FUQUAY-VARINA
north carolina

DRAFT

Environmental Impact Statement

for

Interbasin Transfer for Water Supply from
Cape Fear River to Neuse River

June 2025

Hazen

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DRAFT

Environmental Impact Statement

for

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

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Current Submittal:	DEIS for State Environmental Policy Act Review (June 2025)

EXECUTIVE SUMMARY

ES.1 Introduction

The Town of Fuquay-Varina is located in southern Wake County southeast of Holly Springs and south of the City of Raleigh at the Wake and Harnett County line. The Town of Fuquay-Varina operates and maintains two wastewater treatment facilities, wastewater conveyance infrastructure, and finished water storage and distribution system infrastructure. The Town of Fuquay-Varina does not own water supply and treatment infrastructure and has historically relied on the purchase of bulk finished water from Raleigh Water, Harnett County, and Johnston County to meet the Town's potable water needs via temporary interlocal agreements. The Town of Fuquay-Varina currently purchases the largest percentage of finished water from Harnett County.

The Town of Fuquay-Varina's service area spans two hydrologic basin boundaries as defined in General Statute § 143-215 22G. The Neuse River basin is designated as 10-1 and the Cape Fear River basin is designated as 2-3. Approximately 62 percent of the Town of Fuquay-Varina's service area is located in the Neuse River basin and 38 percent of the service area is located in the Cape Fear River basin. The hydrologic boundary between the Cape Fear basin (2-3) and the Neuse River basin (10-1) is located almost in the center of the Town of Fuquay-Varina's service area, following U.S. 55 to Judd Parkway and Holland Road and then south along U.S. 55 toward the Wake-Harnett County line. The IBT boundary closely matches the hydrologic boundary with the exception of approximately 600 acres south and west of U.S. 401 at the center of town.

ES.2 Description of Proposed Project

The preferred alternative (9A/B) is a regional water supply project between the City of Sanford and the Towns of Pittsboro, Holly Springs, and Fuquay-Varina. All four communities are experiencing growth due to economic development in the region and therefore need additional water supply. The City of Sanford is the lead local entity for this regional water supply project. The Town of Fuquay-Varina and project partners have entered into an interlocal agreement with the City of Sanford to purchase capacity in the City of Sanford's Water Treatment Plant (WTP). The City of Sanford has obtained environmental permits for the regional water supply project. The proposed regional water supply infrastructure improvements include an expansion of the City of Sanford's WTP, a replacement of the existing raw water intake and pump station, and approximately 16 miles of finished water transmission main.

On behalf of the Town of Fuquay-Varina, Hazen and Sawyer (Hazen) is preparing a North Carolina (State) Environmental Policy Act (SEPA) Environmental Impact Statement (EIS) to support the Town of Fuquay-Varina's request for a 6.17 million gallons per day (mgd) transfer of water from the Cape Fear River basin (2-3) to the Neuse River basin (10-1). The proposed interbasin transfer supports the preferred alternative for the Town of Fuquay-Varina to meet the water supply needs in the Town's service area and secure a reliable permanent water supply source. A Notice of Intent (NOI) to the North Carolina Environmental Management Commission (EMC) was submitted by the Town on September 1, 2020.

This EIS has been prepared for the North Carolina Department of Environment Quality (DEQ) as part of the decision-making process associated with the potential issuance of a Record of Decision (ROD). The EIS has been prepared to identify and discuss the potential environmental, cultural, and socioeconomic impacts associated with implementing the proposed action. This document has been prepared in accordance with the requirements of SEPA pursuant to 15A North Carolina Administrative Code (NCAC) 01C and General Statute § 113A.

ES.3 Purpose and Need

The Town of Fuquay-Varina needs to secure a reliable permanent water supply source in lieu of the continuation of temporary interlocal lease agreements with wholesale suppliers to meet the projected growth and water demand. The Town of Fuquay-Varina is pursuing this water supply project to secure a permanent water supply source to meet the water supply needs in the Town's service area. The preferred alternative results in a requirement for an interbasin transfer (IBT) certificate to transfer water from the Cape Fear River basin (2-3) to the Neuse River basin (10-1). Per General Statute § 143-215.22L, an interbasin transfer certificate is required if a daily average water demand of 2 mgd in a calendar month (e.g., maximum month) or 3 mgd in one day (e.g., maximum day) is exceeded.

Per the contractual language in interlocal agreements, the Town of Fuquay-Varina does not have ownership rights to treatment capacity in neighboring treatment facilities. Therefore, the Town of Fuquay-Varina cannot control the production of water or guarantee a reliable water supply. Under all three of the Town of Fuquay-Varina's interlocal agreements (e.g., Raleigh Water, Johnston County, and Harnett County), the suppliers have the right to interrupt finished water service on an as-needed basis or in an emergency. For example, the Town of Fuquay-Varina receives approximately 50 percent of finished water from Harnett County. If service from Harnett County is interrupted, nearly half of the Town of Fuquay-Varina's finished water is at risk.

The Town of Fuquay-Varina's population growth and corresponding water demand projections support the need for additional water supply to meet the Town's water demand and provide a reliable permanent water supply source. Table ES-1 provides a summary of the water demand projections, the current interlocal agreement amounts, and the projected water supply shortfall. Water demands were calculated to assess the average day water demand in a maximum month per General Statute § 143-215.22L. The water supply shortfall is calculated as the difference between the Town of Fuquay-Varina's current total contract amount less the total average day water demand in a maximum month. The water supply shortfall assumes that the Town of Fuquay-Varina's current contract amounts expire as specified in the interlocal agreements and additional water supply is not available. Without provisions for additional water supply capacity, the Town of Fuquay-Varina is projected to have a water supply shortfall beginning in 2030. Additional water supply is needed to satisfy the projected water demand in the Town of Fuquay-Varina's service area. A transfer of water from the to the Cape Fear River basin (2-3) to the Neuse River basin (10-1) would not occur until after 2031.

Table ES-1: Summary of Water Demand Projections, Current Contract Amounts, and Projected Water Supply Deficit

Year	Projected Average Day Water Demand in a Maximum Month, mgd [1] [A]	Interbasin Transfer Projections, Cape Fear (2-3) to Neuse (10-1), mgd [B]	Projected Maximum Day Water Demand, mgd [C]	Current Total Water Supply Contract Amount via Interlocal Agreement, mgd [D]	Projected Water Supply Shortfall Indicated by Value in ( ), mgd [2] [D - A]
2023	3.5	0.00	4.5	5.25	1.7
2025	4.2	0.00	5.4	5.25	1.0 [3]
2030	5.2	0.00	6.6	5.25	0.08 [3]
2035	6.1	0.56	7.8	5.25	(0.86)
2036	6.3	2.42	8.0	3.5	(2.8)
2040	7.1	2.89	9.0	3.5	(3.6)
2041	7.2	3.01	9.2	3.5	(3.7)
2045	8.0	3.47	10.2	3.5	(4.5)
2049	8.7	3.94	11.1	3.5	(5.2)
2050	8.9	5.55	11.4	2	(6.9)
2055	9.9	6.17	12.5	2	(7.9)

[1] Projected water demand for the Town of Fuquay-Varina service area. Water demand projections in the Neuse and Cape Fear River basins are approximately 62% and 38% of the total project water demand, respectively.

[2] Projected water supply deficit is the current contract amount less the average day water demand in a maximum month.

[3] Amount does not include additional 2 mgd from Harnett County via the ILA signed in 2022.

ES.4 Summary of Proposed Alternatives

Sixteen alternatives for the Town of Fuquay-Varina's water supply project were identified for evaluation in this EIS. Table ES-2 provides a summary of each alternative to include key elements, source water supply, if the alternative meets the purpose and need (e.g., permanent water supply source and timing of infrastructure), relative environmental impact, and opinion of probable project cost. Alternatives 1, 2, and 3 consider water supply from the Neuse River basin (10-1). Alternatives 4 through 9 consider water supply from the Cape Fear River basin (2-3). Alternative 10 provides an evaluation of a groundwater system. Alternatives 11 and 12 are IBT minimization alternatives. The difference between Alternatives 9A and 9B is the finished water corridor route between Sanford and the Town of Fuquay-Varina.

Topography, soils, land use, public and recreational lands, agricultural land, archaeological and historic resources, air quality, noise, water resources, floodplains, aquatic and terrestrial species and habitat, forest resources, and environmental justice were evaluated in this EIS. Direct and indirect impacts were described as temporary or permanent with the qualifiers of negligible, minor, major, or moderate. Existing local, state, and federal programs and ordinances will mitigate the potential for direct and indirect impacts from the proposed project. Mitigation is provided for indirect and cumulative impacts related to stormwater, floodplain, riparian buffer, erosion and sedimentation control, wetland protection, open space and parks, water use, land use, historic preservation, tree preservation, endangered species protection via state and federal programs and Town ordinances, where applicable.

Table ES.2: Summary of Alternative Description, Purpose and Need, and Cost Opinion

Alternative	Key Elements	Water Supply Source Basin	Does Alternative Meet Purpose and Need for a Permanent Water Supply Source?	Does Alternative Provide Water Supply in Time Frame to Meet Water Demand Projections?	Does Alternative Result in a Transfer of Water?	Opinion of Probable Project Cost
No-action	• Alternative does not meet purpose and need. • Water supply deficit by 2030.	----	No	No	----	----
Alternative 1 – Surface Water, Purchase Finished Water from Raleigh Water	• Construction of a new reservoir. • Significant environmental impacts to aquatic species, surface waters, wetlands, and floodplains. • Significant property owner impacts in area of inundation. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Johnston County permission required for property acquisition. • Significant economic impact.	Neuse (Construction of new reservoir on Middle Creek)	Yes	No	Yes, but transfer would not require an IBT Certificate per General Statute § 143-215.22L	$836,800,000
Alternative 2 – Surface Water, Purchase Finished Water from Johnston County	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Identified as Johnston County's near-term water supply project. Water supply capacity is fully allocated to growth and development of Johnston County. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Johnston County permission required for property acquisition. • Significant economic impact.	Neuse (New raw water intake on Neuse River at Richardson Bridge Road)	No	No	Yes, but transfer would not require an IBT Certificate per General Statute § 143-215.22L	$878,500,000

Table ES.2: Summary of Alternative Description, Purpose and Need, and Cost Opinion

Alternative	Key Elements	Water Supply Source Basin	Does Alternative Meet Purpose and Need for a Permanent Water Supply Source?	Does Alternative Provide Water Supply in Time Frame to Meet Water Demand Projections?	Does Alternative Result in a Transfer of Water?	Opinion of Probable Project Cost
Alternative 3 – Surface Water, Town of Fuquay-Varina Independent Water Supply in Neuse River Basin	• Construction of a new reservoir. • Significant environmental impacts to aquatic species, surface waters, wetlands, and floodplains. • Significant property owner impacts in area of inundation. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Johnston County permission required for property acquisition. • Significant economic impact.	Neuse (Construction of new reservoir on Middle Creek)	Yes	No	Yes, but transfer would not require an IBT Certificate per General Statute § 143-215.22L	$802,000,000
Alternative 4 – Surface Water, Purchase Finished Water from City of Dunn	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Water supply capacity at existing Dunn raw water intake is fully allocated to growth and development for City of Dunn. • Significant economic impact.	Cape Fear (New raw water intake on Cape Fear River at Dunn)	No	No	Yes	$449,200,000
Alternative 5 – Surface Water, Purchase Finished Water from Harnett County	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Negligible to minor environmental impacts. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Water supply capacity is fully allocated to growth and development for Harnett County. • Instream flow study required. • Significant economic impact.	Cape Fear (New raw water intake on Cape Fear at Lillington)	No	No	Yes	$375,500,000

Table ES.2: Summary of Alternative Description, Purpose and Need, and Cost Opinion

Alternative	Key Elements	Water Supply Source Basin	Does Alternative Meet Purpose and Need for a Permanent Water Supply Source?	Does Alternative Provide Water Supply in Time Frame to Meet Water Demand Projections?	Does Alternative Result in a Transfer of Water?	Opinion of Probable Project Cost
Alternative 6 – Surface Water, Raw Water from Jordan Lake (Cary/Apex)	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Challenge in obtaining allocation from Jordan Lake. • Significant economic impact.	Cape Fear (New raw water intake at Jordan Lake)	No	No	Yes	$497,100,000
Alternative 7 – Surface Water, Raw Water from Jordan Lake (Western Intake Partnership)	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Challenge in obtaining allocation from Jordan Lake. • Significant economic impact.	Cape Fear (New raw water intake at Jordan Lake)	No	No	Yes	$565,000,000
Alternative 8A – Surface Water, Town of Fuquay-Varina Intake on the Cape Fear with Return of Water to Cape Fear River Basin (Cape Fear River)	• Long transmission lines. • Instream flow study required. • Negligible to minor environmental impacts from construction. • Harnett County permission required for property acquisition. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Not a regional water supply solution. • Significant economic impact.	Cape Fear (New raw water intake on Cape Fear at Lillington)	Yes	No	No	$660,100,000

Table ES.2: Summary of Alternative Description, Purpose and Need, and Cost Opinion

Alternative	Key Elements	Water Supply Source Basin	Does Alternative Meet Purpose and Need for a Permanent Water Supply Source?	Does Alternative Provide Water Supply in Time Frame to Meet Water Demand Projections?	Does Alternative Result in a Transfer of Water?	Opinion of Probable Project Cost
Alternative 8B – Surface Water, Town of Fuquay-Varina Intake on the Cape Fear with Return of Water to Cape Fear River Basin (Kenneth Creek)	• Long transmission lines. • Instream flow study required. • Negligible to minor environmental impacts from construction. • Harnett County permission required for property acquisition. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Not a regional water supply solution. • Significant economic impact.	Cape Fear (New raw water intake on Cape Fear at Lillington)	Yes	No	No	$522,800,000
Alternative 9A/B – Surface Water, Purchase Finished Water from City of Sanford	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Regional water supply solution. • Least economic impact. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers.	Cape Fear (New raw water intake on Cape Fear River at NC 42)	Yes	Yes	Yes	$227,300,000 *(cost opinion reflects the cost obligation for the Town of Fuquay-Varina and not entire project)*
Alternative 9C – Surface Water, Purchase Finished Water from City of Sanford with Return of Water to Cape Fear River	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Regional water supply solution. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Significant economic impact.	Cape Fear (New raw water intake on Cape Fear River at NC 42)	Yes	Yes	No	$453,800,000

Table ES.2: Summary of Alternative Description, Purpose and Need, and Cost Opinion

Alternative	Key Elements	Water Supply Source Basin	Does Alternative Meet Purpose and Need for a Permanent Water Supply Source?	Does Alternative Provide Water Supply in Time Frame to Meet Water Demand Projections?	Does Alternative Result in a Transfer of Water?	Opinion of Probable Project Cost
Alternative 9D – Surface Water, Purchase Finished Water from City of Sanford with Return of Water to Cape Fear River via Western Wake Regional WRF	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Regional water supply solution. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Capacity unavailable in Western Wake WRF. • Significant economic impact.	Cape Fear (New raw water intake on Cape Fear River at NC 42)	Yes	Yes	No	$413,900,000
Alternative 10 – Interbasin Transfer Minimization, Groundwater	• Not a regional water supply solution. • Negligible to moderate environmental impacts from construction. • Significant economic impact. • Harnett County permission required for property acquisition. • Significant public health risk of groundwater depletion for private drinking water well population. • Large number of required wells due to low groundwater yield.	----	No	No	----	$897,500,000
Alternative 11 – Interbasin Transfer Minimization, Water Reuse	• Reuse water does not substantially offset potable water use. • State regulation needed to define quality of water required for indirect potable reuse via surface water augmentation. • Significant public perception hurdles.	----	No	No	----	----
Alternative 12 – Interbasin Transfer Minimization, Additional Conservation Measures	• Town of Fuquay-Varina's water use metrics are comparable to national trends and is less than exceed regional per capita use trends in the Cape Fear River basin.	----	No	Town of Fuquay-Varina's water conservation ordinances meet General Statute § 143-215.22L	----	----

The environmental justice impacts for all alternatives are considered to be negligible. The analysis demonstrated no disproportionate impact for direct temporary, direct permanent, or indirect: minority and low-income populations are less than the 50 percent threshold. All alternatives provide drinking water to the same service area. Water service provided to the minority population is, and will continue to be, the same as the water service to areas without a predominantly minority population. Provision of water service under the proposed alternatives does not result in a disparity between minority and non-minority populations. No direct, indirect, or cumulative impact that is disproportionate to minority or low-income populations that rely on the Cape Fear River downstream of the proposed alternatives will occur as a result of implementing Alternatives 4, 5, 6, 7, 9A, or 9B (i.e., alternatives that include an interbasin transfer).

