utilities will have to assess the effect of the proposed transfer on water quality and quantity in the Cape Fear River. Specifically, the petition will need to contain the following (as described above):

- A description of existing and future water transfers (or withdrawals) from the source river basin that are either registered or included in a local water supply plan (LWSP).
- A summary of present and future water supply needs, as identified in LWSPs, for public water systems within the source river basin. This analysis should include agricultural, recreational, and industrial uses, as well as electric power generation.
- A demonstration that the proposed transfer, if added to all other existing and planned transfers (or registered withdrawals) in the source river basin, would not reduce the amount of available water to a degree that would impair existing uses, pursuant to NC′s antidegradation policy.

Safe Yield
Brunswick County should not use the modeled 7Q10 statistics from the Cape Fear Basin Water Supply Plan. Those values were developed to illustrate possible changes in streamflow over time. They were not intended to replace USGS low flow statistics. Brunswick County should contact USGS for an updated 7Q10.

Rather than relying upon a ‘safe yield’ value, Brunswick County should run the Cape Fear model to determine whether or not there appear to be any difficulties meeting future demands.

Hydrologic Modeling
Brunswick County will need to use the Cape Fear River Basin Hydrologic Model to evaluate the direct impact of water withdrawals. The model does not need to be extended downstream, however the output from the hydrologic model should be used as an input to a water quality model on the Cape Fear below Lock and Dam #1. The inflow record for the model will also need to be brought up to date.

The time horizons that should be modeled include:
1. Current demand
2. Projection based on the IBT request
3. 50 yr projection

The model should also include predicted operational changes in any lakes that are expected to occur during the projected timeframe (for example, the operation of Harris lake will change if Shearon Harris is expanded).

Instream Flow
No instream flow study will be required.

Topics for further discussion
Brunswick County is advised to meet with the Division of Water Quality for a discussion of the water quality analyses that will be required to evaluate the impacts of water withdrawals. At this time, DWR’s primary concerns pertaining to water quality include the effect of an increased withdrawal on the water quality and salinity in the estuary.

Brunswick County is also advised to meet with USFW and WRC to discuss any concerns, particularly those pertaining to secondary and cumulative impacts in the receiving basins.

Kennedy, Todd

From: Rynas, Stephen <stephen.rynas@ncdenr.gov>
Sent: Thursday, August 20, 2009 11:09 AM
To: Kennedy, Todd
Subject: RE: Brunswick Co IBT - follow up from phone call

I would just add that any environmental document that is prepared evaluate whether the proposed project would have any "coastal effect" as defined in 15 CFR 930.11. Even if the proposed project does not have a "coastal effect", I would recommend that the environmental document include a written discussion to document that the issue of "coastal effect" was evaluated.

From: Kennedy, Todd [mailto:Todd.Kennedy@tetratech.com]
Sent: Tuesday, August 18, 2009 1:59 PM
To: Rynas, Stephen
Cc: Fields, Toya
Subject: Brunswick Co IBT - follow up from phone call

Stephen,

Thanks for taking the time to discuss Brunswick County's interbasin transfer proposal with me earlier this month.

I took away the following main points from our conversation:

(1) Since construction or direct development of a site was not involved in the IBT request that a CAMA permit would not be required. There are also no federal funds or federal agencies directly involved in the IBT certificate request. Note that a separate EA for expansion to the Northwest WTP would be developed following approval of the IBT.

(2) We will plan to demonstrate conformance with the CAMA land use plan in the EIS per your instructions.

(3) You did not have any other specific comments about secondary and cumulative impacts related to development.

(4) Finally, I understand that you will be reviewing the draft EIS once it is available.

Please feel free to add or correct anything that I have written here.

I have attached the SEPA scoping document that we submitted to the Clearinghouse for reference.

Regards,

Todd

J. Todd Kennedy | **Project Manager**
Direct: 919.485.8278 x111 | Fax: 919.485.8280
todd.kennedy@tetratech.com

Tetra Tech | Complex World, **Clear Solutions™**
P.O. Box 14409 | Research Triangle Park, NC 27709 | www.tetratech.com

Kennedy, Todd

From: John_Ellis@fws.gov
Sent: Monday, September 14, 2009 11:32 AM
To: Kennedy, Todd
Cc: Ogallo, Toya; Howard_Hall@fws.gov
Subject: RE: Brunswick Interbasin Transfer - EIS Scoping

Todd,

I've been out of the office almost every day since late August. I was able to discuss this with Howard Hall of this office this morning to determine if it was a project we had commented on earlier this year, which it wasn't.

The Service concerns will largely be avoidance of wetlands and impacts to Federally listed threatened and endangered species. This includes not only direct impacts but indirect impacts associated with the project. Brunswick County has many unique habitat areas within it.

John
"Kennedy, Todd" <Todd.Kennedy@tetratech.com>

"Kennedy, Todd" <Todd.Kennedy@tetratech.com>

09/14/2009 11:16 AM

To"john_ellis@fws.gov" <john_ellis@fws.gov>

cc"Ogallo, Toya" <toya.f.ogallo@ncdenr.gov>

SubjectRE: Brunswick Interbasin Transfer - EIS Scoping

Dear John,

Since I have not received a response to this email or my phone message, I am going to assume that USFWS does not wish to provide comments on the project at this stage.

Please look for the draft EIS sometime next year.

Thank you.

Todd

From: Kennedy, Todd
Sent: Thursday, September 03, 2009 3:52 PM
To: 'john_ellis@fws.gov'
Subject: Brunswick Interbasin Transfer - EIS Scoping

Greetings John,

Brunswick County is requesting comments on the scope of the Environmental Impact Statement for an interbasin transfer request. The Division of Water Resources (the lead agency) has asked that the County contact the US Fish and Wildlife Service to see if you would like to provide any input on the scope of the EIS or share any concerns. They gave me your name as a contact.

A brief scoping document describing the project is attached. This was circulated through the State Clearinghouse earlier this year. For your information, I have also attached comments that we received from the Natural Heritage Program. We did not receive any comments from Wildlife Resources Commission during the SEPA review.

Please let me know if you intend to provide any comments at this stage. Thanks.

Regards,

Todd

J. Todd Kennedy
Direct: 919.485.8278 x111 | Fax: 919.485.8280
todd.kennedy@tetratech.com

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P.O. Box 14409 | Research Triangle Park, NC 27709 | www.tetratech.com

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Appendix D 2011 Monthly Water Demand

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Table D-1. Calendar Year 2011 Daily Water Demand by Sector (all demand numbers in units of gallons per day)

	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	2011
Total Demand[1]	9,358,258	8,446,097	9,910,813	12,222,516	15,664,129	20,743,581	22,008,516	17,729,194	14,054,710	12,347,548	10,348,065	9,424,806	13,780,836
Industrial Demand[1]	1,791,544	2,082,672	2,025,881	2,194,528	1,561,620	2,037,540	2,397,185	2,718,186	2,360,593	2,370,795	1,980,805	2,298,408	2,192,911
Wholesale Demand[1]	2,487,979	2,428,125	3,331,545	5,249,742	5,066,050	7,474,457	8,043,076	7,407,388	5,337,191	4,423,832	3,173,567	3,089,984	4,884,660
Retail Demand[2]	3,864,993	3,370,943	3,427,362	4,455,048	5,668,675	8,745,631	9,118,121	6,320,300	6,644,545	5,028,597	4,397,899	3,288,590	5,369,578
Unaccounted Water Demand[1]	1,084,710	843,140	932,476	349,140	3,109,720	2,460,338	1,966,263	702,674	-209,056	8,195	368,916	425,244	1,007,660
Unbilled (Operational) Water Demand[1]	129,032	142,857	193,548	133,333	258,065	400,000	483,871	580,645	133,333	516,129	600,000	322,581	326,027
# Connections[1]	33,481	33,521	33,549	33,606	33,623	33,761	33,735	33,907	33,959	33,981	34,041	34,120	33,774
Population Served[3]	73,993	74,081	74,143	74,269	74,307	74,612	74,554	74,934	75,049	75,098	75,231	75,405	74,640
Per Capita Demand[4]	52.23	45.50	46.23	59.99	76.29	117.22	122.30	84.34	88.54	66.96	58.46	43.61	71.94
Peak Day Demand[1]	10,937,000	10,206,000	12,140,000	15,208,000	21,425,000	24,033,000	25,798,000	21,737,000	17,220,000	14,923,000	12,690,000	11,482,000	25,798,000
Monthly PF[5]	68%	68%	72%	92%	114%	156%	160%	129%	105%	90%	78%	68%	N/A

[1] From BCPU data
[2] Retail Demand = Total Demand – Industrial Demand – Wholesale Demand – Operational Demand – Unaccounted Demand
[3] Population = # Connections x 2.21 people/connection
[4] *Per Capita* Demand = Retail Demand / Population
[5] Monthly PF = Monthly Peaking Factor = Monthly Average Day Demand / Annual Average Day Demand

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Appendix E Wastewater Permit Summary

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Table E-1. Brunswick County wastewater permit summary

System	Permit Type	Permit Number	Owner	Public/Privatete	Type	Effluent Dispersal Method	Permitted Flow (MGD)	Subbasin	Receiving Basin
SILVER COAST WINERY	Brunswick Co. EH	84-09712J	MARY ANN & JOHN AZZATO	Private	Commercial	Subsurface	0.004	03-07-57	Lower Waccamaw River
Carolina Shores WWTP	NPDES	NC0044873	Brunswick County	Public	Municipal	Discharge/Spray Irrigation	0.53	03-07-57	Lower Waccamaw River
Waccamaw Elementary School	NPDES	NC0045276	Brunswick County Schools	Public	Institutional	Discharge	0.0057	03-07-57	Lower Waccamaw River
Betty's Waterfront Restaurant	Brunswick Co. EH	92-29393A	Polcaro and Pittman	Private	Commercial	Subsurface	0.01	03-07-59	Lockwood Folly/Shallotte Rivers
BRICKLANDING PLANTATION[1]	Brunswick Co. EH	93-40025A	Carolina Bank LLC	Private	Domestic	Subsurface	0.1	03-07-59	Lockwood Folly/Shallotte Rivers
LOCKWOOD FOLLY	Brunswick Co. EH	89-14990	Lockwood Folly HOA	Private	Domestic	Subsurface	0.00975	03-07-59	Lockwood Folly/Shallotte Rivers
Main Street Grill	Brunswick Co. EH	93-32539A	Corey William Jones	Private	Commercial	Subsurface	0.005	03-07-59	Lockwood Folly/Shallotte Rivers
OCEAN AIRE CAMPGROUND	Brunswick Co. EH	83-41377	Carson Durham	Private	Commercial	Subsurface	unknown	03-07-59	Lockwood Folly/Shallotte Rivers
OCEAN PINES ACRES	Brunswick Co. EH	92-28315	Adolphus Harrelson	Private	Domestic	Subsurface	0.0032	03-07-59	Lockwood Folly/Shallotte Rivers
OYSTER BAY COLONY[1]	Brunswick Co. EH	93-40049	Sea Trail Utility	Private	Domestic	Subsurface	0.0396	03-07-59	Lockwood Folly/Shallotte Rivers
Restaurant	Brunswick Co. EH	88-15668D	Timothy and Willa Norton	Private	Commercial	Subsurface	0.003	03-07-59	Lockwood Folly/Shallotte Rivers
RIVERGATE ESTATES	Brunswick Co. EH	97-47314	Rivergate Estates, Inc.	Private	Domestic	Subsurface	0.00288	03-07-59	Lockwood Folly/Shallotte Rivers
ROBERTO'S RESTAURANT	Brunswick Co. EH	93-33074	RMG Inc	Private	Commercial	Subsurface	0.003	03-07-59	Lockwood Folly/Shallotte Rivers
SEA AIRE PLAZA	Brunswick Co. EH	86-11542A	Joe Lane	Private	Commercial	Subsurface	0.004	03-07-59	Lockwood Folly/Shallotte Rivers
SKEETS CAR WASH	Brunswick Co. EH	98-51450	Security Savings Bank	Private	Commercial	Subsurface	0.00525	03-07-59	Lockwood Folly/Shallotte Rivers
WOODS @ SEA TRAIL	Brunswick Co. EH	86-09712A	The Woods HOA	Private	Domestic	Subsurface	0.0048	03-07-59	Lockwood Folly/Shallotte Rivers
KOA Campground WWTP[1]	Non-Discharge	WQ0020543	Tommy Bradsher	Private	Commercial	Surface irrigation	0.0011443	03-07-59	Lockwood Folly/Shallotte Rivers
Ocean Ridge Plantation WWTF	Non-Discharge	WQ0011614	Brunswick County	Public	Municipal	Reuse	unknown[2]	03-07-59	Lockwood Folly/Shallotte Rivers
Oceanic West Condominiums	Non-Discharge	WQ0029114	Oceanic West Development Group	Private	Domestic	Reuse	0.00054	03-07-59	Lockwood Folly/Shallotte Rivers
Sandpiper Bay WWTP	Non-Discharge	WQ0013398	904 Georgetown Treatment Plant, LLC	Private	Domestic	Reuse	0.55	03-07-59	Lockwood Folly/Shallotte Rivers
Sea Trail WWTP	Non-Discharge	WQ0012748	Brunswick County	Public	Municipal	Spray Irrigation/Reuse	0.500	03-07-59	Lockwood Folly/Shallotte Rivers
Shallotte WWTP	Non-Discharge	WQ0000798	Brunswick County	Public	Municipal	Spray irrigation	0.500	03-07-59	Lockwood Folly/Shallotte Rivers
West Brunswick Regional WRF	Non-Discharge	WQ0023693	Brunswick County	Public	Municipal	Spray Irrigation/Infiltration/Reuse	6.000	03-07-59	Lockwood Folly/Shallotte Rivers
Town of Ocean Isle Beach WWTF	Non-Discharge	WQ0006085	Town of Ocean Isle Beach	Public	Municipal	Reuse	1.032	03-07-59	Lockwood Folly/Shallotte Rivers
Green's Oyster Company Processing Facility	NPDES	NC0074942	Green's Oyster Company	Private	Industrial	Discharge	0.005	03-07-59	Lockwood Folly/Shallotte Rivers
Lloyd's Oyster Company	NPDES	NC0076830	Lloyd's Oyster House	Private	Industrial	Discharge	0.005	03-07-59	Lockwood Folly/Shallotte Rivers
BRUNSWICK COUNTY SCHOOLS	Brunswick Co. EH	93-40036	Brunswick County Schools	Public	Institutional	Subsurface	0.0291	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
C B CAROON CRAB COMPANY	Brunswick Co. EH	93-40023A	CB Caroon Crab Company	Private	Commercial	Subsurface	0.004	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
CASWELL DUNES HOA	Brunswick Co. EH	94-03475	Caswell Dones HOA	Private	Domestic	Subsurface	0.05	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
DUTCHMAN CREEK	Brunswick Co. EH	84-22602A	Dutchman Creek HOA	Private	Domestic	Subsurface	0.0108	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
N C BAPTIST ASSEMBLY (Camp)	Brunswick Co. EH	94-17102	Rich Holbrook	Private	Institutional	Subsurface	0.037584	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
N C BAPTIST ASSEMBLY (Retreat Center)	Brunswick Co. EH	88-21652	Rich Holbrook	Private	Institutional	Subsurface	0.00712	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
PRETTY POND GIRL SCOUT CAMP	Brunswick Co. EH	93-30364	Girl Scouts NC	Private	Institutional	Subsurface	0.005471	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
W.L.B. VILLAS HOA	Brunswick Co. EH	85-19804	WLB Villas HOA	Private	Domestic	Subsurface	0.00432	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Northeast Brunswick Regional WRF	Conjunctive NPDES	NC0086819	Brunswick County	Public	Municipal	Discharge/Reuse	1.650	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Bald Head Island WWTF	Non-Discharge	WQ0000193	Village of Bald Head Island	Public	Municipal	Infiltration/Evaporation	0.4	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Brunswick Forest WWTF	Non-Discharge	WQ0032104	Funston Land and Timber LLC	Private	Domestic	High rate infiltration	0.4	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Cape Fear Manufacturing Facility	Non-Discharge	WQ0018087	DAK Americas Inc	Private	Residuals	Residuals-Land Application	na	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Class A Residuals Distribution Program	Non-Discharge	WQ0034468	Brunswick County	Public	Residuals	Residuals-Land Application	na	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Leland Facility	Non-Discharge	WQ0001861	Gregory Poole Equipment Company	Private	Industrial	Reuse	0.01	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Northwest Water Plant Residuals Disposal Program	Non-Discharge	WQ0018351	Brunswick County	Public	Residuals	Residuals-Land Application	na	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Oak Island Satellite Water Reclamation Facility	Non-Discharge	WQ0031857	Town of Oak Island	Public	Municipal	Reuse	0.4	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Oak Island WWTF	Non-Discharge	WQ0005790	Town of Oak Island	Public	Municipal	Reuse	0.4	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Peggy & Robert Waterman SFR	Non-Discharge	WQ0032827	Peggy & Robert Waterman	Private	Domestic	Surface irrigation	0.000024	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
S & B Maintenance Residuals Land Application Program (D)	Non-Discharge	WQ0000783	S&B Maintenance Inc	Private	Residuals	Residuals-Land Application	na	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Southeast Brunswick Sanitary District WWTF	Non-Discharge	WQ0013200	Southeast Brunswick Sanitary District	Public	Municipal	High rate infiltration	0.5	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Southport Crossing WWTF	Non-Discharge	WQ0030413	Southport Crossing Holdings LLC	Private	Domestic	High rate infiltration	0.25	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Southport Manufacturing Facility NitroGro Distribution Program	Non-Discharge	WQ0004500	Archer Daniels Midland	Private	Residuals	Residuals-Land Application	na	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Town of Carolina Beach Residuals Land Application Program	Non-Discharge	WQ0007728	Town of Carolina Beach	Public	Residuals	Residuals-Land Application	na	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Wastewater Recycling Facility	Non-Discharge	WQ0013224	Carolina Pole Leland	Private	Industrial	Reuse	0.006	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Beaverdam Creek WTP	NPDES	NC0040061	Brunswick County	Public	Water Treatment Plant	Discharge	no limit	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Belville WWTP	NPDES	NC0075540	Brunswick Regional Water and Sewer H2GO	Public	Municipal	Discharge	0.8	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Brunswick Steam Electric Plant	NPDES	NC0007064	Progress Energy	Private	Industrial	Discharge	no limit	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Cape Fear WWTP	NPDES	NC0000663	DAK Americas LLC	Private	Industrial	Discharge	3.5	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Hood Creek NW WTP	NPDES	NC0057533	Brunswick County	Public	Water Treatment Plant	Discharge	no limit	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Military Ocean Terminal / Sunny Point	NPDES	NC0029122	US Army	Public	Institutional	Discharge	0.3	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Southport Facility	NPDES	NC0065099	CPI USA North Carolina	Private	Industrial	Discharge	no limit	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Southport Manufacturing Facility WWTP	NPDES	NC0027065	Archer Daniels Midland	Private	Industrial	Discharge	3.51	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Town Creek Township Park Wastewater Treatment Plant	NPDES	unknown	Brunswick County	Public	Institutional	Discharge	0.001	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Village of Bald Head Island Utilities Dept. WTP	NPDES	NC0085553	Village of Bald Head Island	Public	Water Treatment Plant	Discharge	no limit	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Creekside Townhomes	NPDES	NC006470	Creekside Townhomes	Private	Domestic	Discharge	0.027	03-06-17	Cape Fear River (Town Creek, Smith Creek and the Brunswick River)
Class B Residuals Application Program	Non-Discharge	WQ0034513	Brunswick County	Public	Residuals	Residuals-Land Application	na	na	na

[1] Systems schedule to be taken out of service by July 1, 2012
[2] Non-Discharge database indicates 900,000 gpd, Brunswick County records indicate 100,000 gpd

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Appendix F IBT Tables

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WATER BALANCE TABLE - MAXIMUM DAILY VALUES

CAPE FEAR RIVER WITHDRAWALS ONLY

Year	Water System	Withdrawl from Source	Consumptive Loss			Wastewater Discharge			Total Return to Source Basin	Total Interbasin Transfer
			Cape Fear	Shallotte River	Waccamaw	Cape Fear	Shallotte River	Waccamaw		
A	B	C	D	E		F	G		H=D+F	I=C-H
2010	Brunswick Co.	9.49	0.7	4.16	0.3	3.726	0.094	0.51	4.426	5.064
	Bald Head	0.03				0.03			0.03	0
	Leland	0.03	0.03						0.03	0
	Caswell Beach	0.07	0.07						0.07	0
	Holden Beach	1.08		0.38			0.7		0	1.08
	BR (H2GO)	2.69	2.44			0.25			2.69	0
	Northwest	0.17	0.17						0.17	0
	Oak Island	0.57	0.33			0.24			0.57	0
	Ocean Isle Beach	1.68		0.18			1.5		0	1.68
	Shallotte	0.7		0.38			0.32		0	0.7
	Southport	0.15				0.15			0.15	0
	Navassa	0.17	0.17						0.17	0
	Total	16.83	3.91	5.1	0.3	4.396	2.614	0.51	8.306	8.524

WATER BALANCE TABLE - MAXIMUM DAILY VALUES

Year	Water System	Withdrawl from Source	Consumptive Loss			Wastewater Discharge			Total Return to Source Basin	Total Interbasin Transfer
			Cape Fear	Shallotte River	Waccamaw	Cape Fear	Shallotte River	Waccamaw		
A	B	C	D	E		F	G		H=D+F	I=C-H
2020	Brunswick Co.	12.67	0.93	5.55	0.30	4.97	0.40	0.51	5.91	6.76
	Bald Head	0.04				0.04			0.04	0.00
	Leland	0.04	0.04						0.04	0.00
	Caswell Beach	0.09	0.09						0.09	0.00
	Holden Beach	1.44		0.51			0.93		0.00	1.44
	BR (H2GO)	3.59	3.26			0.33			3.59	0.00
	Northwest	0.23	0.23						0.23	0.00
	Oak Island	0.76	0.44			0.32			0.76	0.00
	Ocean Isle Beach	2.24		0.24			2.00		0.00	2.24
	Shallotte	0.93		0.51			0.43		0.00	0.93
	Southport	0.20				0.20	0.00		0.20	0.00
	Navassa	0.23	0.23						0.23	0.00
	Total	22.47	5.22	6.81	0.30	5.87	3.76	0.51	11.09	11.38

WATER BALANCE TABLE - MAXIMUM DAILY VALUES

Year	Water System	Withdrawl from Source	Consumptive Loss			Wastewater Discharge			Total Return to Source Basin	Total Interbasin Transfer
			Cape Fear	Shallotte River	Waccamaw	Cape Fear	Shallotte River	Waccamaw		
A	B	C	D	E		F	G		H=D+F	I=C-H
2030	Brunswick Co.	15.65	1.15	6.86	0.30	6.15	0.68	0.51	7.15	8.35
	Bald Head	0.05				0.05			0.05	0.00
	Leland	0.05	0.05						0.05	0.00
	Caswell Beach	0.12	0.12						0.11	0.00
	Holden Beach	1.78		0.63			1.15		0.00	1.78
	BR (H2GO)	4.44	4.02			0.41			4.34	0.00
	Northwest	0.28	0.28						0.27	0.00
	Oak Island	0.94	0.54			0.40			0.92	0.00
	Ocean Isle Beach	2.77		0.30			2.47		0.00	2.77
	Shallotte	1.15		0.63			0.53		0.00	1.15
	Southport	0.25				0.25			0.24	0.00
	Navassa	0.28	0.28						0.27	0.00
	Total	27.76	6.45	8.41	0.30	7.25	4.84	0.51	13.70	14.06

WATER BALANCE TABLE - MAXIMUM DAILY VALUES

Year	Water System	Withdrawl from Source	Consumptive Loss			Wastewater Discharge			Total Return to Source Basin	Total Interbasin Transfer
			Cape Fear	Shallotte River	Waccamaw	Cape Fear	Shallotte River	Waccamaw		
A	B	C	D	E		F	G		H=D+F	I=C-H
2040	Brunswick Co.	18.90	1.39	8.29	0.30	7.42	0.99	0.51	8.82	10.09
	Bald Head	0.06				0.06			0.06	0.00
	Leland	0.06	0.06						0.06	0.00
	Caswell Beach	0.14	0.14						0.14	0.00
	Holden Beach	2.15		0.76			1.39		0.00	2.15
	BR (H2GO)	5.36	4.86			0.50			5.36	0.00
	Northwest	0.34	0.34						0.34	0.00
	Oak Island	1.14	0.66			0.48			1.14	0.00
	Ocean Isle Beach	3.35		0.36			2.99		0.00	3.35
	Shallotte	1.39		0.76			0.64		0.00	1.39
	Southport	0.30				0.30			0.30	0.00
	Navassa	0.34	0.34						0.34	0.00
	Total	33.52	7.79	10.16	0.30	8.76	6.01	0.51	16.54	16.98

WATER BALANCE TABLE - MAXIMUM DAILY VALUES

Year	Water System	Withdrawl from Source	Consumptive Loss			Wastewater Discharge			Total Return to Source Basin	Total Interbasin Transfer
			Cape Fear	Shallotte River	Waccamaw	Cape Fear	Shallotte River	Waccamaw		
A	B	C	D	E		F	G		H=D+F	I=C-H
2050	Brunswick Co.	22.05	1.63	9.67	0.30	8.66	1.29	0.51	10.29	11.77
	Bald Head	0.07				0.07			0.07	0.00
	Leland	0.07	0.07						0.07	0.00
	Caswell Beach	0.16	0.16						0.16	0.00
	Holden Beach	2.51		0.88			1.63		0.00	2.51
	BR (H2GO)	6.25	5.67			0.58			6.25	0.00
	Northwest	0.40	0.40						0.40	0.00
	Oak Island	1.32	0.77			0.56			1.32	0.00
	Ocean Isle Beach	3.90		0.42			3.49		0.00	3.90
	Shallotte	1.63		0.88			0.74		0.00	1.63
	Southport	0.35				0.35			0.35	0.00
	Navassa	0.40	0.40						0.40	0.00
	Total	39.11	9.09	11.85	0.30	10.22	7.15	0.51	19.30	19.81

WATER BALANCE TABLE - AVERAGE DAILY VALUES

CAPE FEAR RIVER WITHDRAWALS ONLY

Year	Water System	Withdrawl from Source Cape Fear	Consumptive Loss			Wastewater Discharge			Total Return to Source Basin	Total Interbasin Transfer
			Cape Fear	Shallotte River	Waccamaw	Cape Fear	Shallotte River	Waccamaw		
A	B	C	D	E		F	G		H=D+F	I=C-H
2010	Brunswick Co.	5.99	0.71	2.26	0.1	2.01	0.507	0.4	2.717	3.27
	Bald Head	0.01				0.01			0.01	0
	Leland	0.02	0.02						0.02	0
	Caswell Beach	0.02	0.02						0.02	0
	Holden Beach	0.39		0.1			0.29		0	0.39
	BR (H2GO)	1.66	1.41			0.25			1.66	0
	Northwest	0.11	0.11						0.11	0
	Oak Island	0.16	0.14			0.02			0.16	0
	Ocean Isle Beach	0.62		0.2			0.42		0	0.62
	Shallotte	0.41		0.12			0.29		0	0.41
	Southport	0.09				0.09			0.09	0
	Navassa	0.09	0.09						0.09	0
	Total	9.57	2.5	2.683	0.1	2.377	1.507	0.4	4.877	4.69

WATER BALANCE TABLE - AVERAGE DAILY VALUES

Year	Water System	Withdrawl from Source	Consumptive Loss			Wastewater Discharge			Total Return to Source Basin	Total Interbasin Transfer
			Cape Fear	Shallotte River	Waccamaw	Cape Fear	Shallotte River	Waccamaw		
A	B	C	D	E		F	G		H=D+F	I=C-H
2020	Brunswick Co.	7.71	0.91	2.91	0.10	2.58	0.80	0.40	3.50	4.21
	Bald Head	0.01				0.01			0.01	0.00
	Leland	0.03	0.03						0.03	0.00
	Caswell Beach	0.03	0.03						0.03	0.00
	Holden Beach	0.50		0.13			0.37		0.00	0.50
	BR (H2GO)	2.14	1.82			0.32			2.14	0.00
	Northwest	0.14	0.14						0.14	0.00
	Oak Island	0.21	0.18			0.03			0.21	0.00
	Ocean Isle Beach	0.80		0.26			0.54		0.00	0.80
	Shallotte	0.53		0.15			0.37		0.00	0.53
	Southport	0.12				0.12			0.12	0.00
	Navassa	0.12	0.12						0.12	0.00
	Total	12.32	3.22	3.45	0.10	3.06	2.09	0.40	6.28	6.04

WATER BALANCE TABLE - AVERAGE DAILY VALUES

Year	Water System	Withdrawl from Source	Consumptive Loss			Wastewater Discharge			Total Return to Source Basin	Total Interbasin Transfer
			Cape Fear	Shallotte River	Waccamaw	Cape Fear	Shallotte River	Waccamaw		
A	B	C	D	E		F	G		H=D+F	I=C-H
2030	Brunswick Co.	9.47	1.12	3.58	0.10	3.17	1.10	0.40	4.30	5.18
	Bald Head	0.02				0.02			0.02	0.00
	Leland	0.03	0.03						0.03	0.00
	Caswell Beach	0.03	0.03						0.03	0.00
	Holden Beach	0.62		0.16			0.46		0.00	0.62
	BR (H2GO)	2.62	2.23			0.40			2.62	0.00
	Northwest	0.17	0.17						0.17	0.00
	Oak Island	0.25	0.22			0.03			0.25	0.00
	Ocean Isle Beach	0.98		0.32			0.66		0.00	0.98
	Shallotte	0.65		0.19			0.46		0.00	0.65
	Southport	0.14				0.14			0.14	0.00
	Navassa	0.14	0.14						0.14	0.00
	Total	15.13	3.95	4.24	0.10	3.76	2.68	0.40	7.71	7.42

WATER BALANCE TABLE - AVERAGE DAILY VALUES

Year	Water System	Withdrawl from Source	Consumptive Loss			Wastewater Discharge			Total Return to Source Basin	Total Interbasin Transfer
			Cape Fear	Shallotte River	Waccamaw	Cape Fear	Shallotte River	Waccamaw		
A	B	C	D	E		F	G		H=D+F	I=C-H
2040	Brunswick Co.	11.57	1.37	4.37	0.10	3.88	1.45	0.40	5.25	6.32
	Bald Head	0.02				0.02			0.02	0.00
	Leland	0.04	0.04						0.04	0.00
	Caswell Beach	0.04	0.04						0.04	0.00
	Holden Beach	0.75		0.19			0.56		0.00	0.75
	BR (H2GO)	3.21	2.72			0.48			3.21	0.00
	Northwest	0.21	0.21						0.21	0.00
	Oak Island	0.31	0.27			0.04			0.31	0.00
	Ocean Isle Beach	1.20		0.39			0.81		0.00	1.20
	Shallotte	0.79		0.23			0.56		0.00	0.79
	Southport	0.17				0.17			0.17	0.00
	Navassa	0.17	0.17						0.17	0.00
	Total	18.48	4.83	5.18	0.10	4.59	3.38	0.40	9.42	9.06

WATER BALANCE TABLE - AVERAGE DAILY VALUES

Year	Water System	Withdrawl from Source	Consumptive Loss			Wastewater Discharge			Total Return to Source Basin	Total Interbasin Transfer
			Cape Fear	Shallotte River	Waccamaw	Cape Fear	Shallotte River	Waccamaw		
A	B	C	D	E		F	G		H=D+F	I=C-H
2050	Brunswick Co.	13.60	1.61	5.14	0.10	4.56	1.79	0.40	6.17	7.43
	Bald Head	0.02				0.02	0.00		0.02	0.00
	Leland	0.05	0.05						0.05	0.00
	Caswell Beach	0.05	0.05						0.05	0.00
	Holden Beach	0.89		0.23			0.66		0.00	0.89
	BR (H2GO)	3.77	3.20			0.57			3.77	0.00
	Northwest	0.25	0.25						0.25	0.00
	Oak Island	0.36	0.32			0.05			0.36	0.00
	Ocean Isle Beach	1.41		0.45			0.95		0.00	1.41
	Shallotte	0.93		0.27			0.66		0.00	0.93
	Southport	0.20				0.20			0.20	0.00
	Navassa	0.20	0.20						0.20	0.00
	Total	21.73	5.68	6.09	0.10	5.40	4.06	0.40	11.08	10.66

Notes for Water Balance Tables:

1. Flows represent surface water only and exclude water supplied by groundwater (i.e., 211 WTP). Actual average day and maxiumum day flows were used in the development of the 2010 water balance tables.
2. Flows for 2020 through 2050 are based on the projected increase in water use demand (discussed in Section 1 of the EA) applied to the 2010 water balance tables. Totals for withdrawal from source are equal to total demand minus demand met by the 211 WTP.
3. Consumptive losses were calculated by subtracting the population served by public sewer from the total population. The remaining population was assumed to be served by on-site septic systems. Flows were calculated by applying average water consumption per capita to the remaining population.
4. Consumptive losses and wastewater discharge flows in the Waccamaw IBT River Basin were held constant. There are no plans for an increase in wastewater discharge capacity and flows exceededing plant capacity will be pumped to the West Brunswick WRF in the Shallotte IBT River Basin. In addition, additional water supply for future growth in the Waccamaw basin will be provided by agreement with the Little River and Sewerage Water Company, Inc. in South Carolina.
5. The tables include a transfer of effluent water from the West Brunswick WRF located in the Shallotte IBT River Basin to golf courses located in St. James (Cape Fear IBT River Basin).
6. The tables include a transfer of wastewater from the Village of Calabash in the Shallotte IBT River Basin to the Carolina Shores WWTP in the Waccamaw IBT River Basin.

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Appendix G Land Use Classification

Table F- 1. Existing Land Use Descriptions and Land Use Group Assignments

Description	Land Use Code	Assigned Land Use Group
Agricultural Land, confined animal operation	3	Agricultural Land/Open Field
Agricultural Land, cultivated fields	1	Agricultural Land/Open Field
Agricultural Land, ornamental horticulture	33	Agricultural Land/Open Field
Pasture/Clear fields	15	Agricultural Land/Open Field
Communication Towers	9	Communications & Utilities
Communications & Utilities Facilities	45	Communications & Utilities
Commercial hotel, motel	20	Developed
Commercial office and professional	34	Developed
Commercial retail	8	Developed
Commercial shopping center	49	Developed
Commercial wholesale	10	Developed
Educational Facility, college or higher learning	7	Developed
Educational Facility, day care	11	Developed
Educational Facility, grade school	39	Developed
Educational Facility, private school or other	14	Developed
Institutional, church & related religious facility	6	Developed
Institutional, government services	17	Developed
Institutional, hospital & health clinic	19	Developed
Institutional, membership organization	31	Developed
Manufacturing, Industrial park	21	Developed
Manufacturing, heavy	26	Developed
Manufacturing, light	27	Developed
Storage	50	Developed
Wooded Area	46	Forest

Description	Land Use Code	Assigned Land Use Group
Residential, multi-family	24	High-Density Residential
Residential, neighborhood business	32	High-Density Residential
Water	47	Hydrology
Wetland, marsh	48	Hydrology
Cemetery	5	Low-Density Residential
Mobile Home Park	28	Low-Density Residential
Residential, cleared lot	22	Low-Density Residential
Residential, double-wide mobile home	12	Low-Density Residential
Residential, single family site built detached	40	Low-Density Residential
Residential, single-wide mobile home	41	Low-Density Residential
Residential, vegetated lot	23	Low-Density Residential
Residential, Duplex	13	Medium-Density Residential
Residential, campers, single or grouping	4	Medium-Density Residential
Residential, group quarters	18	Medium-Density Residential
Military Installations	29	Military
Mining & Extraction	30	Mining & Extraction
Developed Outdoor Recreational, camper, RV parks	36	Recreation
Developed Outdoor Recreational, golf course	16	Recreation
Road Right of Way	37	Transportation
Transportation, airport & landing strip	2	Transportation
Transportation, rail facilities	38	Transportation
Transportation, water-related facilities	42	Transportation

Appendix H Protected Species

Table H-1. State and Federally Protected Species in Counties of the Cape Fear IBT River Basin Study Area

Common Name	Row Labels	State Status	Federal Status	County
Invertebrate Animal				
a dart moth	*Agrotis carolina*	SR	FSC	Bla, Bru, Pen
Waccamaw Snail	*Amnicola sp. 1*	SC	-	Col
Barrel Floater	*Anodonta couperiana*	E	-	Bla, NH
Arogos Skipper	*Atrytone arogos arogos*	SR	FSC	Bru, NH
Loammi Skipper	*Atrytonopsis loammi*	SR	FSC	Bru, NH
Waccamaw Ambersnail	*Catinella waccamawensis*	T	-	Col
Waccamaw Siltsnail	*Cincinnatia sp. 1*	SC	-	Col
Pod Lance	*Elliptio folliculata*	SC	-	Bla, Bru, Col, Pen
Cape Fear Spike	*Elliptio marsupiobesa*	SC	-	Bla, NH, Pen
Roanoke Slabshell	*Elliptio roanokensis*	T	-	Bla
Waccamaw Spike	*Elliptio waccamawensis*	E	FSC	Bru, Col
Atlantic Pigtoe	*Fusconaia masoni*	E	FSC	Bla, Pen
Greenfield Rams-horn	*Helisoma eucosmium*	E	FSC	Bru, NH
Venus Flytrap Cutworm Moth	*Hemipachnobia subporphyrea*	SR	FSC	Bla, Bru, Pen
Yellow Lampmussel	*Lampsilis cariosa*	E	FSC	Bla, Col, Pen
Waccamaw Fatmucket	*Lampsilis fullerkati*	T	FSC	Col
Eastern Lampmussel	*Lampsilis radiata*	T	-	Bla, Col, Pen
Tidewater Mucket	*Leptodea ochracea*	T	-	Col
Eastern Pondmussel	*Ligumia nasuta*	T	-	Bru
Graceful Clam Shrimp	*Lynceus gracilicornis*	SC	-	NH
Magnificent Rams-horn	*Planorbella magnifica*	E	FSC	Bru, NH
Rare Skipper	*Problema bulenta*	SR	FSC	Bru, NH