ES.5 Summary of Water Quantity Impacts

The Cape Fear Neuse Combined River Basin (CFNCRB) model was used to evaluate the hydrologic impacts of the Town of Fuquay-Varina's water supply alternatives for this EIS. The CFNCRB model was updated to account for new water supplies that have come online since the previous model updates to include the Falls Lake Reallocation and the Jordan Lake Round 4 Allocations. The CFNCRB model was also updated to include known future water supplies in both the Neuse and Cape Fear River basins. The CFNCRB model uses a hydrologic data set that covers a 90-year hydrologic period at a daily time step. The CFNCRB model results were used to appraise the potential impact of the Town of Fuquay-Varina's water supply through 2055 on the following:

1. The ability to meet municipal water demands.
2. The frequency that Falls Lake and Jordan Lake can continue to meet their recreational and environmental criteria.
3. Low-flow discharge at key points along the Neuse and Cape Fear Rivers.

The following is a summary of the key conclusions of the CFNCRB model results:

- CFNCRB model simulation results demonstrated minimal impacts between alternatives to downstream users in the Cape Fear and Neuse River basins.
- For any given inflow scenario, the Town of Fuquay-Varina's water supply would be 100 percent reliable for Alternatives 1 through 9.
- For the historical hydrology, every municipal water system is 100 percent reliable (i.e., able to meet projected water demand) in the Neuse and Cape Fear River basins. However, some utilities may need to implement water conservation measures from Water Shortage Response Plans (WSRPs) as stated in approved Local Water Supply Plans (LWSPs) slightly more frequently.
- Jordan Lake drops to less than 210 feet of elevation (i.e., the elevation at which there are impacts to recreation) on 0.1 percent of days for Alternatives 1, 2, 3, 4, 5, 8, and 9. Jordan Lake drops to less than 210 feet of elevation 0.2 percent of the time for Alternatives 6 and 7. The Jordan Lake elevation is not less than 210 feet during the recreational season between Memorial Day to Labor Day.

- The Jordan Lake water quality pool storage does not drop below 20 percent (i.e., Drought Stage 4) in any alternative using either historic or climate change inflows. Jordan Lake water quality storage declines to less than 40 percent (i.e., Drought Stage 3) less than 1 percent of the time under the historical hydrology.
- The CFNCRB model suggests the non-drought flow target at Lillington of 550 cubic feet per second (cfs) would not be met approximately 14.5 percent of the time for each alternative using the historical inflow record. During these times Jordan Lake would be in drought Stages 1 through 3 and instream flow downstream of Jordan Lake dam would not make up the difference to reach 550 cfs at the Lillington gage. The range of variability across all alternatives is 0.5 percent.
- The CFNCRB model output indicates that the 600 cfs flow threshold at Fayetteville would not be met on 5.5 percent of days using the historical runoff record. The variability across all alternatives spans a 0.5 percentage point, or 5.4 percent to 5.9 percent.
- Falls Lake drops to less than 242.5 feet (i.e., the elevation below which there are impacts to recreation) approximately 0.3 percent of the time for all alternatives under historical runoff conditions.
- The Falls Lake water quality storage declines to less than 40 percent storage only 1.5 percent of the time. The selection of an alternative does not influence this result.
- The minimum Falls Lake water quality storage declines below 20 percent just once in the historical hydrology under 2055 demands in a repeat of the severe 2007 drought.
- The Falls Lake minimum release and Clayton seasonal flow targets are never impacted.

Climate variability was evaluated using three future climate scenarios in the CFNCRB model. By including an evaluation of the supply alternatives in conjunction with climate variability, this EIS may assess if the alternatives are robust with respect to the water supply reliability and if the alternatives might adversely impact other stakeholders in a climate change scenario. The following is a summary of findings related to the climate change scenarios:

- The impacts of climate change, cumulative development through 2055 in the Cape Fear River basin, and the preferred alternative for the Town of Fuquay-Varina were delineated in the analysis. The impacts in the climate change scenarios dominate the cumulative impacts of water demand growth in the Cape Fear River basin and the selection of a water supply alternative for the Town of Fuquay-Varina. The preferred alternative for the Town of Fuquay-Varina has less impact than climate change or cumulative development elsewhere in the Cape Fear and Neuse basins through 2055.
- Of the three climate models used, one climate model results in markedly less water stress than the historical hydrology and two models demonstrate more water stress in 2055. The CFNCRB model results in conjunction with a review of the academic literature suggests confidence in the impact of climate change to regional hydrology is low.
- All municipal utilities with quantifiable shortage action triggers associated with their WSRPs maintain 100 percent reliability, even under the climate change scenarios.

- For the climate change scenarios, two of the 59 municipal and industrial demand nodes in the CFNCRB model experience brief shortages during the most severe droughts. The two affected municipal systems use the same withdrawal point at the downstream end of the Cape Fear River. Mitigative measures such as implementing demand reductions, modestly increasing the release from Jordan Lake, and considering the storage in the Cape Fear River between Lock and Dam 1 and Lock and Dam 2 may eliminate the shortages.

Impacts on stream flow in the Neuse and Cape Fear River basins were also assessed as part of the EIS. Flow statistics at various nodes in the CFNCRB model include the gage station at Lillington, Fayetteville's raw water intake, and the Cape Fear Public Utility Authority (CFPUA) / Lower Cape Fear Water and Sewer Authority's (LCFWSA) raw water intakes. The following is a summary of the key conclusions from the stream flow analysis:

- Using historical inflows, the difference between No-Action and Alternative 9A/B (without return of water) is a reduction of 4.6 cfs (-1.1 percent) at the Fayetteville raw water intake and 3.1 cfs (-0.8 percent) at the CFPUA/LCFWSA raw water intake.
- Using historical inflows, the difference between No-Action and Alternative 9C (return of water to Cape Fear) is an increase of 3.4 cfs (+0.8 percent) at the Fayetteville raw water intake and 4.6 cfs (+1.2 percent) at the CFPUA raw water intake for Alternative 9C.
- The difference between the No-Action alternative and Alternative 9D is an increase of 0.8 cfs (+0.2 percent) and 0.5 cfs (+0.1 percent) at the same respective downstream locations. The smaller change with Alternative 9D is due to the fact the wastewater in Alternative 9D is returned upstream of the Lillington gage and the releases from Jordan Lake were adjusted accordingly. The recorded discharge at the Lillington gage changes to a lesser degree with the wastewater return location for Alternative 9D.

ES.6 Summary of Water Quality Impacts

The water quality comments during the SEPA scoping phase from the public and other utilities referenced potential impacts on water quality due to emerging contaminants, specifically Per- and polyfluoroalkyl substances (PFAS) and 1,4-dioxane (1,4-D). Comments indicated that PFAS and 1,4-D could potentially be returned to the Cape Fear River basin through the Harnett County North Regional WWTP or to the Neuse River basin through the Town of Fuquay-Varina's Terrible Creek WWTP. PFAS is present in domestic (i.e., residential and commercial) wastewater across the United States. Water quality standards have not been promulgated by the United States Environmental Protection Agency (EPA) or DEQ for PFAS or 1,4-D. A certified analytical method for PFAS in a wastewater matrix has not yet been promulgated per 40 Code of Federal Regulations (CFR) 136. Additionally, peer-reviewed water quality models are not available to address emerging contaminants in ambient waters. In the event water quality standards for PFAS or 1,4-D are promulgated and incorporated into National Pollutant Discharge Elimination System (NPDES) permits, wastewater dischargers must comply with NPDES effluent limit discharge requirements, including the Town of Fuquay-Varina.

The DEQ Division of Water Resources (DWR) did not provide comments in the initial scoping meeting or the SEPA scoping phase that water quality modeling was required of the applicant. In lieu of water quality modeling, an analysis of the low flow statistics from the CFNCRB model was used as a proxy to qualify potential water quality impacts. The modeled 7Q10 differences between any two alternatives using historical hydrology are less than 10 cfs at Lillington and at the other gage sites. A value of 10 cfs at the Lillington gage is approximately 0.3 percent of the median discharge at Lillington and less than 4 percent of the historical 7Q10. The CFNCRB model's precise accounting suggests that there is a small difference across the full range of alternatives. In reality, the measurable differences between alternatives are indiscernible due to United States Geological Survey (USGS) gage accuracy. For example, the Lillington gage was assigned a "Good" rating in the low-flow range of 250 to 600 cfs, which translates to a margin of error of +/- 25 to 60 cfs.

ES.7 Summary of Alternatives

This EIS provides an assessment of water supply alternatives to meet the Town of Fuquay-Varina's purpose and need. The purpose and need consist of the delivery of a permanent water supply solution to the Town of Fuquay-Varina in a time frame necessary to meet the Town's water demand projections. This EIS has also documented the potential technical feasibility, environmental impacts, environmental impacts, environmental justice impacts, and financial impacts of the proposed alternatives.

The water supply alternatives in the Neuse River basin are not readily implementable for the Town of Fuquay-Varina. Water supply in the Neuse River basin is finite, and several utilities in the Neuse are also investigating solutions for their future water supply needs. Based on the comparison of environmental consequences and associated implementation costs, the Neuse River basin alternatives identified in this EIS have greater cost to implement and present more significant environmental challenges and regulatory hurdles. The Neuse River basin Alternatives 1, 2, and 3 result in a total project cost greater than $0.75 billion.

Only the preferred alternative in the Cape Fear River basin is readily implementable for the Town of Fuquay-Varina. Cape Fear River basin Alternatives 4, 5, 6, 7, and 8 do not meet the Town of Fuquay-Varina's project purpose and need for a reliable permanent water supply source or water supply capacity in a timeframe needed for the Town to address the water supply shortfall by 2030. Water supply capacity is fully allocated to the growth and development needs of the proposed water supply purveyors in Alternatives 4 and 5. For Alternatives 6 and 7, it is anticipated that communities with a long-term investment in Jordan Lake water resources planning and infrastructure may receive higher priority in a future allocation process. Alternative 8 will not provide water supply capacity in a time frame needed for the Town of Fuquay-Varina to address the Town's water demand projections.

Alternatives 10, 11, and 12 do not meet or offset the project purpose and need. Water supply capacity via groundwater is not supported by well yield for Alternative 10 in this region. The use of reclaimed water does not contribute to a substantial offset in potable water use for Alternative 11. Alternative 12 is not available to further offset potable water use.

Alternative 9A/B (Purchase Finished Water from City of Sanford) is the preferred alternative and meets the project purpose and need. The water demand and IBT projections account for water conservation per General Statute § 143-215.22L. Alternative 9A/B was selected as preferred due to fulfilling the project purpose and need, minimal environmental impact, and the least financial impact on the Town of Fuquay-Varina's ratepayers. The Town of Fuquay-Varina's water use metrics are comparable to national trends and are less than regional per capita use trends in the Cape Fear River basin. The difference between the preferred alternative to purchase water supply from the City of Sanford with and without a return of water to the Cape Fear River basin is $226.5 million in additional cost to mitigate a reduction of 4.6 cfs under low flow conditions in the Cape Fear River in 2055.

The Town of Fuquay-Varina has proposed modifications to the Town's water conservation ordinance to be more equivalent to water conservation measures for other communities in the Cape Fear River basin. In a Stage 1 water shortage restriction, the Town of Fuquay-Varina currently allows outdoor irrigation on alternating limited days. The Town of Fuquay-Varina has proposed limiting irrigation to one day per week in Stage 1. The Town of Fuquay-Varina has also proposed a prohibition on irrigation in Stage 2 water restrictions to be consistent with the Towns of Cary and Apex. The Town of Fuquay-Varina has also proposed no new turf watering permits issued in Stage 1 restrictions and limiting indoor water use in Stages 2 and 3.

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D Detailed Summary of Water Conservation Measures in Cape Fear River Basin

E Alternative Analysis Project Cost Opinions

F Technical Memorandum for OASIS Hydrologic Model of Cape Fear and Neuse River Basins for Interbasin Transfer

G Public and Agency Comments

List of Acronyms

7Q10	Lowest 7-day average flow that occurs, on average, once every 10 years
AACE	Association for the Advancement of Cost Engineering
ACS	American Community Survey
AFSA	Anadromous fish spawning areas
AMI	Advanced metering infrastructure
AMR	Automated meter reading
AOP	Advanced oxidation process
AQI	Air Quality Index
ATC	Authorization to Construct
AWWA	American Water Works Association
BFE	Base flood elevation
BGPA	Bald and Golden Eagle Protection Act
BMP	Best management practice
BOD	Biochemical oxygen demand
C	Federal candidate
CAMPO	North Carolina Capital Areas Metropolitan Planning Organization
CFPUA	Cape Fear Public Utility Authority
CDSA	Construction Demographic Study Area
CFNCRB	Cape Fear-Neuse Combined River Basin Model
cfs	Cubic feet per second
CoCoRaHS	National Weather Service Community Collaborative Rain, Halil, and Snow Network
COOP	National Weather Service Cooperative Observer Program
CWA	Clean Water Act
DAQ	North Carolina Division of Air Quality
dB(A)	A-weighted decibel
DCP	Drought Contingency Plan
DEMLR	Division of Energy, Mining, and Land Resources
DEQ	North Carolina Department of Environmental Quality
DFR	North Carolina Division of Forest Resources
DOA	North Carolina Department of Administration
DPR	Direct potable reuse
DWI	North Carolina Division of Water Infrastructure
DWR	North Carolina Division of Water Resources
E	Federally endangered
ECIA	East Clayton Industrial Area
EDPNC	Economic Development Partnership of North Carolina
EIS	Environmental Impact Statement

List of Acronyms

EMC	Environmental Management Commission
EPA	United States Environmental Protection Agency
ERC	Environmental Review Commission
ER/EID	Engineer's Report and Environmental Information Document
ESA	Endangered Species Act
ETJ	Extraterritorial jurisdiction
FSC	Federal Species of Concern
FEMA	Federal Emergency Management Agency
FONSI	Finding of No Significant Impact
GAC	Granular activated carbon
GCM	Global climate model
GIS	Geographical information system
gpcd	Gallons per capita day
gpd	Gallons per day
gpm	Gallons per minute
HQW	High quality waters
HUC	Hydrologic unit code
IBT	Interbasin transfer
ILA	Interlocal agreement
IPaC	U.S. Fish and Wildlife Service Information for Planning and Consultation
IPCC	Intergovernmental Panel on Climate Change
IPR	Indirect potable reuse
L1UBH	Lacustrine, limnetic, unconsolidated bottom, permanently flooded
LCFWSA	Lower Cape Fear Water and Sewer Authority
LRWRP	Town of Cary Long Range Water Resources Plan
LWSP	Local water supply plan
MBTA	Migratory Bird Treaty Act
MCL	Maximum contaminant level
mgd	Million gallons per day
mg/L	Milligram per liter
MSL	Mean sea level
NAAQS	National Ambient Air Quality Standards
NCAC	North Carolina Administrative Code
NCDOT	North Carolina Department of Transportation
NCGA	North Carolina Groundwater Association
NEPA	National Environmental Policy Act
NHM	National Hydrologic Model

List of Acronyms

NHP	Department of Natural and Cultural Resources Natural Heritage Program
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NRRRF	Neuse Regional Resource Recovery Facility
NRWASA	Neuse Regional Water and Sewer Authority
NSW	Nutrient sensitive waters
NWI	National Wetland Inventory
NWP	Nationwide Permit
ORW	Outstanding resource waters
OSBM	North Carolina Office of State Budget and Management
OWASA	Orange Water and Sewer Authority
PE	Federally proposed endangered
PEM1	Palustrine, emergent, persistent
PER	Preliminary engineering report
PFAS	Perfluorinated alkyl substances
PFO1	Palustrine, forested, broad-leaved deciduous
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
POTW	Publicly owned treatment works
PRMS	Precipitation-Runoff Modeling System
PSS1	Palustrine, scrub-shrub, broad-leaved deciduous
PUBH	Palustrine, unconsolidated bottom, permanently flooded
PVC	Polyvinyl chloride
PWC	Fayetteville Public Works Commission
R2UBH	Riverine, lower perennial, unconsolidated bottom
R4SBC	Riverine, intermittent, streambed, seasonally flooded
R5UBH	Riverine, unknown perennial, unconsolidated bottom, permanently flooded
RCP	Representative concentration pathways
RCW	Red-cockaded woodpecker
RDU	Raleigh-Durham-Umstead
RSSCT	Rapid small scale carbon tests
ROD	Record of Decision
ROW	Right of way
SAT	Federal similarity of appearance

List of Acronyms

SDSA	Service Demographic Study Area
SDWA	Safe Drinking Water Act
SEPA	State Environmental Policy Act
SFHA	Special Flood Hazard Areas
SHPO	North Carolina State Historic Preservation Office
SNHA	Significant natural heritage area
SRF	State Revolving Fund
Sw	Swamp waters
T	Federally threatened
TAZ	Traffic Analysis Zone
TMDL	Total maximum daily load
Tr	Trout waters
TSS	Total suspended solids
TWP	Triangle Water Supply Partnership
USA	Urban services area
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UT	Unnamed tributaries
UV	Ultraviolet
WDSA	Watershed Demographic Study Area
WIP	Western Intake Partnership
WMO	World Meteorological Organization
WQC	Water quality certification
WRC	North Carolina Wildlife Resources Commission
WRF	Water reclamation facility
WSRP	Water Shortage Response Plans
WTF	Water treatment facility
WTP	Water treatment plant
WWTP	Wastewater Treatment Plant

1. Project Description

1.1 Introduction

The Town of Fuquay-Varina is located in southern Wake County. The Town of Fuquay-Varina is located southeast of Holly Springs and south of the City of Raleigh at the Wake and Harnett County line. The Town of Fuquay-Varina operates and maintains two wastewater treatment facilities, wastewater conveyance infrastructure, and finished water storage and distribution system infrastructure. The Town of Fuquay-Varina does not own water supply and treatment infrastructure and has historically relied on the purchase of bulk finished water from Raleigh Water, Harnett County, and Johnston County to meet the Town's potable water needs via temporary interlocal agreements.

The Town of Fuquay-Varina initiated the planning process for a water supply project in 2016 with the commissioning of a Water Capacity Study (WithersRavenel|Freese and Nichols, 2017). The Water Capacity Study investigated potential future water supply sources and provided preliminary estimates of the projected water demand in the service area. To address the projected gaps in water availability in the future, the Water Capacity Study recommended that the Town of Fuquay-Varina pursue a partnership with a neighboring utility for water supply capacity, as a water source is not readily available to the Town.

The Town of Fuquay-Varina's service area spans two hydrologic basin boundaries as defined in General Statute § 143-215 22G. The Neuse River basin is designated as 10-1 and the Cape Fear River basin is designated as 2-3. Approximately 62 percent of the Town of Fuquay-Varina's service area is located in the Neuse River basin and 38 percent of the service area is located in the Cape Fear River basin. The hydrologic boundary between the Cape Fear basin (2-3) and the Neuse River basin (10-1) is located almost in the center of the Town of Fuquay-Varina's service area, following U.S. 55 to Judd Parkway and Holland Road and then south along U.S. 55 toward the Wake-Harnett County line. The interbasin transfer (IBT) boundary closely matches the hydrologic boundary with the exception of approximately 600 acres south and west of U.S. 401 at the center of the Town of Fuquay-Varina.

1.2 Project Description

On behalf of the Town of Fuquay-Varina, Hazen and Sawyer (Hazen) is preparing a North Carolina (State) Environmental Policy Act (SEPA) Environmental Impact Statement (EIS) to support the Town's request for a 6.17 million gallons per day (mgd) transfer of water from the Cape Fear River basin (2-3) to the Neuse River basin (10-1). The Town of Fuquay-Varina is pursuing an IBT certificate to meet the water supply needs in the Town's service area. The temporary interlocal lease agreements with wholesale purveyors are not available to the Town of Fuquay-Varina long-term. Therefore, the Town of Fuquay-Varina is pursuing this water supply project to secure a reliable permanent water supply source. A Notice of Intent (NOI) to the North Carolina Environmental Management Commission (EMC) was submitted by the Town of Fuquay-Varina on September 1, 2020.

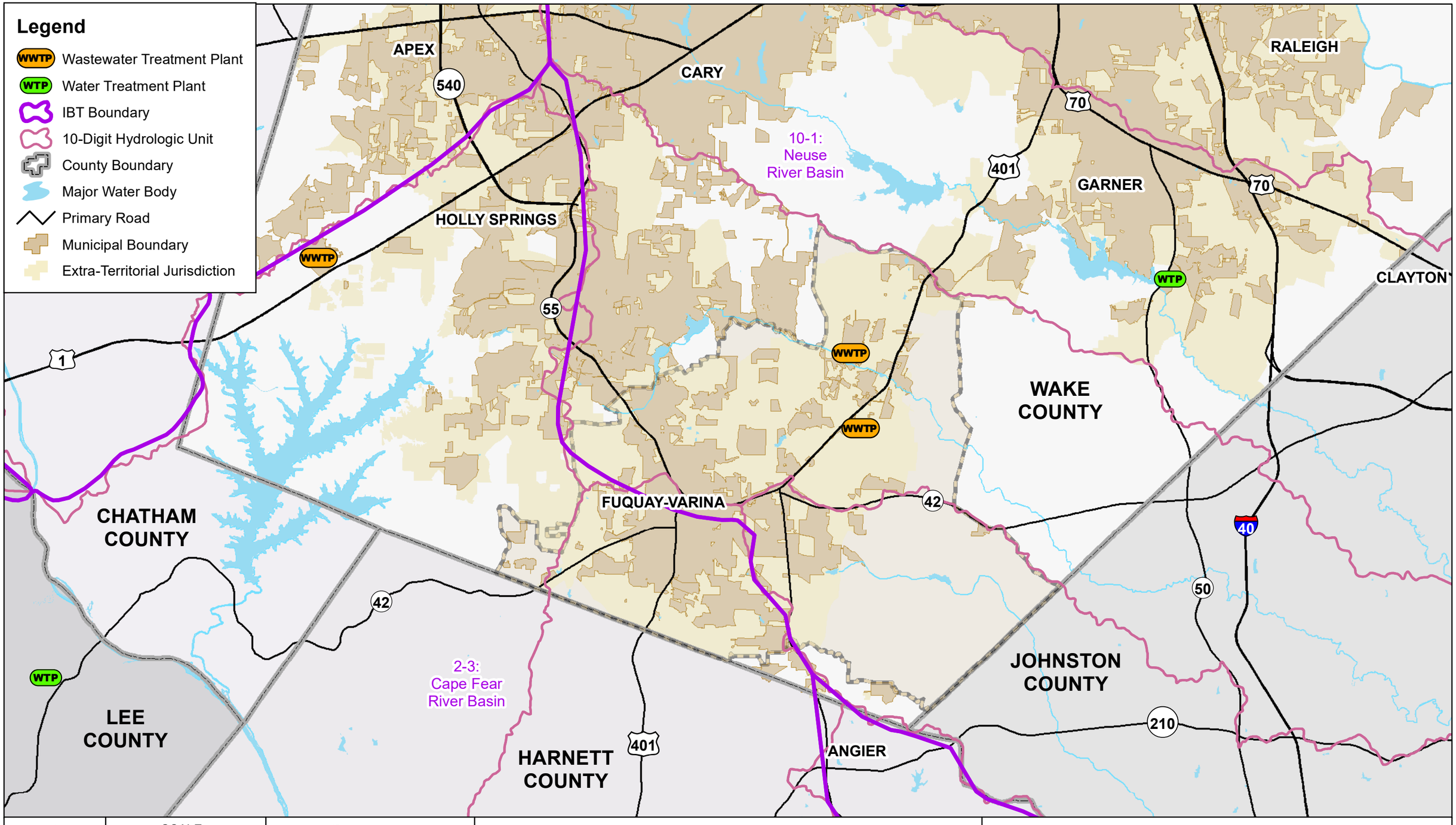
This EIS will support the North Carolina Department of Environment Quality (DEQ) decision-making process associated with the potential issuance of a Record of Decision (ROD). The EIS has been prepared to identify and discuss the potential environmental, cultural, and socioeconomic impacts associated with

implementing the proposed action. This document has been prepared in accordance with the requirements of General Statute § 143-215 .22L(d).

1.3 Service Area Description

The Town of Fuquay-Varina's service area consists of the municipal Town limits and extraterritorial jurisdiction (ETJ). The Town of Fuquay-Varina's service area abuts the Wake-Harnett County line. The Wake-Johnston County line is to the east of the service area. The service area extends north to the west of U.S. 401. The IBT boundary between basin 2-3 (Cape Fear) and basin 10-1 (Neuse) is located almost in the center of the Town of Fuquay-Varina's service area, following U.S. 55 to Judd Parkway and Holland Road and then south along U.S. 55 toward the Wake-Harnett County line. Figure 1-1 provides the location of the Town of Fuquay-Varina's municipal limits, ETJ, and IBT boundary. The Town of Fuquay-Varina's Urban Services Area (USA) extends east from the ETJ to the Wake-Johnston County line south of Highway 42, approximately 1.1 miles east of the ETJ north of Highway 42, and approximately 1 mile west of the ETJ in the southwest corner of the Town's service area near the Wake-Harnett County line.

Figure 1-2 illustrates the general area of review for this EIS. The review area for this interbasin transfer encompasses the Neuse (10-1) and Cape Fear River (2-3) basins. Harnett County is situated in the Cape Fear River (2-3) and South River (2-4) basin. The municipal limit for the City of Sanford (Lee County) is located in both the Deep River (2-2) basin and the Cape Fear River (2-3) basin. The municipal limits for the Towns of Holly Springs, Cary, and Apex are also located in multiple river basins: Neuse River basin (10-1), Haw River basin (2-1), and Cape Fear River basin (2-3). The City of Raleigh and Johnston County are entirely located in the Neuse River basin (10-1). Jordan and Harris Lakes are located in the Haw River basin (2-1) and Cape Fear River (2-3) basins, respectively.



N
W E
S

SCALE
1 inch = 2 miles
0 1 2
Miles

FUQUAY-VARINA
north carolina

Hazen

Figure 1-1: Town of Fuquay-Varina Service Area

Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

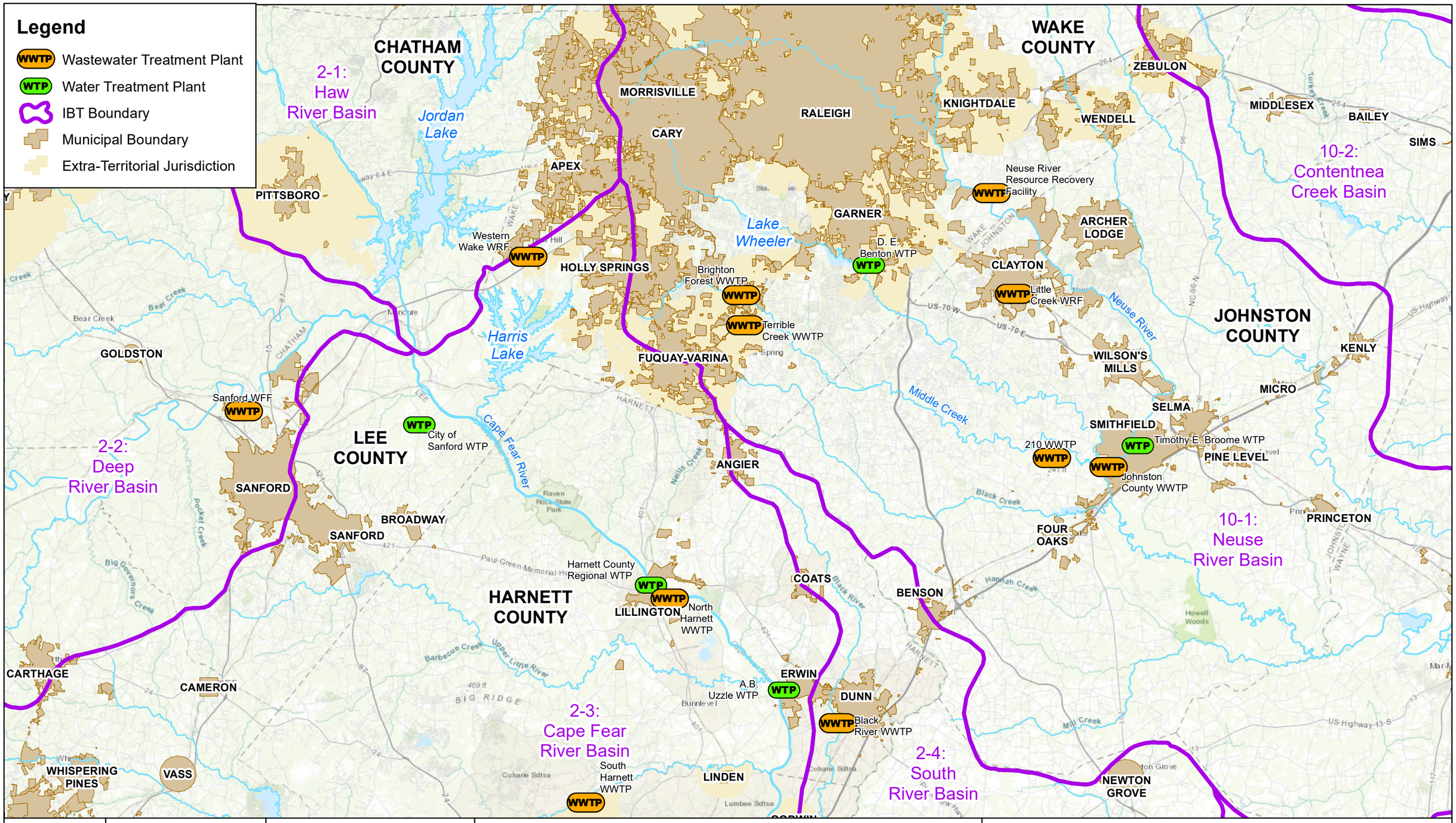


Figure 1-2: Review Area for Interbasin Transfer

Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

1.4 Summary of Town of Fuquay-Varina Infrastructure

1.4.1 Water Distribution

The Town of Fuquay-Varina owns and operates the water distribution system in the majority of the service area. Harnett County provides water service to 397 accounts in the southern end of the Town of Fuquay-Varina's service area near the Wake-Harnett County line. The Town of Fuquay-Varina's water distribution system network includes approximately 250 miles of water line, three pump stations, one ground storage tank, and two elevated storage tanks.

Finished water is delivered to the Town of Fuquay-Varina via three bulk finished water wholesale purveyors. Harnett County supplies the Town of Fuquay-Varina from the primary connection at the Wake County groundwater storage tank and pump station located at Fleming Road. The Town of Fuquay-Varina's secondary connection point with Harnett County is at U.S. 401 near the Wake County and Harnett County border. Raleigh Water's connection to the Town of Fuquay-Varina's distribution system is at U.S. 401 and Ten Ten Road. The Town of Fuquay-Varina's connection point with Johnston County is at Highway 42 and Mount Pleasant Church Road.

1.4.2 Wastewater Collection and Treatment

The Town of Fuquay-Varina's collection system has been designed based on the hydrologic basin boundary between the Neuse and Cape Fear River basins. The Town of Fuquay-Varina currently conveys all produced wastewater in the Cape Fear River basin portion of the Town's service area to Harnett County's North Regional Wastewater Treatment Plant (WWTP) for treatment and discharge. The North Harnett Regional WWTP discharges to the Cape Fear River via National Pollutant Discharge Elimination System (NPDES) permit NC0021636. The Town of Fuquay-Varina conveys the majority of produced wastewater in the Neuse River basin to the Terrible Creek WWTP (NPDES Permit NC0066516) for treatment and discharge. Terrible Creek WWTP was expanded to a maximum month capacity of 3 mgd in 2018 and is currently being expanded to 6 mgd. A small fraction of produced wastewater (i.e., 0.117 mgd) in the Neuse River basin is treated at the Town of Fuquay-Varina's Brighton Forest WWTP, which serves single family homes in the Brighton Forest and Rutherford Subdivisions. The Town of Fuquay-Varina has never had the ability to transfer raw wastewater between the Cape Fear and Neuse River basins.