Common Name	Row Labels	State Status	Federal Status	County
Waccamaw Crayfish	*Procambarus braswelli*	SC	-	Bru, Col
Belle's Sanddragon	*Progomphus bellei*	SR	FSC	Bla
Carter's Noctuid Moth	*Spartiniphaga carterae*	SR	FSC	Bla, Bru, Pen
Townes' Clubtail	*Stylurus townesi*	SR	FSC	Col
Savannah Lilliput	*Toxolasma pullus*	E	FSC	Col
Cape Fear Threetooth	*Triodopsis soelneri*	T	FSC	Bru, Col, NH
Nonvascular Plant				
Savanna Campylopus	*Campylopus carolinae*	SR-T	FSC	Bru
Vascular Plant				
Venus Hair Fern	*Adiantum capillus-veneris*	T	-	Col
Branched Gerardia	*Agalinis virgata*	T	-	Bru, NH, Pen
Savanna Onion	*Allium sp. 1*	SR-L	FSC	Bru, Pen
Seabeach Amaranth	*Amaranthus pumilus*	T	T	Bru, NH, Pen
Savanna Indigo-bush	*Amorpha confusa*	T	FSC	Bla, Bru, Col, NH
Georgia Indigo-bush	*Amorpha georgiana*	E	FSC	Pen
Bog Bluestem	*Andropogon mohrii*	T	-	Bru, Col, Pen
Big Three-awn Grass	*Aristida condensata*	T	-	Bla, NH, Pen
Chapman's Three-awn	*Aristida simpliciflora*	E	-	Bru, Col, Pen
Savanna Indian-plantain	*Arnoglossum ovatum*	E	-	Bla, Bru, Col, Pen
Savanna Milkweed	*Asclepias pedicellata*	SC-V	-	Bla, Bru, Col, NH, Pen
Carolina Spleenwort	*Asplenium heteroresiliens*	E	FSC	Bla
Sandhills Milk-vetch	*Astragalus michauxii*	SC-V	FSC	Bla, NH, Pen
Silverling	*Baccharis glomeruliflora*	SC-H	-	Bru
Blue Water-hyssop	*Bacopa caroliniana*	T	-	Bla, Bru, Col, NH, Pen
Tropical Water-hyssop	*Bacopa innominata*	SC-H	-	NH, Pen
Purple-disk Honeycomb-head	*Balduina atropurpurea*	E	FSC	Bla, Bru

Common Name	Row Labels	State Status	Federal Status	County
Ware's Hair Sedge	*Bulbostylis warei*	SC-H	-	Bru
Many-flower Grass-pink	*Calopogon multiflorus*	E	FSC	Bru, Pen
Long's Bittercress	*Cardamine longii*	SC-V	-	Bla, NH, Pen
Cherokee Sedge	*Carex cherokeensis*	E	-	Pen
Cypress Knee Sedge	*Carex decomposita*	SC-V	-	Bru, NH
Golden Sedge	*Carex lutea*	E	E	Pen
Kidney Sedge	*Carex reniformis*	T	-	Bla, Pen
Nutmeg Hickory	*Carya myristiciformis*	E	-	Bru, Pen
A Spanglegrass	*Chasmanthium nitidum*	T	-	Pen
Woody Goldenrod	*Chrysoma pauciflosculosa*	E	-	Col
Leconte's Thistle	*Cirsium lecontei*	SC-V	-	Bla, Bru, Col, Pen
Georgia Calamint	*Clinopodium georgianum*	E	-	Bru, Pen
Roughleaf Dogwood	*Cornus asperifolia*	E	-	Pen
Swamp-lily	*Crinum americanum*	SC-H	-	NH
Carolina Sunrose	*Crocanthemum carolinianum*	E	-	Bru, NH, Pen
Pinebarren Sunrose	*Crocanthemum corymbosum*	T	-	Bru
Georgia Sunrose	*Crocanthemum georgianum*	E	-	Bru, NH
Florida Scrub Frostweed	*Crocanthemum nashii*	E	-	Bru, NH
Toothed Flatsedge	*Cyperus dentatus*	SC-H	-	Bru
Leconte's Flatsedge	*Cyperus lecontei*	T	-	Bru, NH
Four-angled Flatsedge	*Cyperus tetragonus*	SC-V	-	Bru, NH, Pen
Nerved Witch Grass	*Dichanthelium aciculare ssp. neuranthum*	SC-V	-	Bru, NH
Blue Witch Grass	*Dichanthelium caerulescens*	E	-	Bru, Pen
Venus Flytrap	*Dionaea muscipula*	SC-V	FSC	Bla, Bru, Col, NH, Pen
Sebastian-bush	*Ditrysinia fruticosa*	SC-V	-	Bru, Col, Pen

Common Name	Row Labels	State Status	Federal Status	County
Threadleaf Sundew	*Drosera filiformis*	SC-V	-	Bla, Bru, Col
Dwarf Burhead	*Echinodorus tenellus*	E	-	Bru
Florida Spikerush	*Eleocharis elongata*	E	-	Bru
Robbins' Spikerush	*Eleocharis robbinsii*	SC-V	-	Bla, Bru, NH
Viviparous Spikerush	*Eleocharis vivipara*	E	-	NH, Pen
Terrell Grass	*Elymus virginicus var. halophilus*	SC-V	-	Bru
Green Fly Orchid	*Epidendrum magnoliae*	T	-	Bla, Bru, Col, NH, Pen
Seven-angled Pipewort	*Eriocaulon aquaticum*	SC-V	-	Bla, Bru, Col
Southern Wild-buckwheat	*Eriogonum tomentosum*	SC-H	-	Bla
Coralbean	*Erythrina herbacea*	E	-	Bru, NH
Limesink Dog-fennel	*Eupatorium leptophyllum*	E	-	Bru, NH
Heartleaf Sandmat	*Euphorbia cordifolia*	T	-	Bla
Harper's Fimbry	*Fimbristylis perpusilla*	T	FSC	Bru, Col
Soft Milk-pea	*Galactia mollis*	T	-	Bru
Confederate Huckleberry	*Gaylussacia nana*	E	-	NH
Swamp Jessamine	*Gelsemium rankinii*	SC-V	-	Bru, Col, NH, Pen
Golden Hedge-hyssop	*Gratiola aurea*	SC-V	-	Bla, Bru, Col, Pen
Littleleaf Sneezeweed	*Helenium brevifolium*	E	-	Bru
Spring Sneezeweed	*Helenium vernale*	E	-	Bru, Col
Florida Sunflower	*Helianthus floridanus*	T	-	Bla, Bru, Col
Comfortroot	*Hibiscus aculeatus*	T	-	NH
Waccamaw River Spiderlily	*Hymenocallis pygmaea*	T	FSC	Bru, Col
Coastal Plain St. John's-wort	*Hypericum brachyphyllum*	SC-V	-	Bru, Col, Pen
Peelbark St. John's-wort	*Hypericum fasciculatum*	E	-	NH
Pineland St. John's-wort	*Hypericum suffruticosum*	SC-H	-	Bla
Beach Morning-glory	*Ipomoea imperati*	T	-	Bru

Common Name	Row Labels	State Status	Federal Status	County
Thin-wall Quillwort	*Isoetes microvela*	T	FSC	Bru, Pen
Brown Bogbutton	*Lachnocaulon minus*	T	-	Bru, NH, Pen
Torrey's Pinweed	*Lechea torreyi*	E	-	Bru, Pen
Long-awned Spangletop	*Leptochloa fascicularis var. maritima*	E	-	Bru
Pondberry	*Lindera melissifolia*	E	E	Bla
Yellow-fruited Flax	*Linum floridanum var. chrysocarpum*	T	-	Bru, Col, Pen
Small-flowered Hemicarpha	*Lipocarpha micrantha*	SC-H	-	Col
Pondspice	*Litsea aestivalis*	SC-V	FSC	Bla, Bru, NH
Boykin's Lobelia	*Lobelia boykinii*	E	FSC	Bla
Golden-crest	*Lophiola aurea*	E	-	Bru, Col, NH
Lanceleaf Seedbox	*Ludwigia lanceolata*	E	-	Bru, NH
Flaxleaf Seedbox	*Ludwigia linifolia*	T	-	Bru, Col, NH
Raven's Seedbox	*Ludwigia ravenii*	T	FSC	Bru, Col, NH
Globe-fruit Seedbox	*Ludwigia sphaerocarpa*	E	-	Bla, Col, NH
Shrubby Seedbox	*Ludwigia suffruticosa*	T	-	Bla, Bru, NH
Rough-leaf Loosestrife	*Lysimachia asperulifolia*	E	E	Bla, Bru, Col, NH, Pen
Carolina Bogmint	*Macbridea caroliniana*	E	FSC	Bla, Bru, Col, Pen
Florida Adder's-mouth	*Malaxis spicata*	SC-V	-	Bru, Pen
Pinebarren Smokegrass	*Muhlenbergia torreyana*	SC-V	-	Bru, Pen
Loose Water-milfoil	*Myriophyllum laxum*	E	FSC	Bru
Leafless Water-milfoil	*Myriophyllum tenellum*	E	-	Bla
Bosc's Bluet	*Oldenlandia boscii*	E	-	Bru, Col
Large-seed Pellitory	*Parietaria praetermissa*	SC-V	-	Bru, NH
Carolina Grass-of-parnassus	*Parnassia caroliniana*	T	FSC	Bla, Bru, Col, Pen
Large-leaved Grass-of-parnassus	*Parnassia grandifolia*	T	FSC	Bru, Col, Pen

Common Name	Row Labels	State Status	Federal Status	County
Mudbank Crown Grass	*Paspalum dissectum*	E	-	Bru, Col, Pen
Hairy Smartweed	*Persicaria hirsuta*	E	-	Bru
Small Butterwort	*Pinguicula pumila*	E	-	Pen
A Silkgrass	*Pityopsis graminifolia var. graminifolia*	E	-	Bru, Col
Pineland Plantain	*Plantago sparsiflora*	T	FSC	Bla, Bru, Col, Pen
Yellow Fringeless Orchid	*Platanthera integra*	SC-V	-	Bru, Col, Pen
Snowy Orchid	*Platanthera nivea*	T	-	Bla, Bru, Col, NH, Pen
Hooker's Milkwort	*Polygala hookeri*	SC-V	-	Bru, Col, NH, Pen
Seabeach Knotweed	*Polygonum glaucum*	E	-	Bru, NH
Shadow-witch	*Ponthieva racemosa*	T	-	Bru, Pen
Spiked Medusa	*Pteroglossaspis ecristata*	E	FSC	Bla, NH
Carolina Bishop-weed	*Ptilimnium ahlesii*	SR-L	FSC	Bru, NH
Ribbed Bishop-weed	*Ptilimnium costatum*	T	-	Bru, NH
Sandhills Pyxie-moss	*Pyxidanthera brevifolia*	SR-L	FSC	Bru
Awned Meadow-beauty	*Rhexia aristosa*	SC-V	FSC	Bla, Bru
Swamp Forest Beaksedge	*Rhynchospora decurrens*	T	FSC	Bru, Col
Harper's Beaksedge	*Rhynchospora harperi*	SC-V	-	Bru
Fragrant Beaksedge	*Rhynchospora odorata*	SC-V	-	Bru, Pen
Coastal Beaksedge	*Rhynchospora pleiantha*	T	FSC	Bru, NH
Thorne's Beaksedge	*Rhynchospora thornei*	SC-V	FSC	Bru, Pen
Tracy's Beaksedge	*Rhynchospora tracyi*	T	-	Bru, NH
Limestone Wild-petunia	*Ruellia strepens*	E	-	Pen
Cabbage Palm	*Sabal palmetto*	T	-	Bru
Plymouth Gentian	*Sabatia kennedyana*	T	-	Bru, Col
Small-flowered Buckthorn	*Sageretia minutiflora*	T	-	Pen
Chapman's Arrowhead	*Sagittaria chapmanii*	E	-	Bla, Col

Common Name	Row Labels	State Status	Federal Status	County
Quillwort Arrowhead	*Sagittaria isoetiformis*	T	-	Bla, Bru, Col, NH
Grassleaf Arrowhead	*Sagittaria weatherbiana*	E	FSC	Bla, Bru, Col, NH, Pen
Hooded Pitcher Plant	*Sarracenia minor*	E	-	Bru, Col, NH
Chaffseed	*Schwalbea americana*	E	E	Bla, Pen
Drooping Bulrush	*Scirpus lineatus*	T	-	Bru, NH, Pen
Baldwin's Nutrush	*Scleria baldwinii*	T	-	Bru, Col, Pen
Netted Nutrush	*Scleria reticularis*	T	-	Bru, NH
Smooth-seeded Hairy Nutrush	*Scleria sp. 1*	SR-L	FSC	Pen
Sticky Afzelia	*Seymeria pectinata*	SC-H	-	Bru
Tough Bumelia	*Sideroxylon tenax*	T	FSC	Bru, NH
Leavenworth's Goldenrod	*Solidago leavenworthii*	T	-	Col
Twisted-leaf Goldenrod	*Solidago tortifolia*	E	-	Bla, Bru, NH
Spring-flowering Goldenrod	*Solidago verna*	SR-O	FSC	Bla, Bru, Col, NH, Pen
Coastal Goldenrod	*Solidago villosicarpa*	E	FSC	Bru, NH, Pen
Eaton's Ladies'-tresses	*Spiranthes eatonii*	E	-	Bla, Bru, Pen
Lace-lip Ladies'-tresses	*Spiranthes laciniata*	SC-V	-	Bla, Bru, Col, NH
Giant Spiral Orchid	*Spiranthes longilabris*	E	-	Bla, Bru, Pen
Wireleaf Dropseed	*Sporobolus teretifolius*	T	FSC	Bru, Col
Saltmarsh Dropseed	*Sporobolus virginicus*	T	-	Bru
Water Dawnflower	*Stylisma aquatica*	E	-	Bru
Pickering's Dawnflower	*Stylisma pickeringii var. pickeringii*	SC-V	FSC	Bla, Bru, NH, Pen
Cooley's Meadowrue	*Thalictrum cooleyi*	E	E	Bru, Col, NH, Pen
Small-leaved Meadowrue	*Thalictrum macrostylum*	SR-L	FSC	NH, Pen
Appalachian Golden-banner	*Thermopsis mollis*	SC-V	-	Col
Dune Bluecurls	*Trichostema sp. 1*	SR-L	FSC	Bru, NH
Chapman's Redtop	*Tridens chapmanii*	T	-	Bla, Pen

Common Name	Row Labels	State Status	Federal Status	County
Spike Triodia	*Tridens strictus*	SC-H	-	Pen
Carolina Clover	*Trifolium carolinianum*	SC-H	-	NH
Carolina Least Trillium	*Trillium pusillum var. pusillum*	E	FSC	Pen
Horned Bladderwort	*Utricularia cornuta*	T	-	Bru, Col, NH
Two-flowered Bladderwort	*Utricularia geminiscapa*	SC-V	-	Pen
Dwarf Bladderwort	*Utricularia olivacea*	T	-	Bru, NH, Pen
Northeastern Bladderwort	*Utricularia resupinata*	E	-	Col
Cranberry	*Vaccinium macrocarpon*	T	-	Bla, Bru
Florida Yellow-eyed-grass	*Xyris floridana*	T	-	Bru, Col, Pen
Acid-swamp Yellow-eyed-grass	*Xyris serotina*	T	-	Col
Pineland Yellow-eyed-grass	*Xyris stricta*	E	-	Bru, Pen
Rain Lily	*Zephyranthes simpsonii*	E	FSC	Bru
Vertebrate Animal				
Shortnose Sturgeon	*Acipenser brevirostrum*	E	E	Bla, Bru, Col, NH, Pen
American Alligator	*Alligator mississippiensis*	T	T(S/A)	Bla, Bru, Col, NH, Pen
Eastern Henslow's Sparrow	*Ammodramus henslowii susurrans*	SC	FSC	Bru, Col, Pen
Loggerhead Seaturtle	*Caretta caretta*	T	T	Bru, NH, Pen
Atlantic Highfin Carpsucker	*Carpiodes sp. cf. velifer*	SC	-	Bla
Piping Plover	*Charadrius melodus*	T	T	Bru, NH, Pen
Wilson's Plover	*Charadrius wilsonia*	SC	-	Bru, NH, Pen
Green Seaturtle	*Chelonia mydas*	T	T	Bru, NH, Pen
Star-nosed Mole - Coastal Plain population	*Condylura cristata pop. 1*	SC	-	Bla, Bru, Col, NH, Pen
Rafinesque's Big-eared Bat - Coastal Plain subspecies	*Corynorhinus rafinesquii macrotis*	SC	FSC	Bla, Bru, Col, NH, Pen
Eastern Diamondback Rattlesnake	*Crotalus adamanteus*	E	-	Bla, Bru, Col, NH, Pen

Common Name	Row Labels	State Status	Federal Status	County
Timber Rattlesnake	*Crotalus horridus*	SC	-	Bla, Bru, Col, NH, Pen
Thinlip Chub	*Cyprinella sp. 1*	SC	-	Bla
Black-throated Green Warbler - Coastal Plain population	*Dendroica virens waynei*	SR	FSC	Bla, Bru
Leatherback Seaturtle	*Dermochelys coriacea*	E	E	Bru, NH
Little Blue Heron	*Egretta caerulea*	SC	-	Bru, Col, NH
Snowy Egret	*Egretta thula*	SC	-	Bru, Col, NH
Tricolored Heron	*Egretta tricolor*	SC	-	Bru, NH
Carolina Pygmy Sunfish	*Elassoma boehlkei*	T	FSC	Bru, Col
Pinewoods Darter	*Etheostoma mariae*	SC	FSC	Bla
Waccamaw Darter	*Etheostoma perlongum*	T	FSC	Col
Dwarf Salamander	*Eurycea quadridigitata*	SC	-	Bla, Col
Peregrine Falcon	*Falco peregrinus*	E	-	Bru
Waccamaw Killifish	*Fundulus waccamensis*	SC	FSC	Col
Gull-billed Tern	*Gelochelidon nilotica*	T	-	Bru, NH
American Oystercatcher	*Haematopus palliatus*	SC	-	Bru, NH, Pen
Bald Eagle	*Haliaeetus leucocephalus*	T	-	Bla, Bru, Col, NH, Pen
Four-toed Salamander	*Hemidactylium scutatum*	SC	-	Bla, Pen
Least Killifish	*Heterandria formosa*	SC	-	Bru, NH
Southern Hognose Snake	*Heterodon simus*	SC	FSC	Bla, Bru, NH, Pen
Least Bittern	*Ixobrychus exilis*	SC	-	Bru, NH, Pen
Loggerhead Shrike	*Lanius ludovicianus*	SC	-	Bla, Bru, Col, NH
Northern Yellow Bat	*Lasiurus intermedius*	SC	-	Bru, NH
Black Rail	*Laterallus jamaicensis*	SC	FSC	NH
Kemp's Ridley Seaturtle	*Lepidochelys kempii*	E	E	Bru
Diamondback Terrapin	*Malaclemys terrapin*	SC	FSC, in part	Bru, NH, Pen