The Town of Fuquay-Varina previously owned and operated the 1.2 mgd Kenneth Branch WWTP. The Kenneth Branch WWTP was located in the Cape Fear portion of the Town's service area. The Kenneth Branch WWTP discharged to Kenneth Creek as authorized by NPDES permit NC0028118. The Kenneth Creek receiving stream is a tributary to Neals Creek, which is tributary to the Cape Fear River upstream of the Town of Lillington. In 2006, the Town of Fuquay-Varina decommissioned the Kenneth Branch WWTP and rescinded the NPDES permit (NCDENR, 2008). The Town of Fuquay-Varina deeded the property to the Wake County Public School System in 2022. The Wake County Public School System is currently constructing middle and elementary schools on this property.

1.4.3 Interlocal Agreements for Bulk Finished Water and Wastewater Allocation

Table 1-1 provides a summary of the Town of Fuquay-Varina's Interlocal Agreements (ILAs) with neighboring communities for bulk finished water supply and wastewater allocation. The summary includes the contract amount, expiration date, and comments regarding the likelihood of contract renewal. The Town of Fuquay-Varina has signed temporary interlocal lease agreements with Raleigh Water, Harnett County, Johnston County, and the City of Sanford for the purchase of bulk finished water. The Town of Fuquay-Varina signed an ILA with Harnett County for the purchase of wastewater allocation in the North Harnett Regional WWTP. The Town of Fuquay-Varina purchases approximately 50 percent of finished water from Harnett County. The following sections provide a summary of the interlocal agreements. The ILAs are provided in Appendix A.

Table 1-1: Summary of Town of Fuquay-Varina's Interlocal Agreements for Water Supply and Wastewater Capacity

Supplier	Contract Value	Service	Comment
Johnston County	1.5 mgd	Water	Contract expires in 2049. Town of Fuquay-Varina does not anticipate a contract renewal.
Raleigh Water	0.75 mgd	Water	Contract expired in 2021.
Raleigh Water	1.75 mgd	Water	Town of Fuquay-Varina signed a new contract for 1.75 mgd until 2035. Contract renewal is not anticipated per correspondence with Raleigh Water.
Harnett County	2 mgd	Water	Contract expires in 2040. Town of Fuquay-Varina anticipates a contract renewal in 2040.
Harnett County	2 mgd	Water	The Town of Fuquay-Varina has negotiated an additional 2 mgd with contract expiring in 2032.
Harnett County	2.6 mgd	Wastewater	Contract expires in 2040 and automatically renews for an additional 40 years. The Town of Fuquay-Varina signed an amendment in 2023 to the ILA for the purchase of the Town's additional 3.4 mgd wastewater allocation in the North Harnett Regional WWTP (NC0021636) for a total of 6 mgd.
City of Sanford	6 mgd	Water	Contract expires in 2122 with option to renew for another 99 years. The Town's LWSP lists water supply from the City of Sanford as follows: 8 mgd in 2045, 10 mgd in 2050, and 11 mgd in 2055.

1.4.3.1 Wastewater Allocation

The Town of Fuquay-Varina signed an ILA with Harnett County for the purchase of wastewater allocation in the North Harnett Regional WWTP in 2000. Per the ILA, the Town of Fuquay-Varina does not have any right of ownership in the North Harnett Regional WWTP. Therefore, the Town of Fuquay-Varina does not own actual treatment capacity in the North Harnett Regional WWTP. The Town of Fuquay-Varina's ILA with Harnett County allows the Town to increase the Town's wastewater allocation in the North Harnett Regional WWTP by an additional 3.4 mgd, for a total of 6 mgd. The ILA expires in 2040 and automatically renews for

an additional 40 years. Harnett County issued a Letter of Intent (Harnett County, 2021) to the Town of Fuquay-Varina that confirms the Town's participation in the North Harnett Regional WWTP expansion project. The Town of Fuquay-Varina and Harnett County executed an amendment to the ILA in 2023 for the Town's purchase of an additional 3.4 mgd of capacity.

The Town of Fuquay-Varina's ILA with Harnett County also included a 15-mile interceptor to convey wastewater flow from the Town's service area in the Cape Fear watershed to the North Harnett Regional WWTP. Per a 201 Facilities Plan for the Town of Fuquay-Varina and Harnett County (Marziano and Minier, PA, Consulting Engineers, 2002), a 36-inch interceptor was proposed from the former Kenneth Branch WWTP site. The Town of Fuquay-Varina owns the 36-inch diameter interceptor segment in Wake County. The Town of Fuquay-Varina's ownership of the interceptor terminates at the meter vault at the Wake and Harnett County line. Harnett County owns the remaining 42 and 48-inch diameter interceptor segments from the meter vault to a pump station located on the north side of the Cape Fear River. The pump station pumps raw wastewater to the North Harnett Regional WWTP on the south side of the Cape Fear River.

The Town of Fuquay-Varina and Harnett County interceptor was designed and constructed in accordance with applicable design criteria in the 1996 version of the Minimum Design Criteria for the Permitting of Gravity Sewers (DWR, 1996) to meet the capacity needs of the proposed project in 2000. The hydraulic capacity of the Town of Fuquay-Varina's allocation in the interceptor is 6 mgd average day flow with a hydraulic peak flow of 12 mgd as stated in the ILA. The capacity of the 36-inch diameter interceptor was confirmed with a hydraulic model.

1.4.3.2 Bulk Finished Water

The Town of Fuquay-Varina has not secured a permanent water supply source. The Town of Fuquay-Varina does not own a raw water intake, water treatment infrastructure, or purchased permanent water supply capacity from a neighboring community. The Town of Fuquay-Varina has historically signed temporary ILAs with neighboring communities for wholesale finished water.

The Town of Fuquay-Varina signed an ILA with Harnett County for the purchase of a bulk finished water allocation in the Harnett County Regional Water Treatment Plant (WTP) over a 50-year term. The first ILA was signed in 1989 and specified a finished water allocation of 1 mgd to the Town of Fuquay-Varina. A second ILA was signed in 1999 and specified an additional 1 mgd of allocation, for a total allocation of 2 mgd to the Town of Fuquay-Varina. The Town of Holly Springs was also included in the 1999 agreement. The 1989 and 1999 ILAs expire in 2040. Per the ILA, the Town of Fuquay-Varina does not have any right of ownership or title to the Harnett County Regional WTP. The Town of Fuquay-Varina has the right to expand the Harnett Regional WTP only in expansion increments specified by Harnett County. The Town of Fuquay-Varina must purchase a minimum of 100,000 gallons per day (gpd). Per the 1989 ILA, Harnett County reserves the right to curtail water supply proportionally to Harnett County customer restrictions or in emergency situations.

The 1999 ILA with Harnett County included a 36-inch finished water transmission line and an increase in the finished water pumping capacity at the Harnett County Regional WWTP. The Town of Fuquay-Varina does own real property in the 36-inch finished water transmission main and finished water pump station at 5 mgd

and 2.609 mgd, respectively. Harnett County owns the property associated with the project. The Town of Fuquay-Varina has purchased approximately 75 percent of finished water from Harnett County since 2002.

In 2022, the Town of Fuquay-Varina negotiated with Harnett County for an additional 2 mgd increase in water allocation until 2032. This additional 2 mgd of allocation was not explicitly included in the IBT calculations. The Town of Fuquay-Varina agreement with Harnett County is a temporary measure to provide water to the Town to mitigate the anticipated extended timing of construction of the City of Sanford's WTP and the associated finished water transmission main. The Town of Fuquay-Varina will not use the temporary lease agreement for the additional 2 mgd of water allocation from Harnett County once the City of Sanford's WTP expansion project is completed.

The Town of Fuquay-Varina signed a temporary ILA with Raleigh Water for the purchase of bulk finished water in 2021. The Town of Fuquay-Varina's first ILA with Raleigh Water was signed in 2000 and expired in 2021. The 2021 ILA allows the Town of Fuquay-Varina to purchase up to 1.75 mgd until 2035. The ILA states that the agreement is intended to provide a short-term supply of water until the Town of Fuquay-Varina can secure another water supply. The ILA states that Raleigh Water has the right to deny the Town of Fuquay-Varina water service in the event that water cannot be supplied without negatively impacting City of Raleigh customers.

The ILA between the Town of Fuquay-Varina and Johnston County is for the purchase of up to 1.0 mgd average day and up to 1.5 mgd peak. The ILA specifies that the Town of Fuquay-Varina's supply will be reduced in the event of an extended water shortage or water supply is unavailable to Johnston County. The rate of reduction for the Town of Fuquay-Varina in the ILA is stated to be the same as for Johnston County's other bulk finished water customers. The ILA has a contract expiration date of 2049. Per correspondence with Johnston County, the Town of Fuquay-Varina understands that the ILA with Johnston County will not be renewed after 2049.

The Town of Fuquay-Varina signed an ILA with the City of Sanford for the purchase of 6 mgd. Per the ILA, the Town of Fuquay-Varina has a right of ownership in the City of Sanford's WTP per the formula specified in the ILA. The Town of Fuquay-Varina has the right to future expansion of the water treatment infrastructure. The ILA also specifies that water conservation measures must be followed if stipulated by the City of Sanford or the State of North Carolina.

1.5 Summary of Applicable Regulation

Regulatory codes, statutes, and policy are referenced throughout this EIS to provide context for the alternatives analysis and other sections of this document. For clarity, a summary and explanation of the regulations referenced herein are described in the following sections. If a regulatory issue is mentioned in a subsequent section, the EIS text will provide the regulatory citation or reference.

1.5.1 Permit Requirements for Water Treatment Facilities and Surface Water Withdrawals

For Publicly Owned Treatment Works (POTWs) in North Carolina, a water withdrawal is linked to the filtration capacity of the accompanying water treatment facility. Prior to 2015, most water treatment plant

expansions were required to submit environmental documentation per 15A North Carolina Administrative Code (NCAC) 01C and General Statute § 113A. A proposed water treatment plant expansion (or new water treatment plant) greater than 1 mgd and/or a surface water withdrawal greater than 20 percent of the 7Q10 required the submittal of environmental documentation to the State Department of Administration (DOA) Environmental Review Clearinghouse for review per 15A NCAC 01C. Projects receiving State Revolving Fund (SRF) loans for drinking water projects must submit National Policy Act (NEPA) environmental documentation to the Division of Water Infrastructure (DWI) under a separate process.

Session Law 2015-90 (i.e., House Bill 795) was signed into law in 2015. Session Law 2015-90, also called the SEPA Reform Act, added specific threshold requirements before environmental documentation is required per 15A NCAC 01C. The specific thresholds for the definition of a "significant" project are as follows:

- Greater than $10 million in state-provided grant money
- Greater than 10 acres of land disturbance that results in a permanent change to the landscape.

If a state agency has a project that meets the definition of significant per the aforementioned criteria, then the state agency must provide an evaluation of the proposed project with respect to several factors, as follows:

- Direct impact of the proposed project.
- Significant adverse environmental impacts.
- Proposed mitigation.
- Alternatives to the proposed project.
- Evaluation of the relationship between short-term uses of the impacted environment from the proposed project versus the enhancement of long-term productivity.
- Any irreversible and irretrievable environmental changes that could occur as a result of the proposed project.

A POTW with a water treatment plant expansion and surface water withdrawal project must submit the proposed project to the North Carolina Division of Water Resources (DWR) Public Water Supply Section for plan review and approval. The application materials must include an Engineers Report that includes a purpose and need statement for the water and a description of potential area served by the proposed project. The Engineers Report must also address alternate sources of water supply that are available to the applicant. Once the Plan Review process is concluded, a POTW may proceed with construction. An Authorization to Construct (ATC) from the Public Water Supply Section is typically the final planning and permitting step in a water supply project. In addition to the aforementioned requirements, the ATC process also requires financial statements and any environmental documents, allowances, or permits required throughout the process.

1.5.2 Interbasin Transfer Legislation

An interbasin transfer, as defined by the North Carolina General Statutes, is the regulated movement of surface water from one river basin to another according to specific criteria. The IBT law does not prohibit transfers but requires that the effects of the transfer on the source and receiving basins be quantified prior to EMC approval of the transfer. The EMC issues IBT Certificates. The SEPA rules in 15A NCAC 01C and General Statute § 113A is used as the mechanism for presenting the project to regulatory agencies and stakeholders per General Statute § 143-215.22L. An interbasin transfer certificate is typically based on a 30 year planning window.

The hydrologic river basin boundaries were defined in 1991 by Session Law 712 (General Statute § 143-215 22G). The Cape Fear River is designated as basin 2-3. The Neuse River basin is designated as 10-1. The river basin designations used in Section 3 (Alternatives Analysis) and elsewhere in this EIS refer to the hydrologic river basin as defined by General Statute § 143-215 22G.

North Carolina is a riparian water use state, whereby riparian entities have a right to a reasonable use of water. The North Carolina General Statutes do not define or classify public water supplies as an inherent riparian right. In 1955, the General Assembly passed statutes requiring approval for water use in certain circumstances. The definition of river basins and associated basin designations (e.g., 10-1, 2-3, etc.) were passed in 1991 via Session Law 712 (Senate Bill 943). The General Assembly passed the 1993 Interbasin Transfer law via General Statute § 143-215.22G (Session Law 1993-348). In 2007, a major amendment to the Interbasin Transfer law was passed by the General Assembly (House Bill 820) with General Statutes § 143-215.22G and 215.22L. Updates were made by the General Assembly in 2013 (Session Law 2013-388).

The IBT definitions, requirements, and process are driven by the requirements of the General Statutes. The Administrative Code is deferential to the General Statutes. General Statute § 143-215.22L provides a specific definition of a surface water transfer. Per General Statute § 143-215.22L, an interbasin transfer certificate is required if any average water demand of 2 mgd in a maximum month or 3 mgd in one day (i.e., maximum day) is exceeded. General Statute § 143-215.22L also states the specific requirements for obtaining an IBT Certificate.

Administrative Code 15A NCAC 02E .0400 (adopted 1994) provides a qualitive description of a surface water transfer. In March 2022, DWR issued a draft rule revision for 15A NCAC .0400 (Regulation of Surface Water Transfers) in accordance with General Statute § 150B-21.3A. General Statute § 150B-21.3A requires state agencies to review existing rules every ten years and readopt, modify, or repeal as necessary. Some of the draft rule changes are in response to legal findings that suggest that DWR clarify through rulemaking administrative procedures contained in General Statutes § 143-215.22G and 215.22L.

1.5.3 USGS 7Q10 Statistic

The lowest 7-day average flow that occurs, on average, once every 10 years is defined as the 7Q10. The United States Geological Survey (USGS) publishes stream statistics for many stream locations in the State,

including the 7Q10, based on historic stream gage records. A 7Q10 statistic may be updated and/or determined from published stream gage records using USGS statistical estimating techniques.

The 7Q10 statistic carries regulatory significance at the state and federal level. The 7Q10 is the statistical benchmark threshold in North Carolina for evaluating impacts to aquatic species per 15A NCAC 01C and setting NPDES permit discharge limits per 15A NCAC 02B. NPDES permits include effluent permit limits based on stream flow, which allows for assimilative capacity via effluent dilution and reoxygenation of the receiving stream. All wastewater discharges are required to be treated so that water quality standards are achieved during a low flow 7Q10 condition. Additionally, the 7Q10 statistic is important for permitting water withdrawals for public water supply systems per 15A NCAC 01C, as the 7Q10 may be influenced by a withdrawal and could potentially impact NPDES permitted discharges along the same stream reach.

1.5.4 Instream Flow Studies

The requirement for an instream flow study is referenced in the Alternatives Analysis (Section 3) with respect to new or expanding raw water intakes. If a new or expanding raw water intake exceeds 20 percent of the 7Q10 per 15A NCAC 01C, an environmental analysis of the ecological flow impacts (i.e., an instream flow study) and the preparation of an environmental document would be required. The 7Q10 statistic is the benchmark threshold in North Carolina for evaluating impacts on aquatic species. DWR requires a detailed environmental investigation and/or evaluation in coordination with the responsible resource agency, including but not limited to, the North Carolina Wildlife Resource Commission (WRC) and the United States Fish and Wildlife Service (USFWS) depending on the presence of state and federally listed threatened and endangered species, wild trout populations, or exceptional fishery resources with respect to the intake location. In some instances, a desktop or shortened analysis can be used depending on the available flow and habitat data. Based on applicable project experience with other instream flow studies, particularly streams with habitat for sensitive species, the anticipated time frame for the completion of a detailed instream flow study is 5 to 7 years with a potential cost of greater than $1 million. Examples of engineering fees and time frames for large instream flow study projects are provided in Table 1-2. Four of the five projects are specific to the Mid-Atlantic region.