Common Name	Row Labels	State Status	Federal Status	County
Waccamaw Silverside	*Menidia extensa*	T	T	Col
Eastern Coral Snake	*Micrurus fulvius*	E	-	Bla, Bru, NH, Pen
Wood Stork	*Mycteria americana*	E	E	Bru, Col
Southeastern Myotis	*Myotis austroriparius*	SC	FSC	Bla, Col, NH, Pen
Eastern Woodrat - Coastal Plain population	*Neotoma floridana floridana*	T	-	Bru, NH, Pen
Broadtail Madtom	*Noturus sp. 2*	SC	FSC	Bla, Bru, Col, Pen
Mimic Glass Lizard	*Ophisaurus mimicus*	SC	FSC	Bla, Bru, Col, NH
Eastern Painted Bunting	*Passerina ciris ciris*	SC	FSC	Bru, NH, Pen
Bachman's Sparrow	*Peucaea aestivalis*	SC	FSC	Bla, Bru, Col, Pen
Red-cockaded Woodpecker	*Picoides borealis*	E	E	Bla, Bru, Col, NH, Pen
Northern Pine Snake	*Pituophis melanoleucus melanoleucus*	SC	FSC	Bru, NH
Glossy Ibis	*Plegadis falcinellus*	SC	-	Bru, NH
Carolina Gopher Frog	*Rana capito*	T	FSC	Bla, Bru, NH, Pen
Black Skimmer	*Rynchops niger*	SC	-	Bru, NH, Pen
Pigmy Rattlesnake	*Sistrurus miliarius*	SC	-	Bla, Bru, NH, Pen
Common Tern	*Sterna hirundo*	SC	-	NH, Pen
Least Tern	*Sternula antillarum*	SC	-	Bru, NH, Pen
West Indian Manatee	*Trichechus manatus*	E	E	Bru, NH, Pen

Table H-2. State and Federally Protected Species in the Shallotte IBT River Basin Study Area

Common Name	Scientific Name	State Status	Federal Status	County
Invertebrate Animal				
a dart moth	*Agrotis carolina*	SR	FSC	Bru
Arogos Skipper	*Atrytone arogos arogos*	SR	FSC	Bru
Loammi Skipper	*Atrytonopsis loammi*	SR	FSC	Bru
Pod Lance	*Elliptio folliculata*	SC	-	Bru
Waccamaw Spike	*Elliptio waccamawensis*	E	FSC	Bru
Greenfield Rams-horn	*Helisoma eucosmium*	E	FSC	Bru
Venus Flytrap Cutworm Moth	*Hemipachnobia subporphyrea*	SR	FSC	Bru
Eastern Pondmussel	*Ligumia nasuta*	T	-	Bru
Magnificent Rams-horn	*Planorbella magnifica*	E	FSC	Bru
Rare Skipper	*Problema bulenta*	SR	FSC	Bru
Waccamaw Crayfish	*Procambarus braswelli*	SC	-	Bru
Carter's Noctuid Moth	*Spartiniphaga carterae*	SR	FSC	Bru
Cape Fear Threetooth	*Triodopsis soelneri*	T	FSC	Bru
Nonvascular Plant				
Savanna Campylopus	*Campylopus carolinae*	SR-T	FSC	Bru
Vascular Plant				
Branched Gerardia	*Agalinis virgata*	T	-	Bru
Savanna Onion	*Allium sp. 1*	SR-L	FSC	Bru
Seabeach Amaranth	*Amaranthus pumilus*	T	T	Bru
Savanna Indigo-bush	*Amorpha confusa*	T	FSC	Bru
Bog Bluestem	*Andropogon mohrii*	T	-	Bru
Chapman's Three-awn	*Aristida simpliciflora*	E	-	Bru
Savanna Indian-plantain	*Arnoglossum ovatum*	E	-	Bru
Savanna Milkweed	*Asclepias pedicellata*	SC-V	-	Bru
Silverling	*Baccharis glomeruliflora*	SC-H	-	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Blue Water-hyssop	*Bacopa caroliniana*	T	-	Bru
Purple-disk Honeycomb-head	*Balduina atropurpurea*	E	FSC	Bru
Ware's Hair Sedge	*Bulbostylis warei*	SC-H	-	Bru
Many-flower Grass-pink	*Calopogon multiflorus*	E	FSC	Bru
Cypress Knee Sedge	*Carex decomposita*	SC-V	-	Bru
Nutmeg Hickory	*Carya myristiciformis*	E	-	Bru
Leconte's Thistle	*Cirsium lecontei*	SC-V	-	Bru
Georgia Calamint	*Clinopodium georgianum*	E	-	Bru
Carolina Sunrose	*Crocanthemum carolinianum*	E	-	Bru
Pinebarren Sunrose	*Crocanthemum corymbosum*	T	-	Bru
Georgia Sunrose	*Crocanthemum georgianum*	E	-	Bru
Florida Scrub Frostweed	*Crocanthemum nashii*	E	-	Bru
Toothed Flatsedge	*Cyperus dentatus*	SC-H	-	Bru
Leconte's Flatsedge	*Cyperus lecontei*	T	-	Bru
Four-angled Flatsedge	*Cyperus tetragonus*	SC-V	-	Bru
Nerved Witch Grass	*Dichanthelium aciculare ssp. Neuranthum*	SC-V	-	Bru
Blue Witch Grass	*Dichanthelium caerulescens*	E	-	Bru
Venus Flytrap	*Dionaea muscipula*	SC-V	FSC	Bru
Sebastian-bush	*Ditrysinia fruticosa*	SC-V	-	Bru
Threadleaf Sundew	*Drosera filiformis*	SC-V	-	Bru
Dwarf Burhead	*Echinodorus tenellus*	E	-	Bru
Florida Spikerush	*Eleocharis elongata*	E	-	Bru
Robbins' Spikerush	*Eleocharis robbinsii*	SC-V	-	Bru
Terrell Grass	*Elymus virginicus var. halophilus*	SC-V	-	Bru
Green Fly Orchid	*Epidendrum magnoliae*	T	-	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Seven-angled Pipewort	*Eriocaulon aquaticum*	SC-V	-	Bru
Coralbean	*Erythrina herbacea*	E	-	Bru
Limesink Dog-fennel	*Eupatorium leptophyllum*	E	-	Bru
Harper's Fimbry	*Fimbristylis perpusilla*	T	FSC	Bru
Soft Milk-pea	*Galactia mollis*	T	-	Bru
Swamp Jessamine	*Gelsemium rankinii*	SC-V	-	Bru
Golden Hedge-hyssop	*Gratiola aurea*	SC-V	-	Bru
Littleleaf Sneezeweed	*Helenium brevifolium*	E	-	Bru
Spring Sneezeweed	*Helenium vernale*	E	-	Bru
Florida Sunflower	*Helianthus floridanus*	T	-	Bru
Waccamaw River Spiderlily	*Hymenocallis pygmaea*	T	FSC	Bru
Coastal Plain St. John's-wort	*Hypericum brachyphyllum*	SC-V	-	Bru
Beach Morning-glory	*Ipomoea imperati*	T	-	Bru
Thin-wall Quillwort	*Isoetes microvela*	T	FSC	Bru
Brown Bogbutton	*Lachnocaulon minus*	T	-	Bru
Torrey's Pinweed	*Lechea torreyi*	E	-	Bru
Long-awned Spangletop	*Leptochloa fascicularis var. maritime*	E	-	Bru
Yellow-fruited Flax	*Linum floridanum var. chrysocarpum*	T	-	Bru
Pondspice	*Litsea aestivalis*	SC-V	FSC	Bru
Golden-crest	*Lophiola aurea*	E	-	Bru
Lanceleaf Seedbox	*Ludwigia lanceolata*	E	-	Bru
Flaxleaf Seedbox	*Ludwigia linifolia*	T	-	Bru
Raven's Seedbox	*Ludwigia ravenii*	T	FSC	Bru
Shrubby Seedbox	*Ludwigia suffruticosa*	T	-	Bru
Rough-leaf Loosestrife	*Lysimachia asperulifolia*	E	E	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Carolina Bogmint	*Macbridea caroliniana*	E	FSC	Bru
Florida Adder's-mouth	*Malaxis spicata*	SC-V	-	Bru
Pinebarren Smokegrass	*Muhlenbergia torreyana*	SC-V	-	Bru
Loose Water-milfoil	*Myriophyllum laxum*	E	FSC	Bru
Bosc's Bluet	*Oldenlandia boscii*	E	-	Bru
Large-seed Pellitory	*Parietaria praetermissa*	SC-V	-	Bru
Carolina Grass-of-parnassus	*Parnassia caroliniana*	T	FSC	Bru
Large-leaved Grass-of-parnassus	*Parnassia grandifolia*	T	FSC	Bru
Mudbank Crown Grass	*Paspalum dissectum*	E	-	Bru
Hairy Smartweed	*Persicaria hirsuta*	E	-	Bru
A Silkgrass	*Pityopsis graminifolia var. graminifolia*	E	-	Bru
Pineland Plantain	*Plantago sparsiflora*	T	FSC	Bru
Yellow Fringeless Orchid	*Platanthera integra*	SC-V	-	Bru
Snowy Orchid	*Platanthera nivea*	T	-	Bru
Hooker's Milkwort	*Polygala hookeri*	SC-V	-	Bru
Seabeach Knotweed	*Polygonum glaucum*	E	-	Bru
Shadow-witch	*Ponthieva racemosa*	T	-	Bru
Carolina Bishop-weed	*Ptilimnium ahlesii*	SR-L	FSC	Bru
Ribbed Bishop-weed	*Ptilimnium costatum*	T	-	Bru
Sandhills Pyxie-moss	*Pyxidanthera brevifolia*	SR-L	FSC	Bru
Awned Meadow-beauty	*Rhexia aristosa*	SC-V	FSC	Bru
Swamp Forest Beaksedge	*Rhynchospora decurrens*	T	FSC	Bru
Harper's Beaksedge	*Rhynchospora harperi*	SC-V	-	Bru
Fragrant Beaksedge	*Rhynchospora odorata*	SC-V	-	Bru
Coastal Beaksedge	*Rhynchospora pleiantha*	T	FSC	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Thorne's Beaksedge	*Rhynchospora thornei*	SC-V	FSC	Bru
Tracy's Beaksedge	*Rhynchospora tracyi*	T	-	Bru
Cabbage Palm	*Sabal palmetto*	T	-	Bru
Plymouth Gentian	*Sabatia kennedyana*	T	-	Bru
Quillwort Arrowhead	*Sagittaria isoetiformis*	T	-	Bru
Grassleaf Arrowhead	*Sagittaria weatherbiana*	E	FSC	Bru
Hooded Pitcher Plant	*Sarracenia minor*	E	-	Bru
Drooping Bulrush	*Scirpus lineatus*	T	-	Bru
Baldwin's Nutrush	*Scleria baldwinii*	T	-	Bru
Netted Nutrush	*Scleria reticularis*	T	-	Bru
Sticky Afzelia	*Seymeria pectinata*	SC-H	-	Bru
Tough Bumelia	*Sideroxylon tenax*	T	FSC	Bru
Twisted-leaf Goldenrod	*Solidago tortifolia*	E	-	Bru
Spring-flowering Goldenrod	*Solidago verna*	SR-O	FSC	Bru
Coastal Goldenrod	*Solidago villosicarpa*	E	FSC	Bru
Eaton's Ladies'-tresses	*Spiranthes eatonii*	E	-	Bru
Lace-lip Ladies'-tresses	*Spiranthes laciniata*	SC-V	-	Bru
Giant Spiral Orchid	*Spiranthes longilabris*	E	-	Bru
Wireleaf Dropseed	*Sporobolus teretifolius*	T	FSC	Bru
Saltmarsh Dropseed	*Sporobolus virginicus*	T	-	Bru
Water Dawnflower	*Stylisma aquatica*	E	-	Bru
Pickering's Dawnflower	*Stylisma pickeringii var. pickeringii*	SC-V	FSC	Bru
Cooley's Meadowrue	*Thalictrum cooleyi*	E	E	Bru
Dune Bluecurls	*Trichostema sp. 1*	SR-L	FSC	Bru
Horned Bladderwort	*Utricularia cornuta*	T	-	Bru
Dwarf Bladderwort	*Utricularia olivacea*	T	-	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Cranberry	*Vaccinium macrocarpon*	T	-	Bru
Florida Yellow-eyed-grass	*Xyris floridana*	T	-	Bru
Pineland Yellow-eyed-grass	*Xyris stricta*	E	-	Bru
Rain Lily	*Zephyranthes simpsonii*	E	FSC	Bru
Vertebrate Animal				
Shortnose Sturgeon	*Acipenser brevirostrum*	E	E	Bru
American Alligator	*Alligator mississippiensis*	T	T(S/A)	Bru
Eastern Henslow's Sparrow	*Ammodramus henslowii susurrans*	SC	FSC	Bru
Loggerhead Seaturtle	*Caretta caretta*	T	T	Bru
Piping Plover	*Charadrius melodus*	T	T	Bru
Wilson's Plover	*Charadrius wilsonia*	SC	-	Bru
Green Seaturtle	*Chelonia mydas*	T	T	Bru
Star-nosed Mole - Coastal Plain population	*Condylura cristata pop. 1*	SC	-	Bru
Rafinesque's Big-eared Bat - Coastal Plain subspecies	*Corynorhinus rafinesquii macrotis*	SC	FSC	Bru
Eastern Diamondback Rattlesnake	*Crotalus adamanteus*	E	-	Bru
Timber Rattlesnake	*Crotalus horridus*	SC	-	Bru
Black-throated Green Warbler - Coastal Plain population	*Dendroica virens waynei*	SR	FSC	Bru
Leatherback Seaturtle	*Dermochelys coriacea*	E	E	Bru
Little Blue Heron	*Egretta caerulea*	SC	-	Bru
Snowy Egret	*Egretta thula*	SC	-	Bru
Tricolored Heron	*Egretta tricolor*	SC	-	Bru
Carolina Pygmy Sunfish	*Elassoma boehlkei*	T	FSC	Bru
Peregrine Falcon	*Falco peregrinus*	E	-	Bru
Gull-billed Tern	*Gelochelidon nilotica*	T	-	Bru

Common Name	Scientific Name	State Status	Federal Status	County
American Oystercatcher	*Haematopus palliatus*	SC	-	Bru
Bald Eagle	*Haliaeetus leucocephalus*	T	-	Bru
Least Killifish	*Heterandria formosa*	SC	-	Bru
Southern Hognose Snake	*Heterodon simus*	SC	FSC	Bru
Least Bittern	*Ixobrychus exilis*	SC	-	Bru
Loggerhead Shrike	*Lanius ludovicianus*	SC	-	Bru
Northern Yellow Bat	*Lasiurus intermedius*	SC	-	Bru
Kemp's Ridley Seaturtle	*Lepidochelys kempii*	E	E	Bru
Diamondback Terrapin	*Malaclemys terrapin*	SC	FSC, in part	Bru
Eastern Coral Snake	*Micrurus fulvius*	E	-	Bru
Wood Stork	*Mycteria americana*	E	E	Bru
Eastern Woodrat - Coastal Plain population	*Neotoma floridana floridana*	T	-	Bru
Broadtail Madtom	*Noturus sp. 2*	SC	FSC	Bru
Mimic Glass Lizard	*Ophisaurus mimicus*	SC	FSC	Bru
Eastern Painted Bunting	*Passerina ciris ciris*	SC	FSC	Bru
Bachman's Sparrow	*Peucaea aestivalis*	SC	FSC	Bru
Red-cockaded Woodpecker	*Picoides borealis*	E	E	Bru
Northern Pine Snake	*Pituophis melanoleucus melanoleucus*	SC	FSC	Bru
Glossy Ibis	*Plegadis falcinellus*	SC	-	Bru
Carolina Gopher Frog	*Rana capito*	T	FSC	Bru
Black Skimmer	*Rynchops niger*	SC	-	Bru
Pigmy Rattlesnake	*Sistrurus miliarius*	SC	-	Bru
Least Tern	*Sternula antillarum*	SC	-	Bru
West Indian Manatee	*Trichechus manatus*	E	E	Bru

Table H-3. State and Federally Protected Species in Counties of the Waccamaw IBT River Basin Study Area

Common Name	Scientific Name	State Status	Federal Status	County
Invertebrate Animal				
a dart moth	*Agrotis carolina*	SR	FSC	Bla, Bru
Waccamaw Snail	*Amnicola sp. 1*	SC	-	Col
Barrel Floater	*Anodonta couperiana*	E	-	Bla
Arogos Skipper	*Atrytone arogos arogos*	SR	FSC	Bru
Loammi Skipper	*Atrytonopsis loammi*	SR	FSC	Bru
Waccamaw Ambersnail	*Catinella waccamawensis*	T	-	Col
Waccamaw Siltsnail	*Cincinnatia sp. 1*	SC	-	Col
Pod Lance	*Elliptio folliculata*	SC	-	Bla, Bru, Col
Cape Fear Spike	*Elliptio marsupiobesa*	SC	-	Bla
Roanoke Slabshell	*Elliptio roanokensis*	T	-	Bla
Waccamaw Spike	*Elliptio waccamawensis*	E	FSC	Bru, Col
Atlantic Pigtoe	*Fusconaia masoni*	E	FSC	Bla
Greenfield Rams-horn	*Helisoma eucosmium*	E	FSC	Bru
Venus Flytrap Cutworm Moth	*Hemipachnobia subporphyrea*	SR	FSC	Bla, Bru
Yellow Lampmussel	*Lampsilis cariosa*	E	FSC	Bla, Col
Waccamaw Fatmucket	*Lampsilis fullerkati*	T	FSC	Col
Eastern Lampmussel	*Lampsilis radiata*	T	-	Bla, Col
Tidewater Mucket	*Leptodea ochracea*	T	-	Col
Eastern Pondmussel	*Ligumia nasuta*	T	-	Bru
Magnificent Rams-horn	*Planorbella magnifica*	E	FSC	Bru
Rare Skipper	*Problema bulenta*	SR	FSC	Bru
Waccamaw Crayfish	*Procambarus braswelli*	SC	-	Bru, Col
Belle's Sanddragon	*Progomphus bellei*	SR	FSC	Bla
Carter's Noctuid Moth	*Spartiniphaga carterae*	SR	FSC	Bla, Bru

Common Name	Scientific Name	State Status	Federal Status	County
Townes' Clubtail	*Stylurus townesi*	SR	FSC	Col
Savannah Lilliput	*Toxolasma pullus*	E	FSC	Col
Cape Fear Threetooth	*Triodopsis soelneri*	T	FSC	Bru, Col
Nonvascular Plant				
Savanna Campylopus	*Campylopus carolinae*	SR-T	FSC	Bru
Vascular Plant				
Venus Hair Fern	*Adiantum capillus-veneris*	T	-	Col
Branched Gerardia	*Agalinis virgate*	T	-	Bru
Savanna Onion	*Allium sp. 1*	SR-L	FSC	Bru
Seabeach Amaranth	*Amaranthus pumilus*	T	T	Bru
Savanna Indigo-bush	*Amorpha confuse*	T	FSC	Bla, Bru, Col
Bog Bluestem	*Andropogon mohrii*	T	-	Bru, Col
Big Three-awn Grass	*Aristida condensate*	T	-	Bla
Chapman's Three-awn	*Aristida simpliciflora*	E	-	Bru, Col
Savanna Indian-plantain	*Arnoglossum ovatum*	E	-	Bla, Bru, Col
Savanna Milkweed	*Asclepias pedicellata*	SC-V	-	Bla, Bru, Col
Carolina Spleenwort	*Asplenium heteroresiliens*	E	FSC	Bla
Sandhills Milk-vetch	*Astragalus michauxii*	SC-V	FSC	Bla
Silverling	*Baccharis glomeruliflora*	SC-H	-	Bru
Blue Water-hyssop	*Bacopa caroliniana*	T	-	Bla, Bru, Col
Purple-disk Honeycomb-head	*Balduina atropurpurea*	E	FSC	Bla, Bru
Ware's Hair Sedge	*Bulbostylis warei*	SC-H	-	Bru
Many-flower Grass-pink	*Calopogon multiflorus*	E	FSC	Bru
Long's Bittercress	*Cardamine longii*	SC-V	-	Bla
Cypress Knee Sedge	*Carex decomposita*	SC-V	-	Bru
Kidney Sedge	*Carex reniformis*	T	-	Bla

Common Name	Scientific Name	State Status	Federal Status	County
Nutmeg Hickory	*Carya myristiciformis*	E	-	Bru
Woody Goldenrod	*Chrysoma pauciflosculosa*	E	-	Col
Leconte's Thistle	*Cirsium lecontei*	SC-V	-	Bla, Bru, Col
Georgia Calamint	*Clinopodium georgianum*	E	-	Bru
Carolina Sunrose	*Crocanthemum carolinianum*	E	-	Bru
Pinebarren Sunrose	*Crocanthemum corymbosum*	T	-	Bru
Georgia Sunrose	*Crocanthemum georgianum*	E	-	Bru
Florida Scrub Frostweed	*Crocanthemum nashii*	E	-	Bru
Toothed Flatsedge	*Cyperus dentatus*	SC-H	-	Bru
Leconte's Flatsedge	*Cyperus lecontei*	T	-	Bru
Four-angled Flatsedge	*Cyperus tetragonus*	SC-V	-	Bru
Nerved Witch Grass	*Dichanthelium aciculare ssp. neuranthum*	SC-V	-	Bru
Blue Witch Grass	*Dichanthelium caerulescens*	E	-	Bru
Venus Flytrap	*Dionaea muscipula*	SC-V	FSC	Bla, Bru, Col
Sebastian-bush	*Ditrysinia fruticosa*	SC-V	-	Bru, Col
Threadleaf Sundew	*Drosera filiformis*	SC-V	-	Bla, Bru, Col
Dwarf Burhead	*Echinodorus tenellus*	E	-	Bru
Florida Spikerush	*Eleocharis elongate*	E	-	Bru
Robbins' Spikerush	*Eleocharis robbinsii*	SC-V	-	Bla, Bru
Terrell Grass	*Elymus virginicus var. halophilus*	SC-V	-	Bru
Green Fly Orchid	*Epidendrum magnoliae*	T	-	Bla, Bru, Col
Seven-angled Pipewort	*Eriocaulon aquaticum*	SC-V	-	Bla, Bru, Col
Southern Wild-buckwheat	*Eriogonum tomentosum*	SC-H	-	Bla
Coralbean	*Erythrina herbacea*	E	-	Bru
Limesink Dog-fennel	*Eupatorium leptophyllum*	E	-	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Heartleaf Sandmat	*Euphorbia cordifolia*	T	-	Bla
Harper's Fimbry	*Fimbristylis perpusilla*	T	FSC	Bru, Col
Soft Milk-pea	*Galactia mollis*	T	-	Bru
Swamp Jessamine	*Gelsemium rankinii*	SC-V	-	Bru, Col
Golden Hedge-hyssop	*Gratiola aurea*	SC-V	-	Bla, Bru, Col
Littleleaf Sneezeweed	*Helenium brevifolium*	E	-	Bru
Spring Sneezeweed	*Helenium vernale*	E	-	Bru, Col
Florida Sunflower	*Helianthus floridanus*	T	-	Bla, Bru, Col
Waccamaw River Spiderlily	*Hymenocallis pygmaea*	T	FSC	Bru, Col
Coastal Plain St. John's-wort	*Hypericum brachyphyllum*	SC-V	-	Bru, Col
Pineland St. John's-wort	*Hypericum suffruticosum*	SC-H	-	Bla
Beach Morning-glory	*Ipomoea imperati*	T	-	Bru
Thin-wall Quillwort	*Isoetes microvela*	T	FSC	Bru
Brown Bogbutton	*Lachnocaulon minus*	T	-	Bru
Torrey's Pinweed	*Lechea torreyi*	E	-	Bru
Long-awned Spangletop	*Leptochloa fascicularis var. maritima*	E	-	Bru
Pondberry	*Lindera melissifolia*	E	E	Bla
Yellow-fruited Flax	*Linum floridanum var. chrysocarpum*	T	-	Bru, Col
Small-flowered Hemicarpha	*Lipocarpha micrantha*	SC-H	-	Col
Pondspice	*Litsea aestivalis*	SC-V	FSC	Bla, Bru
Boykin's Lobelia	*Lobelia boykinii*	E	FSC	Bla
Golden-crest	*Lophiola aurea*	E	-	Bru, Col
Lanceleaf Seedbox	*Ludwigia lanceolata*	E	-	Bru
Flaxleaf Seedbox	*Ludwigia linifolia*	T	-	Bru, Col
Raven's Seedbox	*Ludwigia ravenii*	T	FSC	Bru, Col

Common Name	Scientific Name	State Status	Federal Status	County
Globe-fruit Seedbox	*Ludwigia sphaerocarpa*	E	-	Bla, Col
Shrubby Seedbox	*Ludwigia suffruticosa*	T	-	Bla, Bru
Rough-leaf Loosestrife	*Lysimachia asperulifolia*	E	E	Bla, Bru, Col
Carolina Bogmint	*Macbridea caroliniana*	E	FSC	Bla, Bru, Col
Florida Adder's-mouth	*Malaxis spicata*	SC-V	-	Bru
Pinebarren Smokegrass	*Muhlenbergia torreyana*	SC-V	-	Bru
Loose Water-milfoil	*Myriophyllum laxum*	E	FSC	Bru
Leafless Water-milfoil	*Myriophyllum tenellum*	E	-	Bla
Bosc's Bluet	*Oldenlandia boscii*	E	-	Bru, Col
Large-seed Pellitory	*Parietaria praetermissa*	SC-V	-	Bru
Carolina Grass-of-parnassus	*Parnassia caroliniana*	T	FSC	Bla, Bru, Col
Large-leaved Grass-of-parnassus	*Parnassia grandifolia*	T	FSC	Bru, Col
Mudbank Crown Grass	*Paspalum dissectum*	E	-	Bru, Col
Hairy Smartweed	*Persicaria hirsute*	E	-	Bru
A Silkgrass	*Pityopsis graminifolia var. graminifolia*	E	-	Bru, Col
Pineland Plantain	*Plantago sparsiflora*	T	FSC	Bla, Bru, Col
Yellow Fringeless Orchid	*Platanthera integra*	SC-V	-	Bru, Col
Snowy Orchid	*Platanthera nivea*	T	-	Bla, Bru, Col
Hooker's Milkwort	*Polygala hookeri*	SC-V	-	Bru, Col
Seabeach Knotweed	*Polygonum glaucum*	E	-	Bru
Shadow-witch	*Ponthieva racemosa*	T	-	Bru
Spiked Medusa	*Pteroglossaspis ecristata*	E	FSC	Bla
Carolina Bishop-weed	*Ptilimnium ahlesii*	SR-L	FSC	Bru
Ribbed Bishop-weed	*Ptilimnium costatum*	T	-	Bru
Sandhills Pyxie-moss	*Pyxidanthera brevifolia*	SR-L	FSC	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Awned Meadow-beauty	*Rhexia aristosa*	SC-V	FSC	Bla, Bru
Swamp Forest Beaksedge	*Rhynchospora decurrens*	T	FSC	Bru, Col
Harper's Beaksedge	*Rhynchospora harperi*	SC-V	-	Bru
Fragrant Beaksedge	*Rhynchospora odorata*	SC-V	-	Bru
Coastal Beaksedge	*Rhynchospora pleiantha*	T	FSC	Bru
Thorne's Beaksedge	*Rhynchospora thornei*	SC-V	FSC	Bru
Tracy's Beaksedge	*Rhynchospora tracyi*	T	-	Bru
Cabbage Palm	*Sabal palmetto*	T	-	Bru
Plymouth Gentian	*Sabatia kennedyana*	T	-	Bru, Col
Chapman's Arrowhead	*Sagittaria chapmanii*	E	-	Bla, Col
Quillwort Arrowhead	*Sagittaria isoetiformis*	T	-	Bla, Bru, Col
Grassleaf Arrowhead	*Sagittaria weatherbiana*	E	FSC	Bla, Bru, Col
Hooded Pitcher Plant	*Sarracenia minor*	E	-	Bru, Col
Chaffseed	*Schwalbea americana*	E	E	Bla
Drooping Bulrush	*Scirpus lineatus*	T	-	Bru
Baldwin's Nutrush	*Scleria baldwinii*	T	-	Bru, Col
Netted Nutrush	*Scleria reticularis*	T	-	Bru
Sticky Afzelia	*Seymeria pectinata*	SC-H	-	Bru
Tough Bumelia	*Sideroxylon tenax*	T	FSC	Bru
Leavenworth's Goldenrod	*Solidago leavenworthii*	T	-	Col
Twisted-leaf Goldenrod	*Solidago tortifolia*	E	-	Bla, Bru
Spring-flowering Goldenrod	*Solidago verna*	SR-O	FSC	Bla, Bru, Col
Coastal Goldenrod	*Solidago villosicarpa*	E	FSC	Bru
Eaton's Ladies'-tresses	*Spiranthes eatonii*	E	-	Bla, Bru
Lace-lip Ladies'-tresses	*Spiranthes laciniata*	SC-V	-	Bla, Bru, Col
Giant Spiral Orchid	*Spiranthes longilabris*	E	-	Bla, Bru

Common Name	Scientific Name	State Status	Federal Status	County
Wireleaf Dropseed	*Sporobolus teretifolius*	T	FSC	Bru, Col
Saltmarsh Dropseed	*Sporobolus virginicus*	T	-	Bru
Water Dawnflower	*Stylisma aquatic*	E	-	Bru
Pickering's Dawnflower	*Stylisma pickeringii var. pickeringii*	SC-V	FSC	Bla, Bru
Cooley's Meadowrue	*Thalictrum cooleyi*	E	E	Bru, Col
Appalachian Golden-banner	*Thermopsis mollis*	SC-V	-	Col
Dune Bluecurls	*Trichostema sp. 1*	SR-L	FSC	Bru
Chapman's Redtop	*Tridens chapmanii*	T	-	Bla
Horned Bladderwort	*Utricularia cornuta*	T	-	Bru, Col
Dwarf Bladderwort	*Utricularia olivacea*	T	-	Bru
Northeastern Bladderwort	*Utricularia resupinata*	E	-	Col
Cranberry	*Vaccinium macrocarpon*	T	-	Bla, Bru
Florida Yellow-eyed-grass	*Xyris floridana*	T	-	Bru, Col
Acid-swamp Yellow-eyed-grass	*Xyris serotina*	T	-	Col
Pineland Yellow-eyed-grass	*Xyris stricta*	E	-	Bru
Rain Lily	*Zephyranthes simpsonii*	E	FSC	Bru
Vertebrate Animal				
Shortnose Sturgeon	*Acipenser brevirostrum*	E	E	Bla, Bru, Col
American Alligator	*Alligator mississippiensis*	T	T(S/A)	Bla, Bru, Col
Eastern Henslow's Sparrow	*Ammodramus henslowii susurrans*	SC	FSC	Bru, Col
Loggerhead Seaturtle	*Caretta caretta*	T	T	Bru
Atlantic Highfin Carpsucker	*Carpiodes sp. cf. velifer*	SC	-	Bla
Piping Plover	*Charadrius melodus*	T	T	Bru
Wilson's Plover	*Charadrius wilsonia*	SC	-	Bru
Green Seaturtle	*Chelonia mydas*	T	T	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Star-nosed Mole - Coastal Plain population	*Condylura cristata pop. 1*	SC	-	Bla, Bru, Col
Rafinesque's Big-eared Bat - Coastal Plain subspecies	*Corynorhinus rafinesquii macrotis*	SC	FSC	Bla, Bru, Col
Eastern Diamondback Rattlesnake	*Crotalus adamanteus*	E	-	Bla, Bru, Col
Timber Rattlesnake	*Crotalus horridus*	SC	-	Bla, Bru, Col
Thinlip Chub	*Cyprinella sp. 1*	SC	-	Bla
Black-throated Green Warbler - Coastal Plain population	*Dendroica virens waynei*	SR	FSC	Bla, Bru
Leatherback Seaturtle	*Dermochelys coriacea*	E	E	Bru
Little Blue Heron	*Egretta caerulea*	SC	-	Bru, Col
Snowy Egret	*Egretta thula*	SC	-	Bru, Col
Tricolored Heron	*Egretta tricolor*	SC	-	Bru
Carolina Pygmy Sunfish	*Elassoma boehlkei*	T	FSC	Bru, Col
Pinewoods Darter	*Etheostoma mariae*	SC	FSC	Bla
Waccamaw Darter	*Etheostoma perlongum*	T	FSC	Col
Dwarf Salamander	*Eurycea quadridigitata*	SC	-	Bla, Col
Peregrine Falcon	*Falco peregrinus*	E	-	Bru
Waccamaw Killifish	*Fundulus waccamensis*	SC	FSC	Col
Gull-billed Tern	*Gelochelidon nilotica*	T	-	Bru
American Oystercatcher	*Haematopus palliatus*	SC	-	Bru
Bald Eagle	*Haliaeetus leucocephalus*	T	-	Bla, Bru, Col
Four-toed Salamander	*Hemidactylium scutatum*	SC	-	Bla
Least Killifish	*Heterandria formosa*	SC	-	Bru
Southern Hognose Snake	*Heterodon simus*	SC	FSC	Bla, Bru
Least Bittern	*Ixobrychus exilis*	SC	-	Bru
Loggerhead Shrike	*Lanius ludovicianus*	SC	-	Bla, Bru, Col
Northern Yellow Bat	*Lasiurus intermedius*	SC	-	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Kemp's Ridley Seaturtle	*Lepidochelys kempii*	E	E	Bru
Diamondback Terrapin	*Malaclemys terrapin*	SC	FSC, in part	Bru
Waccamaw Silverside	*Menidia extensa*	T	T	Col
Eastern Coral Snake	*Micrurus fulvius*	E	-	Bla, Bru
Wood Stork	*Mycteria americana*	E	E	Bru, Col
Southeastern Myotis	*Myotis austroriparius*	SC	FSC	Bla, Col
Eastern Woodrat - Coastal Plain population	*Neotoma floridana floridana*	T	-	Bru
Broadtail Madtom	*Noturus sp. 2*	SC	FSC	Bla, Bru, Col
Mimic Glass Lizard	*Ophisaurus mimicus*	SC	FSC	Bla, Bru, Col
Eastern Painted Bunting	*Passerina ciris ciris*	SC	FSC	Bru
Bachman's Sparrow	*Peucaea aestivalis*	SC	FSC	Bla, Bru, Col
Red-cockaded Woodpecker	*Picoides borealis*	E	E	Bla, Bru, Col
Northern Pine Snake	*Pituophis melanoleucus melanoleucus*	SC	FSC	Bru
Glossy Ibis	*Plegadis falcinellus*	SC	-	Bru
Carolina Gopher Frog	*Rana capito*	T	FSC	Bla, Bru
Black Skimmer	*Rynchops niger*	SC	-	Bru
Pigmy Rattlesnake	*Sistrurus miliarius*	SC	-	Bla, Bru
Least Tern	*Sternula antillarum*	SC	-	Bru
West Indian Manatee	*Trichechus manatus*	E	E	Bru

Explanation of Status Codes

The following tables include definitions of status codes for rare and protected species in the Study Area. All definitions are from the North Carolina Natural Heritage Program (NCNHP, 2011).

Table H-4. State Protection Status Codes for Animal Species

Code	Status	Definition
E	Endangered	Any native or once-native species of wild animal whose continued existence as a viable component of the State's fauna is determined by the Wildlife Resources Commission to be in jeopardy or any species of wild animal determined to be an 'endangered species' pursuant to the Endangered Species Act. (Article 25 of Chapter 113 of the General Statutes; 1987).
T	Threatened	Any native or once-native species of wild animal which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, or one that is designated as a threatened species pursuant to the Endangered Species Act. (Article 25 of Chapter 113 of the General Statutes; 1987).
SC	Special Concern	Any species of wild animal native or once-native to North Carolina which is determined by the Wildlife Resources Commission to require monitoring but which may be taken under regulations adopted under the provisions of this Article. (Article 25 of Chapter 113 of the General Statutes; 1987).
SR	Significantly Rare	Any species which has not been listed by the N.C. Wildlife Resources Commission as an Endangered, Threatened, or Special Concern species, but which exists in the State in small numbers and has been determined by the N.C. Natural Heritage Program to need monitoring. (This is a N.C. Natural Heritage Program designation.) Significantly Rare species include peripheral species, whereby North Carolina lies at the periphery of the species' range (such as Hermit Thrush). The designation also includes marine and estuarine fishes identified as "Vulnerable" by the N.C. State Museum of Biological Sciences (Ross et al. 1988, Endangered, Threatened, and Rare Fauna of North Carolina. Part II. A Reevaluation of the Marine and Estuarine Fishes).

Table H-5. State Protection Status Codes for Plant Species

Code	Status	Definition
E	Endangered	Any species or higher taxon of plant whose continued existence as a viable component of the State's flora is determined to be in jeopardy" (GS 19B 106: 202.12). Endangered species may not be removed from the wild except when a permit is obtained for research, propagation, or rescue which will enhance the survival of the species.
T	Threatened	Any resident species of plant which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (GS 19B 106:202.12). Regulations are the same as for Endangered species.
SC	Special Concern	Any species of plant in North Carolina which requires monitoring but which may be collected and sold under regulations adopted under the provisions of [the Plant Protection and Conservation Act]" (GS 19B 106:202.12).
SC-V	Special Concern - Vulnerable	Any species or higher taxon of plant that occurred in North Carolina at one time, but for which all known populations are currently considered to be either historical or extirpated (02 NCAC 48F .0401).
SC-H	Special Concern - Historical	Any species or higher taxon of plant that occurred in North Carolina at one time, but for which all known populations are currently considered to be either historical or extirpated (02 NCAC 48F .0401).
SR	Significantly Rare	Species which are rare in North Carolina, generally with 1-100 populations in the state, frequently substantially reduced in numbers by habitat destruction (and sometimes also by direct exploitation or disease).
SR-L	Limited	The range of the species is limited to North Carolina and adjacent states (endemic or near endemic). These are species which may have 20-50 populations in North Carolina, but fewer than 100 populations rangewide. The preponderance of their distribution is in North Carolina and their fate depends largely on conservation here.
SR-T	Throughout	The species is rare throughout its range (fewer than 100 populations total).
SR-D	Disjunct	The species is disjunct to NC from a main range in a different part of the country or world.