Table 1-2: Summary of Engineering Fees and Timeframe for Instream Flow Studies

Instream Flow Study Project	Fee	Fee Date	Time Frame	Fee in 2023$ [1]
Tar River, NC	$1,180,000	2009	8 years	$1,780,000
Swift Creek, NC	$1,400,000	2006	7 years	$2,310,000
Savannah River, GA	$673,000	2007	5 years	$1,080,000
James River, VA	$780,000	2007	5 years	$1,250,000
Russian River, CA	$923,000	2007	> 6 years	$1,480,000

[1] *Fees updated to 2023 dollars using an annual 3% per year inflation.*

A receiving water is classified as a “special case” per the 15A NCAC 02K (i.e., “Dam Safety” rules) if populations of aquatic species listed as threatened or endangered by USFWS and WRC are present downstream of a dam. Special case streams also apply to classifications of exceptional non-game or fishery

resources by the WRC (15A NCAC 2K.0501[g][2] and [3]). If a receiving water is classified as a special case, then a site-specific instream flow study is required to establish a tiered minimum flow release from a dam per 15A NCAC 2K.0502 [c][4] of the 1995 Dam Safety rules. The 1995 Dam Safety Rules also stipulate that the minimum release shall be set no higher than an amount which would reduce the water supply yield by more than 10 percent.

1.5.5 General Statute § 153A-15, Property Acquisition Outside County Boundaries

General Statute § 153A-15 requires the consent of a Board of Commissioners prior to condemnation or property acquisition in another county. A unit of local government may not purchase or condemn land outside the county boundary without written consent of the Board of Commissioners of the county in which the land is located. General Statute § 153A-15 applies to the majority of counties in North Carolina, including Wake County, Johnston County, Cumberland County, Chatham County, Lee County, and Harnett County.

1.5.6 Surface Water Reclassification Process

Administrative Code 15A NCAC 2B .0100 and .0200 outlines the process for surface water reclassification in North Carolina. A local government is required to obtain a letter of resolution from all affected local governments that supports or has no objection to the reclassification process if the reclassification results in a more protective water supply classification due to the potential land use restrictions that will be enforced by the local government responsible for jurisdiction. Water quality studies conducted by DEQ may be required to demonstrate if the water meets the proposed classification. Once the application is completed by the local government, then approval must be granted by the EMC via a formal legal process to amend the existing classification. The legal process (i.e., rulemaking) includes formal hearings and a comment period to solicit feedback from the public. Once the reclassification is adopted by the EMC, the rules go to the Rules Review Commission for approval. Legislative review is required if formally requested by more than 10 people. The United States Environmental Protection Agency (EPA) has final approval authority. The minimum time frame for the reclassification process is 18 months; however, the reclassification can range from three to five years based on other surface water reclassifications in the state.

1.5.7 North Carolina Water Use Rights

North Carolina follows a riparian doctrine for water use in the state and not a water allocation model. The riparian doctrine states that any property owner with property adjacent to a surface water has the right to reasonable use of the water. Riparian rights also apply to groundwater. Reasonable use means that a riparian owner may use and discharge surface water if the use does not diminish the quality or quantity of the downstream use. In North Carolina, riparian landowners have equal riparian rights. Except in specific circumstances, water is not allocated to users in North Carolina. The North Carolina General Statutes do not define or classify public water supplies as an inherent riparian right.

As of 1991, North Carolina requires registration, not a permit, for significant surface water and groundwater withdrawals via General Statute § 143-215.22H and 15A NCAC 02E. Agricultural users must register when a withdrawal meets or exceeds 1 mgd on any single day. Non-agricultural users must register withdrawals

when the withdrawal meets or exceeds 0.1 mgd on any single day. Registrants are required by Administrative Code 15A NCAC 02E.0600 to report all water withdrawals annually for the previous year's use. The General Assembly attached civil penalties in 2008 for failure to comply with registration requirements.

1.5.8 Basinwide Hydrologic Models

General Statute § 143-355(o) compels DWR to develop hydrologic models for each of the 17 major river basins in North Carolina with approval and modification responsibilities granted to the EMC. The models must include water uses in the basin and any other withdrawal, ecological flow, instream flow requirements, future withdrawal projections, and local water supply plan (LWSP) data. The hydrologic models developed for the Cape Fear and the Neuse River basins were updated in this EIS to evaluate the impact of the proposed interbasin transfer.

1.5.9 Local Water Supply Plans

Per General Statute § 143-355(l), POTWs that provide public water service for large community systems must prepare an annual LWSP to DWR for review and approval. The LWSP includes a summary of existing water use, a description of the service area, current and projected population estimates, projected water demands (including residential, commercial, and industrial use), and a summary of existing and future water supplies. LWSPs are publicly available on DEQ's website at https://www.ncwater.org/WUDC/app/LWSP.

Projected water demands in a LWSP are not to be construed or interpreted as a water allocation. The data contained in LWSPs provides a snapshot of the water needs for a community over a 40 to 50 year planning window. It was noted that a few communities expressed overly optimistic forecasting of future water needs, which were substantially out of alignment with the Office of State Budget and Management (OSBM) population estimates. However, in all but a few cases the forecasted water demands in the individual LWSPs were used in the hydrologic modeling for the Town of Fuquay-Varina proposed IBT.

1.5.10 Water Shortage Response Plans

General Statute § 143-215.22H was amended in 2008 via Session Law 2008-143 (House Bill 2499). Every POTW providing water service to a large community is required to implement water conservation measures in response to drought conditions. The statute changes also requires tiered levels of water conservation or other response action based on drought severity. The tiers must include more stringent restrictions as drought severity worsens. The WSRPs must be approved by DWR.

2. Purpose and Need

Population, water demand, and IBT projections were developed to support the Town of Fuquay-Varina's request for a transfer of water from the Cape Fear River basin (2-3) to the Neuse River basin (10-1). An interbasin transfer certificate is based on a 30-year planning horizon. The projections for the proposed action used the year 2025 as the start of the planning horizon and estimated to the year 2055. The following sections summarize the population, water demand, and IBT projections for the Town of Fuquay-Varina. A Technical Memorandum is provided in Appendix B of this EIS that provides a detailed discussion of the data and assumptions in the analysis.

2.1 Population

2.1.1 Historic Population

Historic population data was collected from the Town of Fuquay-Varina's LWSPs, the OSBM, and the American Community Survey (ACS) from the U.S. Census Bureau. The Town of Fuquay-Varina's 2023 population is estimated at 43,500 people. The population in the service area grew at an annual rate ranging from 3.8 percent to 8.3 percent since 2009 based on a five-year moving average. A five-year moving average was used to smooth out the year-over-year variability in growth. The majority of the Town of Fuquay-Varina's growth has occurred in the last 15 years, so a five-year moving average was selected to describe the annual growth in lieu of another metric (e.g., a ten-year moving average). Table 2-1 summarizes the historic population for the Town of Fuquay-Varina. Based on historic data, the Town of Fuquay-Varina's average residential people per account is 2.36, which is slightly lower than the national average of 2.6 as reported by Vickers (2001) and 2.62 reported by the U.S. Census Bureau (2021).

The Town of Fuquay-Varina's growth started to accelerate in 2016 when the annual growth rate increased from 5.85 percent to 13.9 percent. In 2016, the Town of Fuquay-Varina commissioned a Water Capacity Study (WithersRavenel|Freese and Nichols, 2017) to evaluate water supply needs in response to the increase in growth. As a comparison, the 2010 annual growth rate was reported to be 19.58 percent; however, the high 2010 annual growth rate was likely due to a correction in the growth rates of less than 1 percent annually from the previous three years. In 2016, the Town of Fuquay-Varina's reported historic population per the LWSPs began to deviate from the OSBM and ACS population estimates. The OSBM and ACS data reported a slightly lower population than the Town of Fuquay-Varina's LWSP population between 2016 and 2018.

2.1.2 Population Projections

Growth in Wake County and the Piedmont region has been significant due to several factors. The I-540 interchange has been in the planning process since the mid-1990s. The first stretch of I-540 opened in 1999 and the Triangle Expressway Southeast Extension between the Town of Holly Springs and the Town of Garner is under construction after approximately 15 years of delay. More significantly to the growth pressure is the recent economic development drive by the North Carolina Department of Commerce and the Economic Development Partnership of North Carolina (EDPNC) to attract industry to North Carolina. Founded as a non-profit in 2014, EDPNC is funded both by a contract with the North Carolina Department

of Commerce and by private investment to provide economic development services. EPDNC, in partnership with the North Carolina Department of Commerce, has been highly successful in attracting new industry to the Piedmont region.

Table 2-1: Summary of Historic Population

Year	Population from Local Water Supply Plan	Annual Growth Rate (Five-year Moving Average)	Annual Growth Rate	Population from Office of State Budget and Management [2]	Population from American Community Survey [3]
1997	6,249	----	5.5%	----	----
1998	7,066 [1]	----	13.1%	----	----
1999	7,883 [1]	----	11.6%	----	----
2000	8,701 [1]	----	10.4%	----	----
2001	9,518 [1]	----	9.4%	----	----
2002	10,335	10.6%	8.6%	----	----
2003	11,397 [1]	10.0%	10.3%	----	----
2004	12,460 [1]	9.6%	9.3%	----	----
2005	13,522 [1]	9.2%	8.5%	----	----
2006	14,584	8.9%	7.9%	----	----
2007	14,723 [1]	7.4%	0.95%	----	----
2008	14,861 [1]	5.5%	0.94%	----	----
2009	15,000	3.8%	0.93%	----	----
2010	17,937	6.1%	19.6%	18,109	16,152
2011	18,600	5.2%	3.7%	18,643	17,074
2012	19,674	6.2%	5.8%	19,386	18,143
2013	19,804	6.1%	0.66%	19,726	19,164
2014	21,653	7.8%	9.3%	21,693	20,246
2015	22,920	5.1%	5.9%	22,858	21,399
2016	26,105	7.1%	13.9%	24,365	22,722
2017	27,600	7.1%	5.7%	25,548	24,373
2018	29,450	8.3%	6.7%	26,924	25,932
2019	29,200	6.3%	-0.85%	----	----
2020	33,000	7.7%	13.0%	34,604	----
2021	34,152	5.6%	3.5%	----	----
2022	39,468	7.6%	15.6%	----	----
2023	43,481	10.6%	10.2%	----	----

[1] Linear interpolation of population data.

[2] Population recorded using a fiscal year starting July 1.

[3] U.S. Census Bureau data as of April 2020.

The Town of Fuquay-Varina is a secondary recipient of this growth. The Town has not gained new industry but is instead planning around the effects of residential and commercial growth to support surrounding communities' industrial growth. Furthermore, communities in the Triangle Region have been identified as best places in the United States to live and work, which has in part resulted in growth in the Piedmont region. Per the Town of Fuquay-Varina's Planning Department, annual population growth in the Town has been consistent over the last several years. In response to this growth, the Town of Fuquay-Varina has also seen a change in the mix of residential and commercial development over the last several years. The Town of Fuquay-Varina expects this change in land use to continue per the Town's Community Vision Land Use Plan.

The population projections documented in the Town of Fuquay Varina's LWSPs reflect the activity in the region given the uncertainties with the timing of North Carolina Department of Transportation (NCDOT) road projects and other economic development activities. The Town of Fuquay-Varina has adjusted population projections in the annual LWSPs as warranted by activity in the region. Table 2-2 provides a summary of the population projections as reported in the Town of Fuquay-Varina's LWSPs compared to the historic population. The following are observations with respect to the historic population compared to the population projections in the LWSPs:

- The 2010 population projection as reported in a 1989 Diehl and Phillips Comprehensive Water and Wastewater Facility Study, the 2006 LWSP, and the 2009 LWSP was 19,184 people compared to the 2010 historic population of 17,937 people.
- The 2020 population projection as reported in the 2010 LWSP was 27,662 people compared to the historic 2020 population of 33,000 people.
- The 2020 population projection as reported in the 2016 LWSP was 31,105 people compared to the historic 2020 population of 33,000 people.
- The 2030 population projection as reported in the 2002 LWPS was 43,724 people as compared to a population projection of 51,530 people as reported in the 2023 LWSP.

Hazen and Sawyer updated the Town of Fuquay-Varina's population projections to support the proposed request for an interbasin transfer. The Town of Fuquay-Varina commissioned Hazen in early 2019 to begin the planning process. The population projections as reported in the Town of Fuquay-Varina's 2020 to 2023 LWSPs reflect the updated planning estimates for the Town's proposed interbasin transfer project.

ACS Block Group data was used to establish the growth areas in the municipal limits and ETJ (e.g., service area). The Wake County parcel data was linked to meter consumption (i.e., billing data) to filter existing accounts to residential homes and year built. The analysis resulted in a 2018 served population of 27,700 people compared to the historic population estimate of 29,450 people, a reasonable 6 percent difference. The unserved population in the service area was determined to be 17,500 people. The Town of Fuquay-Varina's unserved population is on private well systems.

The North Carolina Capital Areas Metropolitan Planning Organization (CAMPO) Traffic Analysis Zone (TAZ) data was used to estimate the build-out population in the service area. Build-out is defined as the limit of potential development in a service area. The 2018 CAMPO data was used in the analysis. The 2018 TAZ

data has a baseline year of 2013 and projects population and employment out to 2045. The 2013 baseline year for TAZ was updated to 2018 using the ACS Block Group data. The calculations also assume that the Town of Fuquay-Varina will connect homes on private well systems (i.e., unserved population) at a rate of 1 percent per year.

Table 2-2: Population Projections as Reported in Town of Fuquay-Varina's Local Water Supply Plans Compared to Historic Population

Local Water Supply Plan Year	Historic Population	Population Projection as Reported for a Local Water Supply Planning Year						
		2010	2020	2030	2040	2050	2060	2070
1989 Study [1]	----	19,148	21,405	----	----	----	----	----
1997 LWSP	6,249	18,268	38,942	----	----	----	----	----
2002 LWSP	10,335	14,510	25,188	43,724	----	----	----	----
2006 LWSP	14,584	19,184	30,684	42,184	53,684	65,184	----	----
2009 LWSP	15,000	19,184	30,684	42,184	53,684	65,184	----	----
2010 LWSP	17,937	17,937	27,662	42,162	59,662	77,162	94,662	----
2011 LWSP	18,600	----	27,662	42,162	59,662	77,162	94,662	----
2012 LWSP	19,674	----	27,662	42,162	59,662	77,162	94,662	----
2013 LWSP	19,804	----	27,662	42,162	59,662	77,162	94,662	----
2014 LWSP	21,653	----	27,662	42,162	59,662	77,162	94,662	----
2015 LWSP	22,920	----	27,662	42,162	59,662	77,162	94,662	----
2016 LWSP	26,105	----	31,105	43,605	56,105	68,605	73,733	----
2017 LWSP	27,600	----	31,105	43,605	56,105	68,605	73,733	----
2018 LWSP	29,450	----	32,395	45,350	58,960	70,750	77,830	----
2019 LWSP	29,200	----	32,395	45,350	58,960	70,750	77,830	----
2020 LWSP [2]	33,000	----	33,000	51,530	70,290	89,050	108,000	126,000
2021 LWSP [2]	34,152	----	----	51,530	70,290	89,050	108,000	126,000
2022 LWSP [2]	39,468	----	----	51,530	70,290	89,050	108,000	126,000
2023 LWSP [2]	43,481	----	----	51,530	70,290	89,050	108,000	126,000

[1] *Diehl and Philips (1989).*

[2] *The Town of Fuquay-Varina's LWSP reflects IBT planning projections.*

The Town of Fuquay-Varina's near-term development data was compared to the 2025 TAZ projection data as a cross-check for reasonableness. The Town of Fuquay-Varina maintains proposed, approved, or under construction development geographical information system (GIS) data for single and multi-family lots. The Town of Fuquay-Varina's GIS development layer results in an additional 25,750 people that are estimated to be served by the Town in the next 5 to 7 years, which closely correlates to the anticipated 2025 TAZ population estimate. The build-out population is estimated to be approximately 135,000 people in the Neuse and Cape Fear River basins. The TAZ data does not provide an estimate of the timing of build-out population. The population served in the Neuse and Cape Fear River basins at build-out is approximately

62 percent and 38 percent, respectively. The ratio of anticipated growth in the Cape Fear and Neuse River basins is consistent throughout the planning period.