Code	Status	Definition
SR-P	Peripheral	The species is at the periphery of its range in North Carolina. These species are generally more common somewhere else in their ranges, occurring in North Carolina peripherally to their main ranges, mostly in habitats which are unusual in North Carolina.
SR-O	Other	The range of the species is sporadic or cannot be described by the other Significantly Rare categories.

Table H-6. Federal Protection Status Codes

Code	Status	Definition
E	Endangered	A taxon "which is in danger of extinction throughout all or a significant portion of its range" (Endangered Species Act, Section 3).
T	Threatened	A taxon "which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (Endangered Species Act, Section 3).
T(S/A)	Threatened due to Similarity of Appearance	"Section 4 (e) of the [Endangered Species] Act authorizes the treatment of a species (subspecies or population segment) as endangered or threatened even though it is not otherwise listed as endangered or threatened if -- (a) the species so closely resembles in appearance an endangered or threatened species that enforcement personnel would have substantial difficulty in differentiating between the listed and unlisted species; (b) the effect of this substantial difficulty is an additional threat to an endangered or threatened species; and (c) such treatment of an unlisted species will substantially facilitate the enforcement and further the policy of the Act." (Federal Register, November 4, 1997). [The American Alligator is listed as T (S/A) due to Similarity of Appearance with other rare crocodilians, and the southern population of the Bog Turtle is listed as T(S/A) due to Similarity of Appearance with the northern population of the Bog Turtle (which is federally listed as Threatened and which does not occur in North Carolina).]

Code	Status	Definition
C	Candidate	Taxa for which the [Fish and Wildlife] Service has on file enough substantial information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened. Proposed rules have not yet been issued because this action is precluded at present by other listing activity. Development and publication of proposed rules on these taxa are anticipated. The Service encourages State and other Federal agencies as well as other affected parties to give consideration to these taxa in environmental planning." (Federal Register, February 28, 1996). Taxa formerly considered as 'Category 1' are now considered as 'Candidate'. FSC Federal Species of Concern (also known as Species at Risk")
E, XN	Endangered, nonessential experimental population.	The Endangered Species Act permits the reintroduction of endangered animals as "nonessential experimental" populations. Such populations, considered nonessential to the survival of the species, are managed with fewer restrictions than populations listed as endangered. "Section 10 (j) of the Endangered Species Act of 1973, as amended, provides for the designation of introduced populations of federally listed species as nonessential experimental. This designation allows for greater flexibility in the management of these populations by local, state, and Federal agencies. Specifically, the requirement for Federal agencies to avoid jeopardizing these populations by their actions is eliminated and allowances for taking the species are broadened." (U.S. Fish and Wildlife Service, 1995).

Appendix I USGS Communication

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From: jcweaver@usgs.gov [mailto:jcweaver@usgs.gov]
Sent: Wednesday, April 04, 2012 9:30 AM
To: Moore, Emilie
Cc: archive_ask@usgs.gov; jcweaver@usgs.gov
Subject: Re: Low Flow Request,7Q10 Values

Ms. Moore,

In response to your inquiry about the 7Q10 low-flow discharge estimates for two streamgages (USGS Sta's 02105769 and 02109500), a check of the low-flow files here at the USGS North Carolina Water Science Center indicates the following most recent and provisional 7Q10 low-flow discharge estimates:

USGS Sta. 02105769 Cape Fear River at Lock #1 near Kelly, NC
(http://wdr.water.usgs.gov/wy2011/pdfs/02105769.2011.pdf)
Drainage area: 5,255 sqmi
Period of record: July 1969 to current year

7Q10 = ~ 500 cubic feet per second (cfs)
Period of analysis: 1982-2009 climatic years, reflecting the period of regulation by Jordan Lake

Please note that trends have been noted in the annual minimum 7-day average discharges for the period of analysis at this gage, attributed to a combination of the recent droughts on flows in the Cape Fear River and the regulated flow conditions from Jordan Lake during this period.

The most recent published 7Q10 discharge for this streamgage is available in Table 7 of the USGS report available at http://nc.water.usgs.gov/reports/wri014094/. Please note the published 7Q10 discharge (which is about 40 percent higher than the above provisional value) is based on records in the 1982-97 climatic years prior to the recent droughts that have affected streams in North Carolina.

USGS Sta. 02109500 Waccamaw River at Freeland, NC
(http://wdr.water.usgs.gov/wy2011/pdfs/02109500.2011.pdf)
Drainage area: 680 sqmi
Period of record: July 1939 to current year

7Q10 = 1.5 cfs
Period of analysis: 1940-2010 climatic years

Note: The climatic year is the standard annual period used for low-flow analyses at continuous-record gaging stations and is from April 1 through March 31, designated by the year in which the period begins. For example, the 2010 climatic year is from April 1, 2010, through March 31, 2011.

This information is considered preliminary and subject to revision pending further analysis as further data becomes available, and is made available through our cooperative program of water-resources investigations with the North Carolina Department of Environment and Natural Resources.

Hope this information is helpful.

Thank you.

Curtis Weaver

****

J. Curtis Weaver, Hydrologist, PE
USGS North Carolina Water Science Center
3916 Sunset Ridge Road
Raleigh, NC 27607

Phone: (919) 571-4043 // Fax: (919) 571-4041
Mobile: (919) 830-6235

E-mail address -- jcweaver@usgs.gov
Internet address -- http://nc.water.usgs.gov/
****

Appendix J Flow Duration Curves

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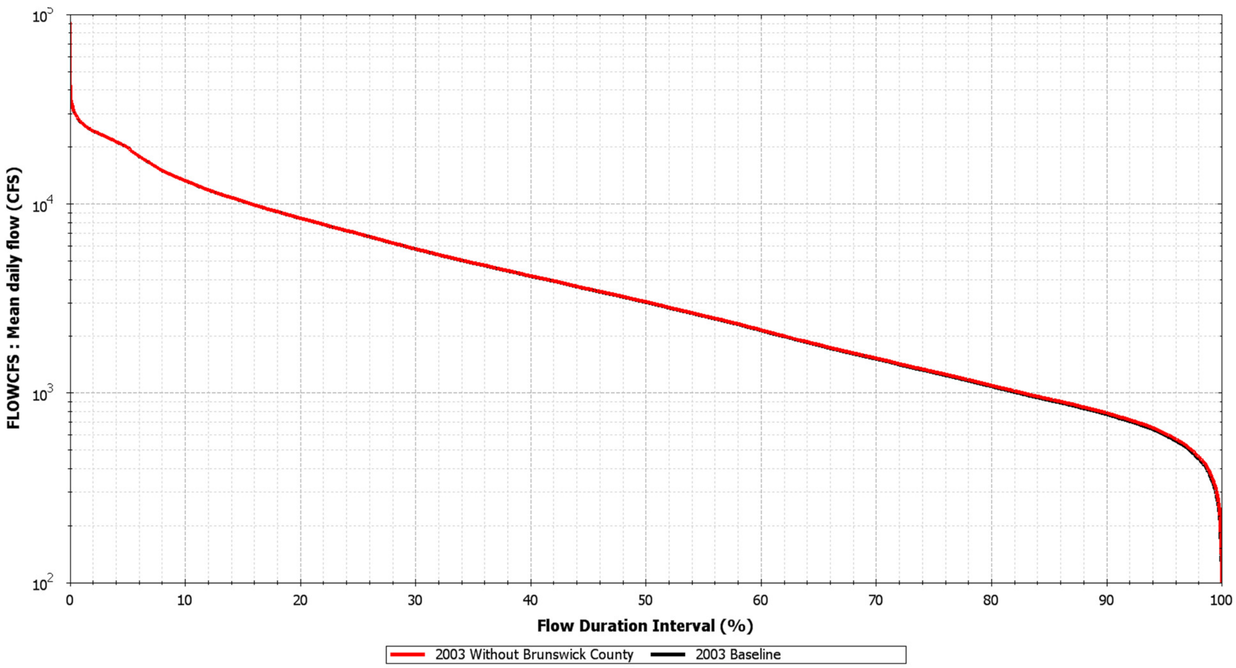

Figure J-1. Full Flow Duration Curve of 2003 Simulated Flow at Lock and Dam #1 With (Black) and Without (Red) Additional Brunswick County Withdrawal.

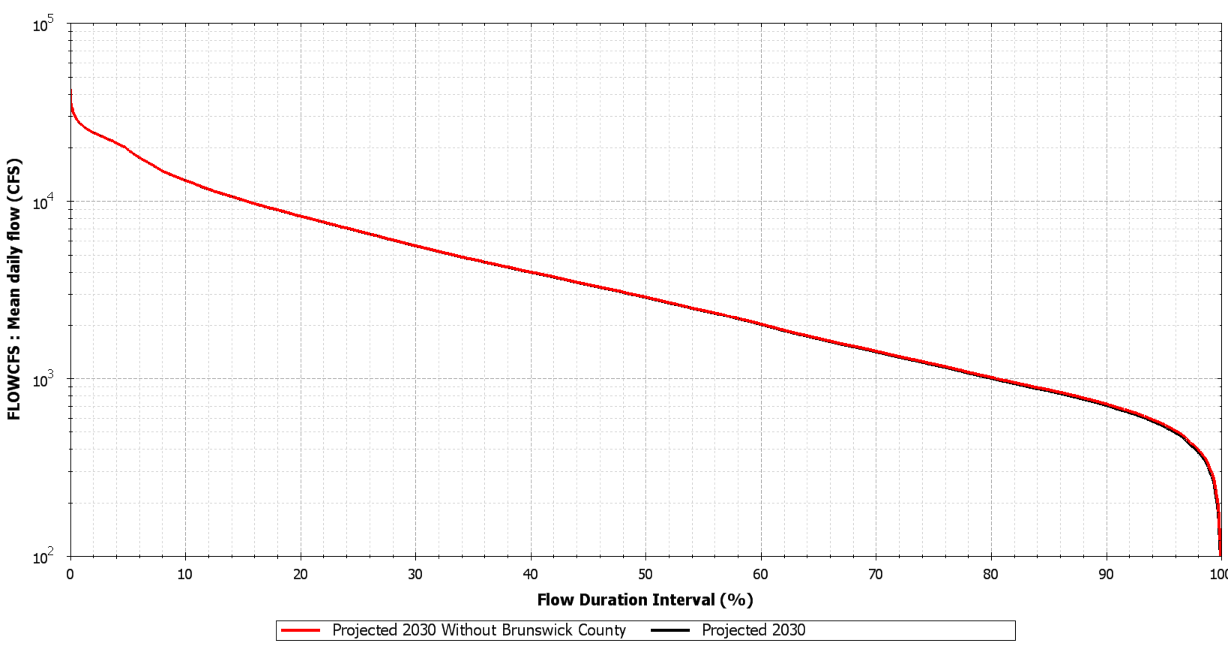

Figure J-2. Full Flow Duration Curve of 2030 Simulated Flow at Lock and Dam #1 With (Black) and Without (Red) Additional Brunswick County Withdrawal.

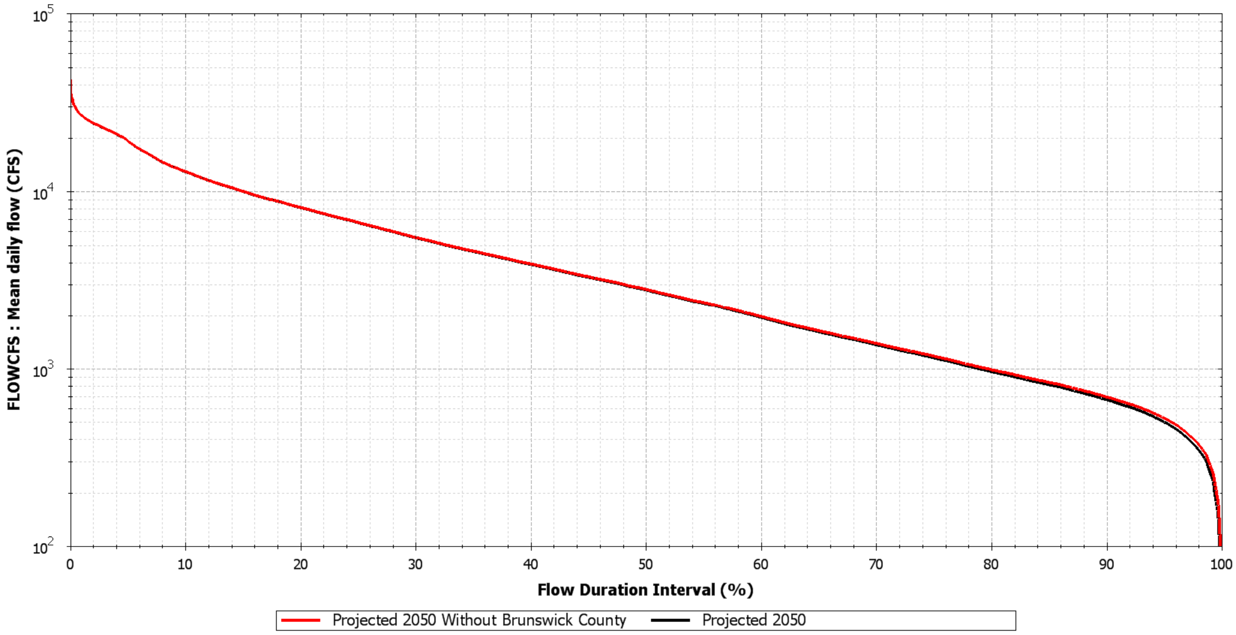

Figure J-3. Full Flow Duration Curve of 2050 Simulated Flow at Lock and Dam #1 With (Black) and Without (Red) Additional Brunswick County Withdrawal.

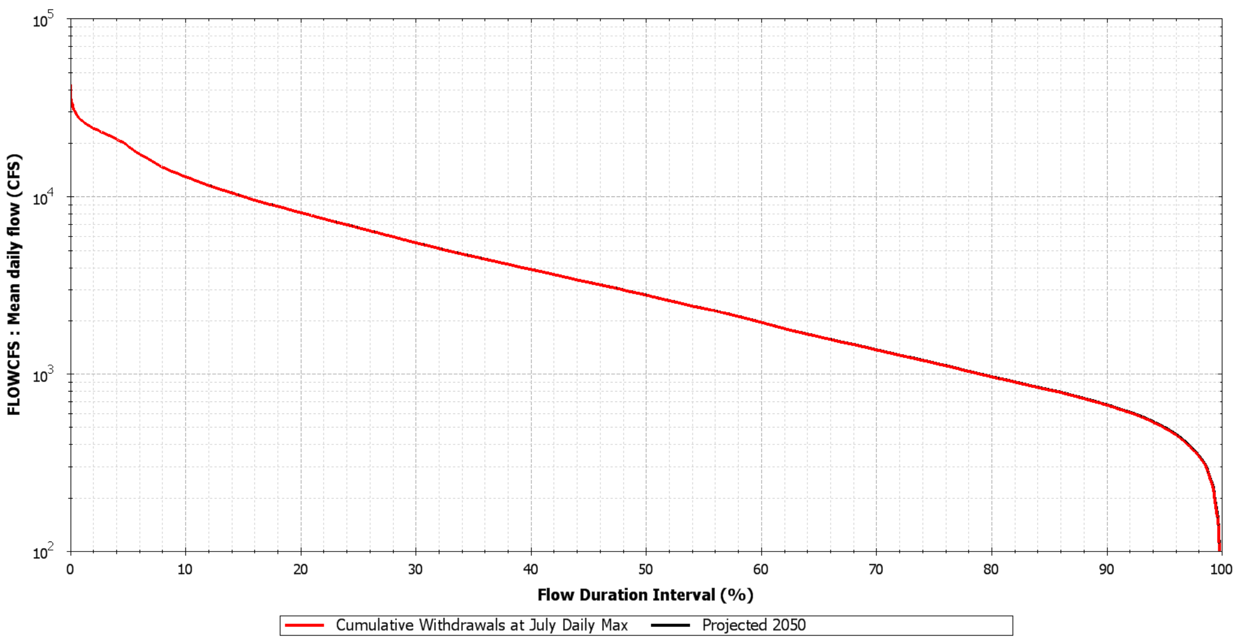

Figure J-4. Full Flow Duration Curve of 2050 Simulated Flow at Lock and Dam #1 with Average July Withdrawal (Black) and with Maximum July Withdrawal (Red)

Appendix K NCDENR Review Comments

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NCDENR
North Carolina Department of Environment and Natural Resources

Pat McCrory
Governor

John E. Skvarla, III
Secretary

MEMORANDUM

TO: Toya F. Ogallo, Environmental Engineer
River Basin Management Section
Division of Water Resources

FROM: Lyn Hardison Lyn
Division of Environmental Assistance and Outreach
Permit Assistance & Project Review Coordinator

RE: Draft Environmental Assessment
Brunswick County Interbasin Transfer – Expansion of the Northwest Water Treatment plant to meet future water demands
Brunswick County
DENR # 1582

Date: February 26, 2013

The Department of Environment and Natural Resources has reviewed the proposal for the referenced project. Based on the information provided, our agencies have identified permits that may be required and mentioned several concerns of impact this project may have on the natural and aquatic resources and the addition of more water chemistry information to the report.

Please forward this memorandum and the agencies comments to the applicant so the agencies concerns can be addressed and the necessary adjustments can be made to the draft environmental assessment.

The Department encourages the applicant to continue communicating with the agencies prior to the completion of the report and moving forward with the projects.

Thank you for the opportunity to respond.

Attachment

1601 Mail Service Center, Raleigh, North Carolina 27699-1601
Phone: 919-707-8600 \ Internet: www.ncdenr.gov

RECEIVED
JAN 22 2013

Department of Environment and Natural Resources
Project Review Form

Project Number	County	Date Received	Date Response Due
# 1582	Brunswick	01/17/2013	2/7/2013
Draft Environmental Assessment - Brunswick County Interbasin Transfer - Expansion of the Northwest Water Treatment plant to meet the future water demands			

This project is being reviewed as indicated below:

Regional Office	Sections	In-House Review	
☐ Asheville	☒ Air DC - See Comment	☒ Marine Fisheries	☐ Waste Mgmt
☐ Fayetteville	☒ Water JHG 01-28-13 no comment	☒ Coastal Management	☐ Air Quality
☐ Mooresville	☒ Aquifer Protection ver 02/01/2013	☐ Water Resources Management	
☐ Raleigh	☒ Land Quality Engineer D 02/04/2013	☒ Water Supply Section	
☐ Washington	☒ UST	☒ Parks & Recreation	
☒ Wilmington		☒ Water Quality	
☐ Winston-Salem		☐ Water Quality (DOT)	
		☒ Wildlife Maria Dunn	
		☐ Wildlife (DOT) _____	

	Date:	In-House Reviewer/Agency:

Response (check all applicable)

☐ No objection to project as proposed ☐ No comment

☐ Insufficient information to complete review ☐ Other (specify or attach comments)

① Air - DC. This site may need to obtain Air Quality prm. Many Water Treatment plants in Wilm do have DAQ permits.