Several projection methods were used to evaluate the Town of Fuquay-Varina's population out to 2055. The population projections were developed using several statistical techniques on the historic data set. The data suggests that the historic growth follows an exponential pattern. The statistical best-fit growth curve resulted in a 2055 population scenario of 360,000 people, which is double the TAZ build-out population estimate. Population projections were then prepared using an annual growth rate to match the average number of accounts per year since 2015. This method resulted in a population estimate of 197,000 people in 2055. A linear best fit method resulted in a 2055 served population estimate of 98,400 people. The linear best fit method is consistent with the Town of Fuquay-Varina's expectations for growth based on the Town's Community Vision Land Use Plan. Additionally, a portion of this future served population estimate includes population in the service area on private wells. The Town of Fuquay-Varina anticipates that 20 to 25 private wells per year will be converted to Town services over the planning period. The selected population estimate for the IBT planning process using the linear fit method is summarized in Table 2-3.

Table 2-3: Summary of Population Projections in Town of Fuquay-Varina Service Area

Year	IBT Planning Population Projection [1]	IBT Planning Annual Percent Increase
2020	33,000	----
2025	42,150	4.7%
2030	51,530	3.8%
2035	60,910	3.2%
2040	70,290	2.7%
2045	79,670	2.4%
2050	89,050	2.2%
2055	98,430	1.9%

[1] *Population projection using linear best fit statistical method.*

2.2 Water Demand Analysis

The Town's account data was evaluated to discern trends in water use across the Town's service area. Account data was obtained from the Town's LWSP data. The water use classes evaluated are those reported by the Town to DWR as part of the annual LWSP. The six classes (e.g., residential, commercial, industrial, institutional, system process, and unaccounted-for) may be conceptually divided into revenue water classes (e.g., residential, commercial, industrial, and institutional) and non-revenue classes (e.g., system process, and unaccounted-for). Residential accounts, as a percent of the total number of accounts, ranged from 89 to 95 percent. Residential use accounted for approximately two-thirds of the water use in the service area between 2019 and 2022. The service area has seen an average increase in the number of residential accounts at an average of 6.1 percent per year between 2013 and 2022. Commercial accounts have historically comprised approximately 8 percent of the total number of accounts and 16 percent of the total water demand. The growth in residential and commercial accounts illustrates the

rapid rate of growth and is the primary driving force behind the Town's urgency to attain a new and reliable water supply.

2.2.1 Per Capita Demand

Unit water demand estimates for the Town of Fuquay-Varina's service area were evaluated by water use class and then added together to provide an aggregate unit demand (i.e., water use across all water classes divided by population served or a per capita demand metric). Table 2-4 summarizes the total water billed and purchased concurrently with per capita use. The Town of Fuquay-Varina has experienced a general decline in overall per capita demand since 2002 consistent with regional and national trends. Over the latest 10-year period (2013 to 2022), the aggregate per capita usage in the Town of Fuquay-Varina's service area was 81.9 gpcd, which represents approximately a 20 to 25 percent reduction from the prior 10-year period between 2003 and 2012 when the aggregate per capita demand was approximately 105 gpcd. The Town of Fuquay-Varina is now more efficient (i.e., using less water on an aggregate per capita basis) than most regional peer utilities in the Cape Fear River basin (refer to Table 2-5).

Table 2-4: Summary of Total Water Billed and Purchased Water Per Capita Demand for Town of Fuquay-Varina

Year	Total Water Billed, mgd [1]	Per Capita Water Demand (Billed), gpcd [1]	Total Water Purchased, mgd [1]	Per Capita Water Demand (Purchased), gpcd [1]	Unaccounted-For Water, %	Non-Revenue Water (Process and Unaccounted-for Water), gpcd [1]
2006	1.183	81.1	1.536	105.3	23.0%	24.2
2009	1.821	121.4	1.826	121.7	0.3%	0.3
2010	1.593	88.8	1.846	102.9	13.7%	14.1
2011	1.112	59.8	1.804	97.0	38.4%	37.2
2012	1.512	76.9	1.677	85.3	9.9%	8.4
2013	1.475	74.5	1.702	85.9	13.3%	11.5
2014	1.629	75.2	1.912	88.3	14.8%	13.1
2015	1.822	79.5	2.008	87.6	9.3%	8.1
2016	1.864	71.4	2.136	81.8	12.7%	10.4
2017	1.949	70.6	2.186	79.2	10.8%	8.6
2018	2.067	70.2	2.306	78.3	10.4%	8.1
2019	2.253	77.2	2.478	84.9	9.1%	7.7
2020	2.173	65.8	2.517	76.3	13.7%	10.4
2021	2.580	75.5	2.791	81.7	7.6%	6.2
2022	2.703	68.5	2.977	75.4	9.2%	6.9
Average (2013 – 2022)	**2.05**	**72.8**	**2.30**	**81.9**	**11.1%**	**9.1**

[1] *Per Town of Fuquay-Varina Local Water Supply Plans.*

Table 2-4 also includes an estimate of unaccounted for (i.e., non-revenue water) as reported in the Town of Fuquay-Varina's LWSPs. Unaccounted for water is the percentage of water not billed to customers and can include water for firefighting, flushing, water leakage, or theft. The Town of Fuquay-Varina's percentage of unaccounted for water has declined from 15.7 percent in 2002 to 9.2 percent in 2022. The average national water loss is 16 percent (Wiant, 2017; EPA, 2013).

Table 2-5 provides a summary of total per capita use for utilities in the Cape Fear and Neuse River basins based on approved 2022 LWSPs. The Town of Fuquay-Varina's total per capita use is less than other communities in the Cape Fear and Neuse River basins. Out of the utilities compared, only the Town of Holly Springs demonstrated a total per capita use comparable to the Town of Fuquay-Varina. The 2022 per capita use for Raleigh Water and Cary-Apex was 90.4 and 95.3 gpcd, respectively. Other utilities in the state range from 72 to 150 gpcd.

Table 2-5: Summary of Total Per Capita Use Data for North Carolina Utilities in the Cape Fear and Neuse River Basins

Utility	River Basin [1]	Data of Approved Local Water Supply Plan	Residential Per Capital Use, gpcd [2, 3]	Total Per Capita Use, gpcd [2, 4]
Raleigh Water	Neuse	2022 LWSP	51.3	90.4
Cary-Apex	Neuse and Cape Fear	2022 LWSP	49.1	95.3
Holly Springs	Neuse and Cape Fear	2022 LWSP	45.5	72.2
Harnett County	Cape Fear	2022 LWSP	49.1	96.1
Johnston County	Neuse	2022 LWSP	53.5	90.0
City of Durham	Cape Fear	2022 LWSP	42.5	93.9
City of Sanford	Cape Fear	2022 LWSP	41.6	135.7
Fayetteville PWC	Cape Fear	2021 LSWP	53.2	125.1
City of Greensboro	Cape Fear	2022 LWSP	52.3	108.5
City of Burlington	Cape Fear	2022 LWSP	50.2	154.1
City of High Point	Cape Fear	2022 LWSP	48.9	114.6
Town of Fuquay-Varina	Neuse and Cape Fear	2022 LWSP	48.1	75.4
Cape Fear Utility Authority	Cape Fear	2022 LWSP	58.7	101.8

[1] Hydrologic river basin boundaries as defined in 1991 by Session Law 712 (General Statute § 143-215 22G).

[2] Data extracted from approved 2022 Local Water Supply Plans.

[3] The residential per capita use is the residential service area demand divided by the year-round service area population.

[4] The total per capita use is the total service area demand (i.e., all revenue and non-revenue water use classes) divided by the year-round service area population.

2.2.2 Future Per Capita Demand

Projecting future water use for the Town of Fuquay-Varina involves multiplying the expected population by the expected rate of water use. The Town of Fuquay-Varina's historic 10-year average unit demand across all water classes divided by population served (i.e., aggregate per capita demand) from 2013 through 2022 was 81.9 gpcd. That value, nearly 82 gpcd, is a starting point for determining an appropriate water utilization

planning target for meeting the Town of Fuquay-Varina's expected growth. To assure a reliable supply over the next 30 years, the rate of use assumption for the Town was rounded up to 85 gpcd. The planning unit demand must account for the wider range of conditions that may occur over the 30-year IBT certificate period. These extenuating conditions may include periods of hot dry weather or more typical non-revenue water ratios as the Town of Fuquay-Varina's distribution system ages. Appendix B contains additional analyses of these factors.

2.2.3 Water Demand Projections

Table 2-6 provides a summary of the annual average, average day in a maximum month, and maximum day water demand for the Town of Fuquay-Varina. The annual average water demand projections assume 85 gpcd applied to the linear best fit population estimate over the planning period. Maximum month water demands were calculated to assess the average day water demand in a maximum month to meet the requirements of General Statute § 143 215.22L. Per General Statute § 143 215.22L, an interbasin transfer certificate is required if a daily average water demand of 2 mgd in a calendar month (e.g., maximum month) or 3 mgd in one day (e.g., maximum day) is exceeded. Maximum month and maximum day peaking factors of 1.18 and 1.5 were selected based on the Town of Fuquay-Varina's 2019 to 2022 water meter data.

Table 2-6: Summary of Annual Average, Maximum Month, and Maximum Day Water Demand Projections for Town of Fuquay-Varina

Year	Population [1]	Annual Average Water Demand, mgd [2]	Average Day in a Maximum Month Water Demand, mgd [3]	Maximum Day Water Demand, mgd [4]
2025	42,150	3.6	4.2	5.4
2030	51,530	4.4	5.2	6.6
2035	60,910	5.2	6.1	7.8
2040	70,290	6.0	7.1	9.0
2045	79,670	6.8	8.0	10.2
2050	89,050	7.6	8.9	11.4
2055	98,430	8.4	9.9	12.6

[1] Population projections from linear best fit regression method.

[2] Assumes a per capita use of 85 gpcd over the planning period.

[3] Maximum month peaking factor of 1.18. Maximum month water demands were calculated to assess the average day water demand in maximum month to meet the intent of General Statute § 143-215.22L.

[4] Maximum day peaking factor of 1.5.

2.3 Wastewater Flow Projections

Wastewater flow projections were developed for the Town of Fuquay-Varina (Hazen, 2023) using parameters specific to the characteristics of the Town of Fuquay-Varina's service areas in the Cape Fear and Neuse River basins. The wastewater flow projections are based on a percent account growth, a unit use per account, and a unit flow per account. The people per account is 2.36 based on the analysis from the interbasin transfer evaluation. The Neuse River basin per capita use averaged approximately 75.4 mgd

between 2018 and 2022 with a range of 56 and 82 gpcd from 2009 to 2022. The average Cape Fear River basin unit wastewater use was slightly higher at 99.5 gpcd between 2018 and 2022 with a range of 87.4 to 141.6 gpcd between 2009 to 2022.

Table 2-7 summarizes the wastewater flow projections in the Cape Fear and Neuse service areas through 2055. A range of percent annual sewer account growth was used to bracket the extent for which additional wastewater capacity would be needed in both river basins. The average percent wastewater account growth is 7.6 percent per year based on the aforementioned analysis with a minimum of 4.3 percent and a maximum of 10 percent. The Town of Fuquay-Varina anticipates that sustained growth will continue to occur over the next several years. Near-term account growth is anticipated to be between 4.3 and 7.6 percent. Wastewater flow projections are expected to be between 3.1 and 3.6 mgd in the Neuse service area by 2030 at an account growth of 7.6 and 10 percent, respectively. Wastewater flow projections in the Cape Fear service area are anticipated to be between 2.9 and 3.4 mgd by 2030 using an account growth of 7.6 and 10 percent, respectively. The 2055 wastewater flow projection in the Neuse service area is estimated to be between 4.1 and 7.6 mgd. The 2055 wastewater flow projection in the Cape Fear service area is estimated to be between 4.0 and 7.6 mgd. For planning purposes, the wastewater flow projections using the account growth rate of 7.6 percent was used.

Table 2-7: Summary of Town of Fuquay-Varina Annual Average Wastewater Flow Projections

Year	Neuse River Basin, mgd			Cape Fear River Basin, mgd		
	4.3% Account Growth	7.6% Account Growth [1]	10% Account Growth [1]	4.3% Account Growth	7.6% Account Growth [1]	10% Account Growth [1]
2025	1.7	1.9	2.0	1.8	2.0	2.1
2030	2.4	3.1	3.6	2.2	2.9	3.4
2035	2.9	3.7	5.2	2.7	4.1	5.1
2040	3.1	4.4	5.7	3.0	4.6	5.7
2045	3.4	4.9	6.3	3.3	5.0	6.3
2055	4.1	5.9	7.6	4.0	6.2	7.6

[1] *An accelerated growth of 7.6% and 10% reflects near-term growth as a result of the current economic opportunities in the region. The growth rate was reduced to 2% per year post 2035 for these two scenarios.*

2.4 Interbasin Transfer Projections

The interbasin transfer projections reflect the water demand in the Neuse River basin less water supply from the Neuse River basin. With the exception of 512 homes, all of the finished water supplied to the Neuse River basin is discharged to the Neuse River basin via the Town of Fuquay-Varina's Terrible Creek and Brighton Forest WWTPs. Water supplied to the Cape Fear River basin is discharged to the Cape Fear River via Harnett County's North Harnett Regional WWTP.

Tables 2-8 and 2-9 provide a summary of the average day in a maximum month and maximum day water demand projections, the Town of Fuquay-Varina's water supply contract amounts in the Neuse and Cape Fear River basins, and interbasin transfer projections. The basin distribution percentages are supported by

the TAZ population (Appendix B). Per the Town of Fuquay-Varina's discussions with Raleigh Water and Johnston County staff, the Town anticipates water supply purchases from Raleigh Water and Johnston County will end in 2035 and 2049, respectively. The interbasin transfer based on the average day in a maximum month by 2055 was calculated to be 6.17 mgd. By 2055, approximately 13 mgd of water supply will be required to support peak day needs in the Town of Fuquay-Varina's service area.

2.4.1 Consumptive Water Loss

Consumptive water loss is defined as the amount of water withdrawn from a surface water without recycling of the water (i.e., a return) to the source or origin (USGS, 2007). A few examples of consumptive loss activities include evaporation, transpiration, agricultural use, household use, lawn watering, household wastewater to a septic system, firefighting, and transmission main flushing. The water that is not returned to a centralized wastewater treatment plant, or "consumed," is the difference between the monthly average wastewater flow and the monthly average water use. Consumptive loss is typically applied as a percentage over the service area.

Appendix B provides a summary of the monthly consumptive loss percentages in the Town of Fuquay-Varina's service area from 2002 to 2022. The median consumptive loss over the period of record is approximately 17.5 percent (i.e., 17.5 percent of water supplied to the Town of Fuquay-Varina's service area is not returned to a centralized wastewater treatment plant). There are 512 non-vacant parcels that are located in the Cape Fear hydrologic boundary. Water is supplied to these parcels from the Cape Fear River and returned to the Cape Fear River via the North Harnett Regional WWTP. However, these 512 non-vacant parcels are legislatively located in the Neuse River basin per General Statute § 143-215.22L. Therefore, the only transfer of water for these parcels is the consumptive loss from these homes. The Town of Fuquay-Varina's medium consumptive loss percentage was applied to these non-vacant parcels in the interbasin transfer calculation. Figure 1-1 provides an illustration of the Town of Fuquay-Varina's service area to include the hydrologic and legislated IBT boundary.

Table 2-8: Summary of Average Day in a Maximum Month Water Demand, Water Supply Contract Amounts, and Interbasin Transfer

Year	Total Projected Demand, Average Day in a Maximum Month, mgd	Basin Distribution [1]		Water Demand in Basin, mgd [2]		Water Supply Source by Seller, mgd				Total Water Supply in Basin, mgd		Interbasin Transfer, Cape Fear to Neuse, mgd [4, 5]
		Neuse	Cape Fear	Neuse	Cape Fear	Raleigh (Neuse) [3]	Johnston County (Neuse) [3]	Harnett County (Cape Fear) [3]	Sanford (Cape Fear)	Neuse	Cape Fear	
2022	3.5	62.0%	38.0%	2.18	1.33	1.75	1.5	2	0	3.25	2	0.00
2025	4.2	61.7%	38.3%	2.61	1.62	1.75	1.5	2	6	3.25	8	0.00
2030	5.2	61.7%	38.3%	3.19	1.98	1.75	1.5	2	6	3.25	8	0.00
2035	6.1	62.0%	38.0%	3.79	2.32	1.75	1.5	2	6	3.25	8	0.56
2036	6.3	62.0%	38.0%	3.90	2.39	0	1.5	2	6	1.5	8	2.42
2040	7.1	62.0%	38.0%	4.37	2.68	0	1.5	2	6	1.5	8	2.89
2041	7.2	62.0%	38.0%	4.49	2.75	0	1.5	2	6	1.5	8	3.01
2045	8.0	62.0%	38.0%	4.95	3.04	0	1.5	2	8	1.5	10	3.47
2049	8.7	62.0%	38.0%	5.42	3.32	0	1.5	2	8	1.5	10	3.94
2050	8.9	62.0%	38.0%	5.54	3.40	0	0	2	10	0	12	5.55
2055	9.9	62.3%	37.7%	6.15	3.73	0	0	2	11	0	13	6.17

[1] Basin distribution based on TAZ build-out population analysis.

[2] Water demand in Town's service area.

[3] Water supply source currently in contract via temporary lease agreement (Interlocal Agreement).

[4] Water demand in Neuse less water supply from Neuse basin.

[5] A consumptive loss factor was applied to non-vacant parcels located in the Cape Fear River basin per hydrologic boundary line but are included in the Neuse River basin per the regulatory interbasin boundary line.

Table 2-9: Summary of Maximum Day Water Demand, Water Supply Contract Amounts, and Interbasin Transfer

Year	Total Projected Maximum Day Demand, mgd	Basin Distribution [1]		Water Demand in Basin, mgd [2]		Water Supply Source by Seller, mgd				Total Water Supply in Basin, mgd		Interbasin Transfer, Cape Fear to Neuse, mgd [4, 5]
		Neuse	Cape Fear	Neuse	Cape Fear	Raleigh (Neuse) [3]	Johnston County (Neuse) [3]	Harnett County (Cape Fear) [3]	Sanford (Cape Fear)	Neuse	Cape Fear	
2022	4.5	62.0%	38.0%	2.77	1.69	1.75	1.5	2	0	3.25	2	0.0
2025	5.4	61.7%	38.3%	3.32	2.06	1.75	1.5	2	6	3.25	8	0.08
2030	6.6	61.7%	38.3%	4.06	2.51	1.75	1.5	2	6	3.25	8	0.82
2035	7.8	62.0%	38.0%	4.82	2.95	1.75	1.5	2	6	3.25	8	1.58
2036	8.0	62.0%	38.0%	4.96	3.04	0	1.5	2	6	1.5	8	3.48
2040	9.0	62.0%	38.0%	5.56	3.41	0	1.5	2	6	1.5	8	4.07
2041	9.2	62.0%	38.0%	5.71	3.50	0	1.5	2	6	1.5	8	4.22
2045	10.2	62.0%	38.0%	6.30	3.86	0	1.5	2	8	1.5	10	4.81
2049	11.1	62.0%	38.0%	6.89	4.23	0	1.5	2	8	1.5	10	5.41
2050	11.4	62.0%	38.0%	7.04	4.32	0	0	2	10	0	12	7.05
2055	12.5	62.3%	37.7%	7.81	4.74	0	0	2	11	0	13	7.83

[1] *Basin distribution based on TAZ build-out population analysis.*

[2] *Water demand in Town's service area.*

[3] *Water supply source currently in contract via temporary lease agreement (Interlocal Agreement).*

[4] *Water demand in Neuse less water supply from Neuse basin.*

[5] *A consumptive loss factor was applied to non-vacant parcels located in the Cape Fear River basin per hydrologic boundary line but are included in the Neuse River basin per the regulatory interbasin boundary line.*

2.5 Purpose and Need Summary

The Town of Fuquay-Varina needs to secure a reliable permanent water supply source in lieu of the continuation of temporary interlocal lease agreements with wholesale suppliers to meet the projected growth and water demand. Per the contractual language in the ILAs (refer to Section 1.4), the Town of Fuquay-Varina does not have the right of ownership of treatment capacity in neighboring purveyor's treatment facilities. Therefore, the Town of Fuquay-Varina cannot control the production of water or guarantee a reliable water supply. Raleigh Water and Johnston County have the right to interrupt water service on an as-needed basis per the signed ILAs. Harnett County also reserves the right to curtail water supply proportionally to Harnett County customer restrictions or in emergency situations. The Town of Fuquay-Varina receives approximately 50 percent of finished water from Harnett County. If service from Harnett County is interrupted, approximately half of the Town of Fuquay-Varina's finished water is at risk.

The Town of Fuquay-Varina's population growth and corresponding water demand projections support the need for additional water supply to meet the Town's water demand and provide a reliable permanent water supply source. Table 2-10 summarizes the Town of Fuquay-Varina's average day in a maximum month water demand projections, the interbasin transfer projections from the Cape Fear River basin to the Neuse River basin, the Town's total current water supply contract amount, and the projected water supply shortfall. The water supply shortfall is calculated as the difference between the Town of Fuquay-Varina's current total

Table 2-10: Fuquay-Varina Average Day in a Maximum Month Water Demand and Interbasin Transfer Projections, Water Contract Amounts, and Water Supply Shortfall

Year	Projected Average Day Water Demand in a Maximum Month, mgd [1] [A]	Interbasin Transfer Projections, Cape Fear (2-3) to Neuse (10-1), mgd [B]	Projected Maximum Day Water Demand, mgd [C]	Current Total Water Supply Contract Amount via Interlocal Agreement, mgd [D]	Projected Water Supply Shortfall Indicated by Value in ( ), mgd [2] [D - A]
2025	4.2	0.00	5.4	5.25	1.0 [3]
2030	5.2	0.00	6.6	5.25	0.08 [3]
2035	6.1	0.56	7.8	5.25	(0.86)
2036	6.3	2.42	8.0	3.5	(2.8)
2040	7.1	2.89	9.0	3.5	(3.6)
2041	7.2	3.01	9.2	3.5	(3.7)
2045	8.0	3.47	10.2	3.5	(4.5)
2049	8.7	3.94	11.1	3.5	(5.2)
2050	8.9	5.55	11.4	2	(6.9)
2055	9.9	6.17	12.5	2	(7.9)

[1] Projected water demand for the Town of Fuquay-Varina service area. Water demand projections in the Neuse and Cape Fear River basins are approximately 62% and 38% of the total project water demand, respectively.

[2] Projected water supply deficit is the current contract amount less the average day water demand in a maximum month.

[3] Amount does not include additional 2 mgd from Harnett County via the ILA signed in 2022.

contract amount less the total average day water demand in a maximum month. The water supply shortfall assumes that the Town of Fuquay-Varina's current contract amounts expire as planned and additional water supply is not available. Without provisions for additional water supply capacity, the Town of Fuquay-Varina is projected to have a water supply shortfall beginning in 2030. Additional water supply is needed to satisfy the projected water demand in the Town of Fuquay-Varina's service area. A transfer of water from the Neuse River basin (10-1) to the Cape Fear River basin (2-3) would not occur until 2031.

3. Alternatives Analysis

The following sections present an analysis of the alternatives available to the Town of Fuquay-Varina for additional finished water supply capacity. Sixteen alternatives were evaluated for this EIS. Figure 3-1 provides an overview of the alternatives that include infrastructure (e.g., water treatment facilities, transmission, etc.). The collective infrastructure for the evaluated alternatives is located in the Neuse River (10-1) basin, the Cape Fear River (2-3) basin, and the Haw River (2-1) basin. A summary of the evaluated alternatives is listed as follows:

- No-action
- Alternative 1 – Surface Water, Purchase Finished Water from Raleigh Water
- Alternative 2 – Surface Water, Purchase Finished Water from Johnston County
- Alternative 3 – Surface Water, Town of Fuquay-Varina Independent Water Supply in Neuse River Basin
- Alternative 4 – Surface Water, Purchase Finished Water from City of Dunn
- Alternative 5 – Surface Water, Purchase Finished Water from Harnett County
- Alternative 6 – Surface Water, Raw Water from Jordan Lake (Cary/Apex)
- Alternative 7– Surface Water, Raw Water from Jordan Lake (Western Intake Partnership)
- Alternative 8A – Surface Water, Town of Fuquay-Varina Intake on the Cape Fear with Return of Water to Cape Fear River Basin (Cape Fear River)
- Alternative 8B – Surface Water, Town of Fuquay-Varina Intake on the Cape Fear with Return of Water to Cape Fear River Basin (Kenneth Creek)
- Alternative 9A/B – Surface Water, Purchase Finished Water from City of Sanford
- Alternative 9C – Surface Water, Purchase Finished Water from City of Sanford with Return of Water to Cape Fear River
- Alternative 9D – Surface Water, Purchase Finished Water from City of Sanford with Return of Water to Cape Fear River via Western Wake Regional Water Reclamation Facility (WRF)
- Alternative 10 – Interbasin Transfer Minimization, Groundwater
- Alternative 11 – Interbasin Transfer Minimization, Water Reuse
- Alternative 12 – Interbasin Transfer Minimization, Additional Conservation Measures

Section 3-15 provides a summary of the infrastructure for each alternative and an opinion of probable construction cost. Section 5-14 provides a discussion of the hydrologic modeling results for each alternative. The hydrologic model evaluates the impact of the proposed water withdrawal and interbasin transfer in the Neuse and Cape Fear River basins.

The alternatives were evaluated against the Purpose and Need Statement in Section 2.4 of this EIS, as follows:

- Does the alternative meet the purpose and need for a reliable permanent water supply source.
- Does the alternative provide water supply capacity in a time frame needed for the Town of Fuquay-Varina to address their water demand projections.

Legend

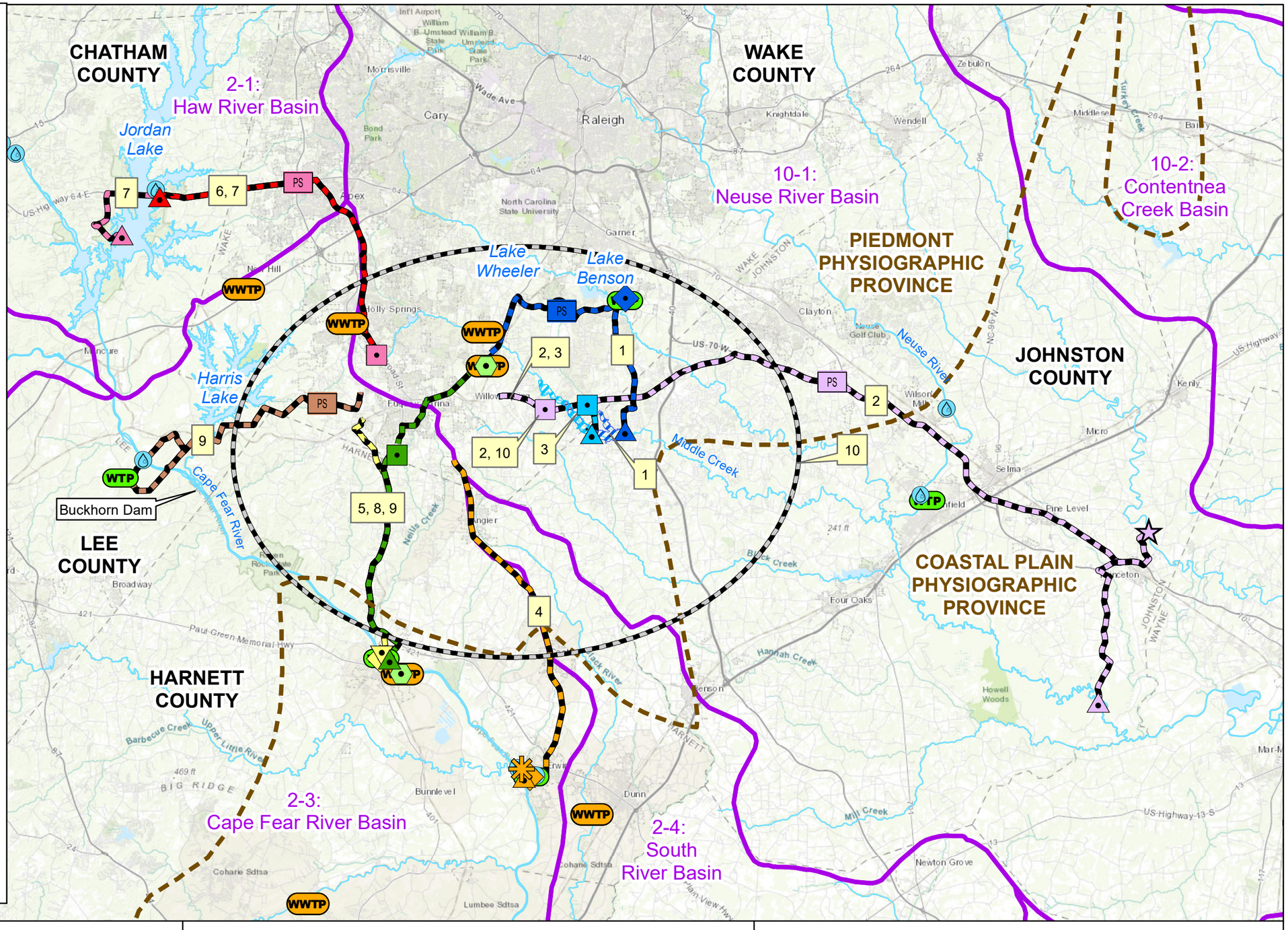
- Wastewater Treatment Plant
- Water Treatment Plant
- Physiographic Province
- IBT Boundary
- Existing Raw Water Intake

Proposed Infrastructure

- Elevated Water Tank
- Booster Pump Station
- Raw Water Intake and Pump Station
- Withdrawal Increase at Existing Intake
- Raw Water Storage Facility and Pump Station
- Raw Water Storage Facility, Raw Water Intake, and Pump Station
- New WTP
- Expansion of Existing WTP
- Expansion of Existing WWTP
- Middle Creek Reservoir

Alternative Pipeline

- 1, Raleigh
- 2, Johnston County
- 3, FV Independent Reservoir
- 4, Dunn
- 5, Harnett County
- 6, Jordan Lake - Cary Intake
- 7, Jordan Lake - WIP Intake
- 8, Cape Fear with Return Options
- 9, Sanford Options
- 10, Groundwater Well Field



SCALE
1 inch = 5 miles
0 1 2 3 4 5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 3-1: Overview of Alternatives

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

3.1 No-action

The Town of Fuquay-Varina has not secured a permanent water supply source. The Town of Fuquay-Varina does not own a raw water intake, water treatment infrastructure, or purchased permanent water supply capacity from a neighboring community. The Town of Fuquay-Varina has historically signed temporary Interlocal Agreements (ILAs) with neighboring communities for wholesale finished water supply.

Figure 3-2 provides an illustration of the no-action alternative. The Town of Fuquay-Varina's metered distribution points with Raleigh Water, Johnston County, and Harnett County remain in the same locations. Infrastructure is not expanded in the no-action alternative.

Per Section 1.4.3, the Town of Fuquay-Varina has signed temporary ILAs with Raleigh Water, Harnett County, and Johnston County for the purchase of bulk finished water. The ILAs with Raleigh Water, Harnett County, and Johnston County expire in 2035, 2040, and 2049, respectively. Per conversations between the Town of Fuquay-Varina and the Town's ILA partners, it was communicated to the Town of Fuquay-Varina that additional water supply would not be provided beyond the current ILAs. However, both Raleigh Water and Harnett County agreed to additional water with a 2035 expiration to assist the Town of Fuquay-Varina until a permanent water supply solution becomes available. The Town of Fuquay-Varina signed an ILA in 2023 with the City of Sanford for a permanent water supply source.

Table 3-1 summarizes the Town of Fuquay-Varina's average day in a maximum month water demand projections, the interbasin transfer projections from the Cape Fear River basin to the Neuse River basin, the Town of Fuquay-Varina's total current water supply contract amount (via Interlocal Agreements), and the projected water supply shortfall. The water supply shortfall is calculated as the difference between the Town of Fuquay-Varina's current total ILA contract amount less the total average day water demand in a maximum month. The water supply shortfall assumes that the Town of Fuquay-Varina's current ILA amounts expire as planned and additional water supply is not available (excluding the City of Sanford). Without provisions for additional water supply capacity, the Town of Fuquay-Varina is projected to have a water supply shortfall beginning in 2031.