Call Dean Carroll (910) 796-7242

RETURN TO:
Lyn Hardison – Lyn.Hardison@ncdenr.gov, 252-948-3842
943 Washington Square Mall
Washington N C 27889
Courier No. 16-04-01

State of North Carolina
Department of Environment and Natural Resources

Reviewing Office: Wilmington Regional Office WiRO

INTERGOVERNMENTAL REVIEW - PROJECT COMMENTS

Project Number: 1582 Due Date: 2/7/13

After review of this project it has been determined that the ENR permit(s) and/or approvals indicated may need to be obtained in order for this project to comply with North Carolina Law. Questions regarding these permits should be addressed to the Regional Office indicated on the reverse of the form. All applications, information and guidelines relative to these plans and permits arc available from the same Regional Office.

	PERMITS	SPECIAL APPLICATION PROCEDURES or REQUIREMENTS	Normal Process Time (statutory time limit)
☐	Permit to construct & operate wastewater treatment facilities, sewer system extensions & sewer systems not discharging into state surface waters.	Application 90 days before begin construction or award of construction contracts. On-site inspection. Post-application technical conference usual.	30 days (90 days)
☐	NPDES - permit to discharge into surface water and/or permit to operate and construct wastewater facilities discharging into state surface waters.	Application 180 days before begin activity. On-site inspection. Pre-application conference usual. Additionally, obtain permit to construct wastewater treatment facility-granted after NPDES. Reply time, 30 days after receipt of plans or issue of NPDES permit-whichever is later.	90-120 days (N/A)
☐	Water Use Permit	Pre-application technical conference usually necessary	30 days (N/A)
☒	Well Construction Permit if required	Complete application must be received and permit issued prior to the installation of a well.	7 days (15 days)
☐	Dredge and Fill Permit	Application copy must be served on each adjacent riparian property owner. On-site inspection. Pre-application conference usual. Filling may require Easement to Fill from N.C. Department of Administration and Federal Dredge and Fill Permit.	55 days (90 days)
☐	Permit to construct & operate Air Pollution Abatement facilities and/or Emission Sources as per 15 A NCAC (2Q.O100 thru 2Q.0300)	Application must be submitted and permit received prior to construction and operation of the source. If a permit is required in an area without local zoning, then there are additional requirements and timelines (2Q.0113).	90 days
☐	Permit to construct & operate Transportation Facility as per 15 A NCAC (2D.0800, 2Q.0601)	Application must be submitted at least 90 days prior to construction or modification of the source.	90 days
☐	Any open burning associated with subject proposal must be in compliance with 15 A NCAC 2D.1900	N/A	60 days (90 days)
☐	Demolition or renovations of structures containing asbestos material must be in compliance with 15 A NCAC 20.1110 (a) (1) which requires notification and removal prior to demolition. Contact Asbestos Control Group 919-707-5950.		
☐	Complex Source Permit required under 15 A NCAC 2D.0800		
☒	The Sedimentation Pollution Control Act of 1973 must be properly addressed for any land disturbing activity. An erosion & sedimentation control plan will be required if one or more acres to be disturbed. Plan filed with proper Regional Office (Land Quality Section) At least 30 days before beginning activity. A fee of **$65** for the first acre or any part of an acre. An express review option is available with additional fees.		20 days (30 days)
☐	Sedimentation and erosion control must be addressed in accordance with NCDOT's approved program. Particular attention should be given to design and installation of appropriate perimeter sediment trapping devices as well as stable stormwater conveyances and outlets.		(30 days)
☐	Mining Permit	On-site inspection usual. Surety bond filed with ENR Bond amount varies with type mine and number of acres of affected land. Any arc mined greater than one acre must be permitted. The appropriate bond must be received before the permit can be issued.	30 days (60 days)
☐	North Carolina Burning permit	On-site inspection by N.C. Division Forest Resources if permit exceeds 4 days	1 day (N/A)
☐	Special Ground Clearance Burning Permit - 22 counties in coastal N.C. with organic soils	On-site inspection by N.C. Division Forest Resources required "if more than five acres of ground clearing activities are involved. Inspections should be requested at least ten days before actual bum is planned."	1 day (N/A)
☐	Oil Refining Facilities	N/A	90-120 days (N/A)
☐	Dam Safety Permit	If permit required, application 60 days before begin construction. Applicant must hire N.C. qualified engineer to: prepare plans, inspect construction. certify construction is according to ENR approved plans. May also require permit under mosquito control program. And a 404 permit from Corps of Engineers. An inspection of site is necessary to verify Hazard Classification. A minimum fee of $200.00 must accompany the application. An additional processing fee based on a percentage or the total project cost will be required upon completion.	30 days (60 days)

	PERMITS	SPECIAL APPLICATION PROCEDURES or REQUIREMENTS	Normal Process Time (statutory time limit)
☐	Permit to drill exploratory oil or gas well	File surety bond of $5,000 with ENR running to State of NC conditional that any well opened by drill operator shall, upon abandonment, be plugged according to ENR rules and regulations.	10 days N/A
☐	Geophysical Exploration Permit	Application filed with ENR at least 10 days prior to issue of permit. Application by letter. No standard application form.	10 days N/A
☐	State Lakes Construction Permit	Application fees based on structure size is charged. Must include descriptions & drawings of structure & proof of ownership of riparian property.	15-20 days N/A
☐	401 Water Quality Certification	N/A	60 days (130 days)
☐	CAMA Permit for MAJOR development	$250.00 fee must accompany application	55 days (150 days)
☐	CAMA Permit for MINOR development	$50.00 fee must accompany application	22 days (25 days)
☐	Several geodetic monuments are located in or near the project area. If any monument needs to be moved or destroyed, please notify: N.C. Geodetic Survey, Box 27687 Raleigh, NC 27611		
☐	Abandonment of any wells, if required must be in accordance with Title 15A. Subchapter 2C.0100.		
☐	Notification of the proper regional office is requested if "orphan" underground storage tanks (USTS) are discovered during any excavation operation.		
☐	Compliance with 15A NCAC 2H 1000 (Coastal Stormwater Rules) is required.		45 days (N/A)
☐	Tar Pamlico or Neuse Riparian Buffer Rules required.		

* Other comments (attach additional pages as necessary, being certain to cite comment authority)

REGIONAL OFFICES

Questions regarding these permits should be addressed to the Regional Office marked below.

☐ **Asheville Regional Office**
2090 US Highway 70
Swannanoa, NC 28778
(828) 296-4500

☐ **Mooresville Regional Office**
610 East Center Avenue, Suite 301
Mooresville, NC 28115
(704) 663-1699

☐ **Wilmington Regional Office**
127 Cardinal Drive Extension
Wilmington, NC 28405
(910) 796-7215

☐ **Fayetteville Regional Office**
225 North Green Street, Suite 714
Fayetteville, NC 28301-5043
(910) 433-3300

☐ **Raleigh Regional Office**
3800 Barrett Drive, Suite 101
Raleigh, NC 27609
(919) 791-4200

☐ **Winston-Salem Regional Office**
585 Waughtown Street
Winston-Salem, NC 27107
(336) 771-5000

☐ **Washington Regional Office**
943 Washington Square Mall
Washington, NC 27889
(252) 946-6481

North Carolina Wildlife Resources Commission

Gordon S. Myers, Executive Director

MEMORANDUM

TO: Lyn Hardison, Environmental Assistance Coordinator
Division of Environmental Assistance & Outreach

FROM: Maria T. Dunn, Northeast Coastal Region Coordinator Maria T. Dunn
Habitat Conservation Program

DATE: February 25, 2013

SUBJECT: Draft Environmental Assessment – Brunswick County Interbasin Transfer – Expansion of the Northwest Water Treatment Plant, Brunswick County, North Carolina.
OLIA No. 1582

Biologists with the North Carolina Wildlife Resources Commission (NCWRC) reviewed the draft environmental assessment (DEA) with regard to impacts of the project on fish and wildlife resources. Our comments are provided in accordance with the North Carolina Environmental Policy Act (G.S. 113A-1 et seq., as amended; 1 NCAC-25), provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), the Coastal Area Management Act (G.S. 113A-100 through 113A-128), and Sections 401 and 404 of the Clean Water Act (as amended).

Brunswick County proposes to expand the Northwest Water Treatment Plant (WTP) by withdrawing an additional 18.3 MGD of water from the Cape Fear River upstream of Lock & Dam 1. This increase includes a 10.5 MGD grandfathered transfer as well as a 7.8 MGD overage that necessitates the Inter Basin Transfer (IBT) due to the distributed customers in the Shallotte River Basin and Waccamaw IBT River Basin. This increase is projected to meet demands through approximately 2042. Several alternatives including No Additional IBT Alternative, the preferred Northwest WTP expansion, New Surface WTP, Purchase Water from Existing Utility in Receiving Basin, Expanded or New Groundwater WTP, and Seawater Desalination WTP were considered.

The Cape Fear River upstream of Lock & Dam 1 to Buckhorn Dam, through Chatham, Lee, Bladen, Harnett, and Cumberland counties is designated a Primary Nursery Area (PNA) by the NC Wildlife Resources Commission. PNAs are crucial habitat areas due to the opportunities provided for spawning adults as well as egg, larvae, and juvenile fish. This is especially true for anadromous fish, such as striped bass (*Morone saxatilis*), blueback herring (*Alosa aestivalis*) and numerous shad species. These species are of special importance due to their sportfish standing as well as the depressed populations of the blueback herring and its potential "Endangered" listing by the National Marine Fisheries Service (NMFS) under the Endangered Species Act. To enhance habitat availability and opportunities, significant

Mailing Address: Division of Inland Fisheries • 1721 Mail Service Center • Raleigh, NC 27699-1721
Telephone: (919) 707-0220 • **Fax:** (919) 707-0028

efforts have created fish passage above Lock & Dam 1. This passage is to be completed March 2013 by the US Army Corps of Engineers and will greatly increase spawning opportunities for anadromous fish. Increased withdrawals from the Cape Fear River should not compromise these efforts directly or indirectly. Direct impacts to these species would include compromising the Lock & Dam 1 passage structure as well as entrainment and impingement of eggs, larvae, and juvenile fish at the intake site. To minimize this impact, any intake should be outfitted with a screen system that includes a maximum intake velocity of 0.25 ft/sec through a mesh or slotted surface with openings not to exceed 1.0 millimeter. Methodology to clean the screen system must also be designed to minimize impacts to eggs, larvae, and juvenile fish. Indirect impacts of the proposed increased withdrawal include reduced habitat opportunities due to the hydrologic reduction of riparian wetlands or changes in instream river design, increased salinities downstream the intake due to reduced freshwater input, and reduced river flow. These concerns should be addressed prior to implementation of the IBT to help alleviate impact concerns to aquatic resources.

We appreciate the opportunity to provide comments on this DEA. If you need further assistance, additional information, or if details of the project change as it progresses, please contact me at (252) 948-3916.

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Water Quality

Pat McCrory
Governor

Charles Wakild, P. E.
Director

John Skvarla
Secretary

February 14, 2013

MEMORANDUM

TO: Lyn Hardison, Environmental Assistance Coordinator, DENR

THRU: Jeff Manning, Basinwide Planning Unit, DWQ

FROM: Hannah Headrick, SEPA Coordinator, DWQ

SUBJECT: Brunswick County – IBT to allow for expansion of Northwest Water Treatment Plant DWQ#14464; DENR#1582

The Division of Water Quality (DWQ) has reviewed the subject document prepared by Brunswick County to support an interbasin transfer (IBT) certificate for transporting a maximum of 18.3 million gallons per day (MGD) from the Cape Fear IBT River Basin to the Shallotte IBT River Basin that will allow the County to meet its future potable water demand by expanding the Northwest Water Treatment Plant. The following concerns should be addressed in an amended EA:

1. Section 2.4.3 - Existing Surface Water Quality: The following information should be added to Table 20:
   - Cape Fear River AU# 18-(71)a – From upstream of the mouth of Toomers Creek to a line across the river between Lilliput Creek and Snows Cut – is also impaired for Turbidity.
   - Cape Fear River AU # 18-(87.5)b1b – Prohibited area near Southport – is missing from table 20. It is impaired due to "loss of use" for Shellfish growing area – Prohibited.
2. Section 2.4.4 - Total Maximum Daily Load (TMDL): Discussion of the Mercury TMDL should be updated to include information on the EPA-approved (October 12, 2012) Mercury TMDL. Please refer to this website: http://portal.ncdenr.org/web/wq/ps/mtu/tmdl/tmdls/mercury.

If you have any questions about these comments, please contact me at (919) 807-6434 or hannah.headrick@ncdenr.gov. Thank you.

Ecc: Jim Gregson – WiRO

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Marine Fisheries

Pat McCrory
Governor

Dr. Louis B. Daniel III
Director

John E. Skvarla, III
Secretary

MEMORANDUM:

TO: Lynn Hardison, DENR Permits Coordinator

THROUGH: Anne Deaton, DMF Habitat Section Chief

FROM: Jessi Baker, DMF Marine Biologist

SUBJECT: Brunswick County Interbasin Transfer – Draft EA

DATE: February 26, 2013

The North Carolina Division of Marine Fisheries (DMF) submits the following comments pursuant to General Statute 113-131. DMF has reviewed the Brunswick County Interbasin Transfer Environmental Assessment from Brunswick County. They propose to increase the transfer of water withdrawn from the Cape Fear River at Lock and Dam #1 from the Cape Fear IBT River Basin to the Shallotte IBT River Basin by 7.8 MGD. To accomplish this, Brunswick County will also need to expand the Northwest WTP and ultimately increase water withdrawals at Lock and Dam #1.

Recently, a Rock Arch Rapids fish passage structure has been constructed at Lock and Dam #1 due to concerns about anadromous fish migration up the Cape Fear River beyond the dam. DMF has concerns regarding how additional withdrawals at this location will impact water flows over the rapids and downstream of the dam, and ultimately, fish passage. DMF requests that Brunswick County address fish passage during this process. DMF will also have concerns regarding the design and construction of the intake structure and impacts on fish impingement and entrainment.

DMF recognizes that the WTP expansion EA may be the more appropriate location to discuss these issues and will take the opportunity to comment during the next phase when more details are provided. Please feel free to contact Jessi Baker at (252) 808-8064 or jessi.baker@ncdenr.gov if you have any further questions or concerns.

3441 Arendell Street, P.O. Box 769, Morehead City, North Carolina 28557
Phone: 252-726-7021 \ FAX: 252-726-0254 \ Internet: portal.ncdenr.org/web/mf

Kennedy, Todd

From: Kennedy, Todd
Sent: Friday, March 22, 2013 4:36 PM
To: 'jessi.baker@ncdenr.gov'
Cc: 'Anne.Deaton@ncdenr.gov'; Ogallo, Toya
Subject: Comments on Brunswick County IBT EA
Attachments: Brunswick IBT DENR 1582_NCDMF_02-26-13.pdf

Dear Jessi,

We received your comments on the Environmental Assessment for Brunswick County Interbasin Transfer (December 2012). A copy of those comments is attached.

In these comments you request that the following issues be addressed: (1) potential impacts of the withdrawals on the newly constructed fish passage at Lock and Dam 1, and (2) potential impacts from the water supply intake. Our responses to each of these comments are provided below.

1. **Potential impacts of the IBT on the newly constructed fish passage at Lock and Dam 1** - A new fish passage structure (FPS) at Lock and Dam #1 on the Cape Fear River was completed in November 2012 by the US Army Corps of Engineers. The Basis of Design report provided the design, associated analyses (e.g., hydrologic and hydraulic analysis), and the biological rationale for the project (US Army Corps of Engineers, 2010). The rock arch rapids design is a type of rock ramp that provides fish passage over low-head dams by emulation of natural rapids and facilitation of fish hydrodynamics. The FPS alternative was chosen over others including removal of the dam in part due to the need to protect the water supply intake structures located just upstream (e.g., LCFWSA intake).

   The FPS is designed to increase fish passage and increase spawning opportunities for anadromous fish. Spawning migration in the Atlantic coastal region occurs primarily during periods of increased but moderate river flow and temperature such as late winter and spring (NOAA, 2013). The design of the FPS accounts for flows during this period including an assumed “spawning flow” of 5,000 cfs, a flow level near the mean flow for the river (5,063 cfs based on gage data from 1982-2012; USGS Water Data Report), and typical spring flows during March and April which are somewhat greater (i.e., up to about 9,000 cfs; US Army Corps of Engineers, 2010). Maximum, cumulative withdrawals for 2050 (164 cfs; incorporates all LCFWSA customers including Brunswick) just above the FPS during these periods represent 2 to 3 percent of river flows. Maximum withdrawal is more likely to occur in the summer given seasonal water use patterns; therefore, water withdrawals from the river during the spawning migration would represent an even smaller proportion of flow (as would considering only Brunswick’s portion). As such the impact of withdrawals on FPS function would be insignificant.

2. **Potential impacts from the water supply intake** - The Lower Cape Fear Water and Sewer Authority (LCFWSA) supplies raw water to Brunswick County’s Northwest WTP from its intake on the Cape Fear River above Lock and Dam #1. The County is one of several LCFWSA customers receiving a portion of the withdrawal. A FONSI for expansion of the LCFWSA’s intake to accommodate a 96-MGD withdrawal above Lock and Dam #1 was issued by NCDEH in 2009. *The new LCFWSA intake has now been constructed and is in operation*. As discussed in the EA to support that project prepared by McKim and Creed for LCFWSA, the three new intake screens manufactured by Johnson Screens are connected to a new 60 inch intake pipeline. The configuration of the new, additional intake is “identical in form and operation” to the existing intake pipe and no known impacts to aquatic species from the previous configuration have been reported according to the EA approved by NCDEH. Further from the EA, the mesh size (slot size is approximately 0.1118 inches) was designed to prevent entrainment of fish including eggs and larvae, and velocity through the intake screens will not exceed 0.5 feet per second. That EA contains correspondence with Vann Stancil of WRC.

U.S. Army Corps of Engineers. 2010. Fish Passage at Lock and Dam No. 1, Cape Fear River, Bladen County, North Carolina. 100% Design Submittal. Basis of Design. Prepared by SEPI Engineering and Construction and Tetra Tech, Inc.
NOAA (National Oceanic and Atmospheric Administraion). 2013. Diadromous Fish Passage: A Primer on Technology, Planning, and Design for the Atlantic and Gulf Coasts. National Marine Fisheries Service. Accessed March 20, 2013. http://www.nero.noaa.gov/hcd/docs/FishPassagePrimer.pdf.

We will include this information in the next draft of the EA.

Please let me know at your earliest convenience if these responses address your concerns. Also, I am happy and available to discuss these issues further over the phone if that would be helpful.

Kind Regards,

Todd

J. Todd Kennedy, PH, QEP | **Associate Director**
Direct: 919.485.2067 | Main: 919.485.8278 | Fax: 919.485.8280
todd.kennedy@tetratech.com

Tetra Tech | **DIV-WTR, Water Resources Group**
P.O. Box 14409 | 1 Park Drive, Suite 200 | Research Triangle Park, NC 27709 | www.tetratech.com

Kennedy, Todd

From: Kennedy, Todd
Sent: Wednesday, March 20, 2013 11:49 AM
To: 'hannah.headrick@ncdenr.gov'
Cc: 'jeff.manning@ncdenr.gov'; Ogallo, Toya
Subject: Comments on Brunswick County IBT EA
Attachments: Brunswick IBT DENR 1582_NCDWQ_14464_.02-14-13.pdf

Dear Hannah,

We received your comments on the Environmental Assessment for Brunswick County Interbasin Transfer (December 2012). A copy of those comments are attached.

In these comments you request that the following issues be addressed: (1) add information to Table 20, Impairment Ratings for the Cape Fear River in the Cape Fear Study Area, and (2) add information to Section 2.4.4, Total Maximum Daily Load (TMDL) regarding the mercury TMDL. Our responses to each of these comments are provided below.

(1) Add information to Table 20, Impairment Ratings for the Cape Fear River in the Cape Fear Study Area. This table has been revised (see highlights below) and will appear in the next draft of the EA.

Location along Cape Fear River	Use Category	Reason for Impairment	Parameter
From a line across the river between Lilliput Creek and Snows Cut to a line across the river from Walden Creek to the basin	Aquatic Life	Standard Violation	Arsenic
			Copper
			Nickel
From the raw water supply intake at Federal Paper Board Corporation (Riegelwood) to Bryant Mill Creek	Aquatic Life	Fair Bioclassification	Ecological/biological Integrity Benthos
From upstream of the mouth of Toomers Creek to a line across the river between Lilliput Creek and Snows Cut	Aquatic Life	Standard Violation	Turbidity
			Copper
			Low Dissolved Oxygen
			Low pH
Prohibited area east of the ICWW in the Cape Fear River	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Prohibited area north of Southport Restricted Area and west of the ICWW in the Cape Fear River	Aquatic Life	Standard Violation	Arsenic
			Copper
			Nickel

Location along Cape Fear River	Use Category	Reason for Impairment	Parameter
	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Prohibited area near Southport	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Prohibited area south of the Southport Restricted Area	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open

(2) Add information to Section 2.4.4, Total Maximum Daily Load (TMDL) regarding the mercury TMDL. The second paragraph in this section will be revised in the next draft as follows:

North Carolina has issued a statewide fish consumption advisory for mercury; therefore, all surface waters in the state are considered impaired by mercury (NCDWQ, 2013). As a result, a statewide mercury TMDL was developed by NCDWQ and approved by EPA in October 2012. The TMDL estimated the proportions of mercury contributions to water and fish from wastewater discharges, in-state air sources, and out-of-state air sources, and calculated the reductions needed to protect North Carolina waters from mercury impairment and remove the fish consumption advisory. Using statistical analysis and the Community Multi-scale Air Quality (CMAQ) model, NCDWQ determined that a 67% reduction is needed from the 2002 baseline mercury loading. Reductions in both point and nonpoint sources are required, though the most significant source of mercury is nonpoint atmospheric deposition. The NPDES program will play a role in managing mercury from wastewater point sources, which account for 2% of the mercury load, while reductions in atmospheric deposition will require strategies involving other agencies outside of NCDWQ such as the NC Division of Air Quality.

NCDWQ (North Carolina Division of Water Quality). 2013. North Carolina Statewide Mercury TMDL. North Carolina Division of Water Quality. Accessed March 20, 2013. http://portal.ncdenr.org/web/wq/ps/mtu/tmdl/tmdls/mercury.

Please let me know at your earliest convenience if these responses address your concerns. Thank you.

Kind Regards,

Todd

J. Todd Kennedy, PH, QEP | **Associate Director**
Direct: 919.485.2067 | Main: 919.485.8278 | Fax: 919.485.8280
todd.kennedy@tetratech.com

Tetra Tech | **DIV-WTR, Water Resources Group**
P.O. Box 14409 | 1 Park Drive, Suite 200 | Research Triangle Park, NC 27709 | www.tetratech.com

Kennedy, Todd

From: Kennedy, Todd
Sent: Friday, March 22, 2013 4:34 PM
To: 'maria.dunn@ncwildlife.org'
Cc: Ogallo, Toya
Subject: Comments on Brunswick County IBT EA
Attachments: Brunswick IBT DENR 1582_NCWRC_02-25-13.pdf

Follow Up Flag: Follow up
Flag Status: Completed

Dear Maria,

We received your comments on the Environmental Assessment for Brunswick County Interbasin Transfer (December 2012). A copy of those comments is attached.

In these comments you request that the following issues be addressed: (1) potential impacts of the IBT on the newly constructed fish passage at Lock and Dam 1, (2) potential impacts from the water supply intake, and (3) potential indirect impacts of the withdrawal on habitat, stream salinities downstream, and reduced river flow. Our responses to each of these comments are provided below.

1. **<u>Potential impacts of the IBT on the newly constructed fish passage at Lock and Dam 1</u>** - A new fish passage structure (FPS) at Lock and Dam #1 on the Cape Fear River was completed in November 2012 by the US Army Corps of Engineers. The Basis of Design report provided the design, associated analyses (e.g., hydrologic and hydraulic analysis), and the biological rationale for the project (US Army Corps of Engineers, 2010). The rock arch rapids design is a type of rock ramp that provides fish passage over low-head dams by emulation of natural rapids and facilitation of fish hydrodynamics. The FPS alternative was chosen over others including removal of the dam in part due to the need to protect the water supply intake structures located just upstream (e.g., LCFWSA intake).

   The FPS is designed to increase fish passage and increase spawning opportunities for anadromous fish. Spawning migration in the Atlantic coastal region occurs primarily during periods of increased but moderate river flow and temperature such as late winter and spring (NOAA, 2013). The design of the FPS accounts for flows during this period including an assumed “spawning flow” of 5,000 cfs, a flow level near the mean flow for the river (5,063 cfs based on gage data from 1982-2012; USGS Water Data Report), and typical spring flows during March and April which are somewhat greater (i.e., up to about 9,000 cfs; US Army Corps of Engineers, 2010). Maximum, cumulative withdrawals for 2050 (164 cfs; incorporates all LCFWSA customers including Brunswick) just above the FPS during these periods represent 2 to 3 percent of river flows. Maximum withdrawal is more likely to occur in the summer given seasonal water use patterns; therefore, water withdrawals from the river during the spawning migration would represent an even smaller proportion of flow (as would considering only Brunswick’s portion). As such the impact of withdrawals on FPS function would be insignificant.

2. **<u>Potential impacts from the water supply intake</u>** - The Lower Cape Fear Water and Sewer Authority (LCFWSA) supplies raw water to Brunswick County’s Northwest WTP from its intake on the Cape Fear River above Lock and Dam #1. The County is one of several LCFWSA customers receiving a portion of the withdrawal. A FONSI for expansion of the LCFWSA’s intake to accommodate a 96-MGD withdrawal above Lock and Dam #1 was issued by NCDEH in 2009. *The new LCFWSA intake has now been constructed and is in operation*. As discussed in the EA to support that project prepared by McKim and Creed for LCFWSA, the three new intake screens manufactured by Johnson Screens are connected to a new 60 inch intake pipeline. The configuration of the new, additional intake is “identical in form and operation” to the existing intake pipe and no known impacts to aquatic species from the previous configuration have been reported according to the EA approved by NCDEH. Further from the EA, the

mesh size (slot size is approximately 0.1118 inches) was designed to prevent entrainment of fish including eggs and larvae, and velocity through the intake screens will not exceed 0.5 feet per second. That EA contains correspondence with Vann Stancil of WRC.

3. **<u>Potential indirect impacts of the withdrawal on habitat, stream salinities downstream, and reduced river flow</u>** – From Section 6.1.1.1 of the Brunswick EA, "given the size of the withdrawals relative to the river's low flow regime and the tidal nature of the river below Lock and Dam #1, NCDWR deemed that a study of stream flow impacts on habitat and recreation downstream of the dam would not be needed (July 17, 2009 letter from NCDWR to Tetra Tech; contained within the scoping comments provided in Appendix C)." Beyond the hydrologic analysis provided in the EA (see Section 6.1.1.1.3) demonstrating that impacts from the Brunswick withdrawal on river flow are small (c.f. Table 63), we provide the following additional information. When cumulative withdrawals are considered they represent about 3% of mean river flow (5,063 cfs based on gage data for 1982-2012; USGS Water Data Report), 6% of median river flow (2,540 cfs), and 17% of 10th percentile river flow (969 cfs). The cumulative withdrawals incorporate all LCFWSA customers including Brunswick just above the Lock and Dam and are 164 cfs for the 2050 planning horizon. Note that current max withdrawals, for all users, are about half of that (c.f. Table 69 in the EA). Based on this information, the proposed Brunswick withdrawal on its own as well as the combined withdrawals at this location in the river are not expected to have significant indirect impacts on habitat, stream salinity, or river flow.

References:

U.S. Army Corps of Engineers. 2010. Fish Passage at Lock and Dam No. 1, Cape Fear River, Bladen County, North Carolina. 100% Design Submittal. Basis of Design. Prepared by SEPI Engineering and Construction and Tetra Tech, Inc.
NOAA (National Oceanic and Atmospheric Administraion). 2013. Diadromous Fish Passage: A Primer on Technology, Planning, and Design for the Atlantic and Gulf Coasts. National Marine Fisheries Service. Accessed March 20, 2013. http://www.nero.noaa.gov/hcd/docs/FishPassagePrimer.pdf.

We will include this information in the next draft of the EA.

Please let me know at your earliest convenience if these responses address your concerns. Also, I am happy and available to discuss these issues further over the phone if that would be helpful.

Kind Regards,

Todd

J. Todd Kennedy, PH, QEP | **Associate Director**
Direct: 919.485.2067 | Main: 919.485.8278 | Fax: 919.485.8280
todd.kennedy@tetratech.com

Tetra Tech | **DIV-WTR, Water Resources Group**
P.O. Box 14409 | 1 Park Drive, Suite 200 | Research Triangle Park, NC 27709 | www.tetratech.com

NCDENR

North Carolina Department of Environment and Natural Resources

Pat McCrory
Governor

John E. Skvarla, III
Secretary

MEMORANDUM

TO: Toya F. Ogallo, Environmental Engineer
River Basin Management Section
Division of Water Resources

FROM: Lyn Hardison Lyn
Division of Environmental Assistance and Outreach
Permit Assistance & Project Review Coordinator

RE: Environmental Assessment/Finding of No Significant Impact
Brunswick County Interbasin Transfer – Expansion of the Northwest Water Treatment plant to meet future water demands
Brunswick County
DENR # 1582

Date: April 18, 2013

We appreciate the effectiveness in addressing agency comments that were received during the Department's internal review. The Environmental Assessment and Finding of No Significant Impact can be forwarded to the State Clearinghouse for further State review.

Thank you for your assistance.

1601 Mail Service Center, Raleigh, North Carolina 27699-1601
Phone: 919-707-8600 \ Internet: www.ncdenr.gov

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Appendix L FONSI and State Environmental Review Clearinghouse Comments

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NCDENR
North Carolina Department of Environment and Natural Resources
Division of Water Resources

Pat McCrory
Governor

Thomas A. Reeder
Director

John E. Skvarla, III
Secretary

FINDING OF NO SIGNIFICANT IMPACT
ENVIRONMENTAL ASSESSMENT FOR THE BRUNSWICK COUNTY PUBLIC UTILITIES INTERBASIN TRANSFER CERTIFICATE

Pursuant to the requirements of the Surface Water Transfers Act [G.S. 143-215.22I] and the State Environmental Policy Act (G.S. 113A), Brunswick County Public Utilities (the County) has prepared an environmental assessment (EA) to support the County's request for an interbasin transfer certificate.

Brunswick County Public Utilities currently provides water to more than 34,000 retail customers and 11 wholesale customers through its two water treatment plants (WTP). The Northwest WTP, permitted for 24 million gallons per day (MGD), is located near the City of Northwest and receives raw water from the Cape Fear River via the Lower Cape Fear Water and Sewer Authority. The 211 WTP is permitted for 6 MGD and treats groundwater from the Castle Hayne Aquifer. Wastewater within the County is handled through individual onsite septic systems, clustered and centralized land application, reuse, and surface water discharging systems. This treatment, service, and disposal of water creates an interbasin transfer from the Cape Fear River Basin to the Shallotte and Waccamaw River Basins, both of which are subbasins to the Lumber River Basin.

The County is requesting an interbasin transfer certificate from the Environmental Management Commission to transfer 18.3 MGD, limited on a maximum daily basis, from the Cape Fear River Basin to the Shallotte River Basin. The County currently has a grandfathered transfer capacity of 10.5 MGD. This increase is based on a 30-year water demand projection (through the year 2042). No increase in IBT is being requested for the Waccamaw IBT River Basin: minor growth is expected in this area and future water will be supplied by the Little River Water and Sewerage Company in South Carolina via an agreement with the County.

A hydrologic analysis was performed using the Division of Water Resources' Cape Fear Hydrologic Model to evaluate the County's impact on flow in the Cape Fear River, and determine whether future demands will be met for public water systems in the source basin. The proposed IBT increase did not change NCDWR's (2008) previous conclusion that full demand for all withdrawals at Lock and Dam #1 are met through 2050. Similarly, the impacts of the transfer on water quality are predicted to be insignificant based on a statistical data analysis and the Division of Water Quality's water quality model of the Lower Cape Fear River Estuary.

Secondary and cumulative impacts for the project are those that could be derived from growth inducement in the Shallotte IBT River Basin. Future growth in the County is expected to primarily occur as low- and medium-density residential uses. Due to the fact that Brunswick County falls under the Coastal Area Management Act (CAMA), there are numerous state and local regulatory measures in place to mitigate the effects of growth including the CAMA Land Use Plan and Areas of Environmental Concern requirements, the 20 Coastal Counties Stormwater Law, and the NPDES Phase II Stormwater Rules.

There are no construction activities associated with this request. Any potential impacts associated with construction of WTP improvements and transmission lines in the source or receiving basin would be reviewed under environmental documents prepared under SEPA specifically for these projects as required by state and federal regulations. An EA for the Northwest WTP plant expansion and associated improvements will be prepared as required by SEPA if an IBT certificate is approved.

Based on the findings of the EA, the Division of Water Resources has concluded that the proposed project will not result in significant adverse effect on the environment. This decision is based upon the requirements of NC GS 143-215.22I, information in the attached EA, and review by governmental agencies. Therefore the EA supports a Finding of No Significant Impact such that preparation of an environmental impact statement will not be required. This FONSI completes the environmental review record, which is available for inspection and comment for 30 days at the State Clearinghouse.

4/25/13

Thomas A. Reeder — Date

Director, Division of Water Resources

North Carolina
Department of Administration

Pat McCrory, Governor | Bill Daughtridge, Jr., Secretary

May 30, 2013

Ms. Toya Ogallo
NCDENR
Division of Water Resources
1611 Mail Service Center
Raleigh, North Carolina 27699-1611

Re: SCH File # 13-E-4300-0406; EA/FONSI; Interbasin Transfer associated with expansion of Brunswick County's Northwest Water Treatment Plant

Dear Ms. Ogallo:

The above referenced environmental impact information has been reviewed through the State Clearinghouse under the provisions of the North Carolina Environmental Policy Act.

No comments were made by any state/local agencies in the course of this review. Therefore, no further environmental review action on your part is required for compliance with the Act.

Sincerely,

Crystal Best

Crystal Best
State Environmental Review Clearinghouse

cc: Region O

Mailing Address:
1301 Mail Service Center
Raleigh, NC 27699-1301

Telephone: (919)807-2425
Fax (919)733-9571
State Courier #51-01-00
e-mail state.clearinghouse@doa.nc.gov

Location Address:
116 West Jones Street
Raleigh, North Carolina

NORTH CAROLINA STATE CLEARINGHOUSE
DEPARTMENT OF ADMINISTRATION
INTERGOVERNMENTAL REVIEW

COUNTY: BRUNSWICK

H01: WATER SUPPLY SYSTEMS

RECEIVED
MAY 02 2013
HISTORIC PRESERVATION OFFICE

STATE NUMBER: 13-E-4300-0406
DATE RECEIVED: 04/29/2013
AGENCY RESPONSE: 05/24/2013
REVIEW CLOSED: 05/29/2013

MS RENEE GLEDHILL-EARLEY
CLEARINGHOUSE COORDINATOR
DEPT OF CULTURAL RESOURCES
STATE HISTORIC PRESERVATION OFFICE
MSC 4617 - ARCHIVES BUILDING
RALEIGH NC

CH 09-0947

Due 5/10/13 A- NCH/eff 5-17-13

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5

PROJECT INFORMATION

APPLICANT: NCDENR

TYPE: State Environmental Policy Act
Environmental Assessment/Finding of No Significant Impact

DESC: Interbasin Transfer associated with expansion of Brunswick County's Northwest Water Treatment Plant

CROSS-REFERENCE NUMBER: 09-E-4300-0295

The attached project has been submitted to the N. C. State Clearinghouse for intergovernmental review. Please review and submit your response by the above indicated date to 1301 Mail Service Center, Raleigh NC 27699-1301.

If additional review time is needed, please contact this office at (919)807-2425.

AS A RESULT OF THIS REVIEW THE FOLLOWING IS SUBMITTED: [X] NO COMMENT [ ] COMMENTS ATTACHED

SIGNED BY: Renee Gledhill-Earley DATE: 5.22.13

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INTERGOVERNMENTAL REVIEW

COUNTY: BRUNSWICK

H01: WATER SUPPLY SYSTEMS

STATE NUMBER: 13-E-4300-0406
DATE RECEIVED: 04/29/2013
AGENCY RESPONSE: 05/24/2013
REVIEW CLOSED: 05/29/2013

MS LYN HARDISON
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SIGNED BY: Lyn B. Hardison

DATE: 5-24-13

NORTH CAROLINA STATE CLEARINGHOUSE
DEPARTMENT OF ADMINISTRATION
INTERGOVERNMENTAL REVIEW

COUNTY: BRUNSWICK

H01: WATER SUPPLY SYSTEMS

STATE NUMBER: 13-E-4300-0406
DATE RECEIVED: 04/29/2013
AGENCY RESPONSE: 05/24/2013
REVIEW CLOSED: 05/29/2013

MS CAROLYN PENNY
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AS A RESULT OF THIS REVIEW THE FOLLOWING IS SUBMITTED: ☒ NO COMMENT ☐ COMMENTS ATTACHED

SIGNED BY: John D Burbach DATE: May 9, 2013

SFHA impacts will be addressed separately as required. There are none directly associated with the IBT FONSI.

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COUNTY: BRUNSWICK

H01: WATER SUPPLY SYSTEMS

STATE NUMBER: 13-E-4300-0406
DATE RECEIVED: 04/29/2013
AGENCY RESPONSE: 05/24/2013
REVIEW CLOSED: 05/29/2013

MS CARRIE ATKINSON
CLEARINGHOUSE COORDINATOR
DEPT OF TRANSPORTATION
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SIGNED BY: ______________________ DATE: May 4, 2013