The no-action alternative does not satisfy the purpose and need of the proposed project for the Town of Fuquay-Varina. The no-action alternative does not secure a reliable permanent water supply source for the Town of Fuquay-Varina. Additionally, the Town of Fuquay-Varina will be unable to meet the water demand needs in the Town's service area as the current temporary interlocal agreements expire, which will result in a water supply shortfall of approximately 7.9 mgd in 2055.

Table 3-1: Summary of Average Day in the Maximum Month Water Demand, Wholesale Water Supply Contracts, and Projected Water Supply Deficit

Year	Average Day Water Demand in a Maximum Month [1]			Current Total Water Supply Contract Amount via Interlocal Agreement			Projected Water Supply Shortfall Indicated by Value in ( ), mgd [2]
	Total, mgd [A]	Neuse Basin, mgd [B]	Cape Fear Basin, mgd [C]	Raleigh Water (Neuse), mgd [D]	Johnston County (Neuse), mgd [E]	Harnett County (Cape Fear), mgd [2] [F]	[D + E + F - A]
2025	4.2	2.61	1.62	1.75	1.5	2	1.0 [3]
2030	5.2	3.19	1.98	1.75	1.5	2	0.08 [3]
2035	6.1	3.79	2.32	1.75	1.5	2	(0.86)
2036	6.3	3.90	2.39	0	1.5	2	(2.8)
2040	7.1	4.37	2.68	0	1.5	2	(3.6)
2041	7.2	4.49	2.75	0	1.5	2	(3.7)
2045	8.0	4.95	3.04	0	1.5	2	(4.5)
2049	8.7	5.42	3.32	0	1.5	2	(5.2)
2050	8.9	5.54	3.40	0	0	2	(6.9)
2055	9.9	6.15	3.73	0	0	2	(7.9)

[1] Projected water demand for the Town of Fuquay-Varina service area.

[2] The projected water supply shortfall is the Town of Fuquay-Varina's total contract amount less the average day water demand in a maximum month.

[3] Amount does not include additional 2 mgd from Harnett County via the ILA signed in 2022.

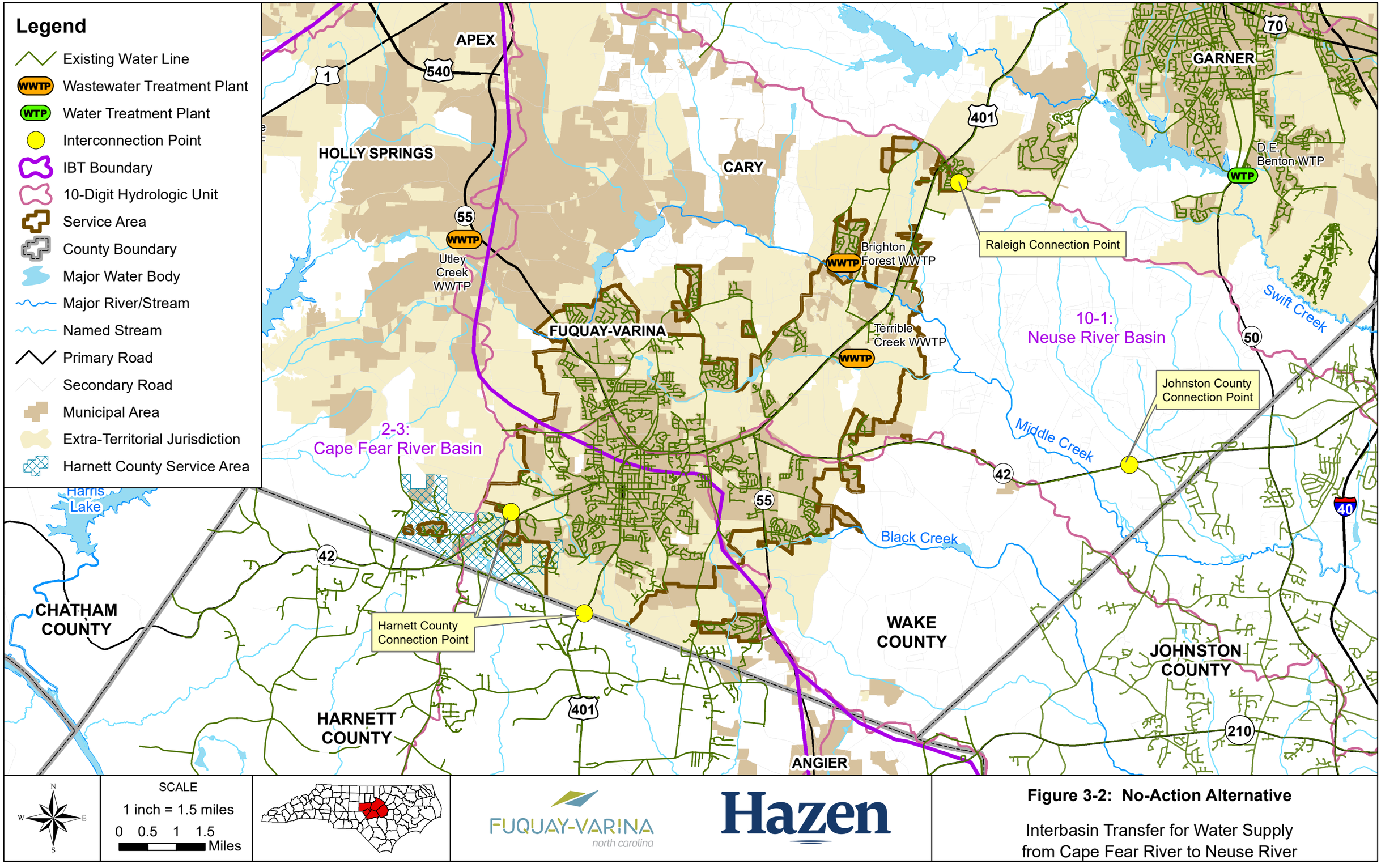


Figure 3-2: No-Action Alternative

Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

3.2 Alternative 1 – Surface Water, Purchase Finished Water from Raleigh Water

The City of Raleigh (Raleigh Water) is located in Wake County in the Piedmont Ecoregion of North Carolina. Raleigh Water operates the largest municipal system in the county. The City of Raleigh is bounded by Johnston County to the south, Franklin and Nash Counties to the east and north, the Towns of Cary, Apex, and Holly Springs to the west, and the Town of Fuquay-Varina to the south. Raleigh Water's service area encompasses 309 square miles to include corporate limits, ETJ, short-range urban service areas, and long-range urban services areas for the City of Raleigh and the Towns of Garner, Rolesville, Wake Forest, Knightdale, Wendell, and Zebulon. Garner and Rolesville merged their water and sewer systems with Raleigh in 2001 and 2002, respectively. Wake Forest merged their utilities in 2005. Knightdale, Wendell, and Zebulon merged utilities with Raleigh in 2006.

Raleigh Water also provides finished water wholesale to several surrounding communities on a regular and emergency basis. Table 3-2 provides a summary of Raleigh Water's 2022 average sales and contract amounts. In 2022, Raleigh Water sold approximately 2.15 mgd of finished water out of a total contract amount of 6.8 mgd. The ILA with the Town of Fuquay-Varina was updated in 2021 for Raleigh Water to supply up to 1.75 mgd to the Town on a regular basis through 2035. In May 2021, Raleigh Water and Franklin County signed an agreement for Raleigh Water to provide a regular wholesale supply of 0.4 mgd to Franklin County with a contract expiration date of 2030. Raleigh Water also has ILAs for emergency use contracts with the Town of Cary, the City of Durham, Holly Springs, and Johnston County. Johnson County is working with Raleigh Water to convert the emergency use ILA to a regular use ILA with a term of 10 to 15 years.

Table 3-2: Summary of Raleigh Water Bulk Finished Water Sales Contracts

Purchaser	Average Day Sold, mgd [1]	Contract Amount, mgd	Contract Expiration Date	Contract Type
Cary	0.376	0	2032	Emergency
City of Durham	0	1.3	2026	Emergency
Franklin County [2]	0.40	0.4	2030	Regular
Fuquay-Varina [3]	0.712	1.75	2035	Regular
Holly Springs	0	1.2	2029	Emergency
Johnston County [4]	0.66	2.15	2028	Emergency
Total	2.15	6.8	----	----

[1] Per Raleigh Water 2022 Local Water Supply Plan.
[2] Interlocal Agreement established in 2022 for Raleigh Water to supply up to 0.4 mgd to Franklin County.
[3] Interlocal Agreement updated in 2021 for Raleigh Water to supply up to 1.75 mgd to Fuquay-Varina.
[4] Johnston County is negotiating an interim regular use contract with Raleigh Water.

3.2.1 Existing Water Supply and Treatment Infrastructure

Raleigh Water currently owns, operates, and maintains two water treatment facilities. The E.M. Johnson WTP is located in north Raleigh near the intersection of Interstate 540 and Falls of Neuse Road. The water

supply source for the E.M. Johnson WTP is the Falls Lake Reservoir. The permitted capacity of the E.M. Johnson WTP is 86 mgd.

The Falls Lake Reservoir is owned and operated by the United States Army Corps of Engineers (USACE). Construction of the Falls Lake dam and reservoir was authorized by Congress via the Flood Control Act of 1965. The Falls Lake water surface covers 12,500 acres and drains 770 square miles. The reservoir is a multi-purpose federal project constructed to provide flood control, water supply, water quality, fish and wildlife enhancement, and recreational use benefits. The dam was constructed in the early 1980s and became fully operational in 1983.

Conservation storage in Falls Lake includes the sum of water supply storage and water quality storage pools. Raleigh Water owns the rights to the entire water supply storage. The safe yield of the water supply storage is approximately 84 mgd. The safe yield of 84 mgd is the yield reported as if Falls Lake was an independent water source. The Falls Lake yield, as reported in the 2022 approved LWSP, is stated as 88.2 mgd, which considers the conjunctive benefit of both Falls Lake and Lakes Wheeler and Benson. The water quality storage is designed to provide low flow augmentation for the purpose of maintaining and improving downstream water quality.

The water quality storage is used to maintain minimum flow targets at two locations downstream of Falls Lake Dam. The first flow target location is immediately downstream of the dam. Instream flows must be maintained at 100 cubic feet per second (cfs) from April through October and between 50 and 65 cfs from November through March. The second flow target location is approximately 33 river miles downstream of the dam at the USGS stream gage on the Neuse River near Clayton. The minimum instream flow target at the Clayton gage is 184 cfs from November to March and 254 cfs from April through October (USACE, 2018). Due to the distance and corresponding time lag between the dam and the second flow target at the Clayton gage, it is typical for the USACE to set the release at Falls Dam sufficiently high to exceed the downstream flow target by about 10 percent as a buffer for the uncertainty in the natural flow that will arrive at the gage approximately one day into the future. The USGS stream gage was relocated from Smithfield to Clayton in 1994 due to shifting stream bed issues (e.g., sand) at Smithfield (USACE, 1994).

The second drinking water supply source for Raleigh Water is storage in Lakes Benson and Wheeler reservoirs. Lakes Benson and Wheeler reservoirs are owned and operated by Raleigh Water. The combined water surface covers 926 acres and drains 66 square miles. The reservoirs served as the primary raw water source for the City from 1953 to 1987 and were re-activated for water supply in 2010 upon completion of the 20 mgd Dempsey E. Benton WTP. Raleigh Water secured a Biological Opinion from the USFWS in 2006 for the construction of the Dempsey E. Benton WTP and the reactivation of Lakes Benson and Wheeler (USFWS, 2006). A Biological Opinion was prepared due to the presence of the federally endangered dwarf wedgemussel in Swift Creek downstream of Lake Benson dam. The safe yield of the combined storage in Lakes Benson and Wheeler during the drought of record in 2007 and 2008 is 11.2 mgd.

3.2.2 Population and Water Demand Projections for Raleigh Water

Table 3-3 provides a summary of population and water demand projections for Raleigh Water. The 2022 LWSP projections are based on Raleigh Water's Falls Lake re-allocation request to the USACE. Raleigh Water is anticipating an increase in service area growth ranging from 1.6 percent to 2.7 percent over the next 50 years. Raleigh Water is projected to reach an average day demand of approximately 107 mgd by 2050 compared to a combined 2050 water supply system safe yield of 99.4 mgd (i.e., the combination of Falls Lake and Lakes Benson and Wheeler) based on the drought-of-record for the combined system. The yield of 99.4 mgd for the combined system is greater than the sum of the yields of the two individual supply systems at 95.2 mgd (i.e., an independent yield of 11.2 mgd for Lakes Benson and Wheeler plus the independent Falls Lake yield of 84 mgd). Raleigh Water's recent water demand projections assume further reductions in total per capita use due to water conservation measures and the use of reclaimed water.

Raleigh Water commissioned an Integrated Master Plan in early 2021. The Integrated Master Plan incorporated Raleigh Water's utility system assets into a single master plan framework for planning system infrastructure needs. The Integrated Master Plan includes asset management, traditional capital improvements project prioritization, and evaluating interdependencies between utility systems. As part of the Integrated Master Plan effort, Raleigh Water updated water demand projections using a probabilistic analysis. Raleigh Water's approved 2022 LWSP reflects the analysis from the Integrated Master Plan using a 50th percentile of the water demand projections.

Table 3-3: Population and Water Demand Projections for Raleigh Water

	2022	2030	2040	2050	2055 [1]	2060
Service area population projections [2]	620,000	769,000	903,000	1,134,200	1,239,100	1,344,000
Annual percent growth in service area [2]	----	2.73%	1.62%	2.31%	1.72%	1.71%
Average day service area demand, mgd [2]	56.07	71.86	88.94	104.88	113.99	123.10
Water sales, mgd [2]	1.26	4.30	2.55	2.55	2.55	2.55
Future water sales, mgd [2]	0	0	0	0	0	0
Total average day water demand, mgd [2]	57.33	76.16	91.49	107.43	116.54	125.65
Maximum day demand, mgd [3]	79.1	105.1	126.3	148.3	160.8	173.4

[1] Data interpolated from approved Local Water Supply Plan.

[2] From 2022 approved Local Water Supply Plan for Raleigh Water. Water demands are based on the 50th percentile of the Integrated Master Plan water demand projections.

[3] Maximum day demand estimated using a maximum day demand peaking factor of 1.38 based on historic pumping records.

3.2.3 Water Supply Capacity Planning

Raleigh Water has been in a continuous process of water supply planning since the late 1990s. After the Dempsey E. Benton WTP was permitted and under construction, Raleigh Water submitted a request to the USACE Wilmington District in 2008 to impound the Little River for additional water supply storage. Agency review during the scoping process for the proposed Little River reservoir compelled Raleigh Water to consider other water supply alternatives.

One of the evaluated alternatives was the reallocation of the conservation storage pool in Falls Lake. The alternatives evaluation started during the Little River Reservoir EIS process indicated that reallocating 16.2 percent of the conservation pool volume from the water quality storage pool to the water supply storage pool would meet Raleigh Water's long-term water supply needs without compromising the ability of the water quality storage to continue to meet its objectives (USACE, 2018). In 2013, Raleigh Water made a formal request to the USACE Wilmington District for the additional water supply allocation in Falls Lake.

An Integrated Water Supply Reallocation Feasibility Study and Environmental Assessment was completed in 2018 (USACE, 2018). The Finding of No Significant Impact (FONSI) was signed by the Assistant Secretary for the Army (Civil Works) in January 2019. Twenty-three water supply alternatives were evaluated in the Feasibility Study. A reallocation of the water quality pool to the water supply pool was determined to be the preferred alternative. The expanded water supply storage supports a water supply yield of approximately 84 mgd based on the drought-of-record and a peak day withdrawal of 120 mgd using a typical summer peaking factor. Raleigh Water is in the process of expanding the E.M. Johnson WTP to 120 mgd in several phases (Hazen, 2019a).

The Falls Lake water supply pool and expansion of the E.M. Johnston WTP will provide Raleigh Water with reliable water supply capacity through approximately 2050. As part of the Integrated Master Plan, Raleigh Water conducted a review of water supply capacity alternatives. Future water supply expansion alternatives include raising the Lake Benson and Lake Wheeler water supply pool by 2 feet, a new intake along the Neuse River between Falls dam and the Johnston County line, constructing Little River Reservoir in northeastern Wake County, and a reallocation of the Falls Lake Sediment Storage Pool (HDR | Hazen, 2023). It is anticipated that one or more water supply alternatives will be selected by Raleigh Water to carry forward in the planning process for the next water supply improvements project. The time frame for planning, permitting, design, and construction of water supply and treatment infrastructure can range from 10 to 20 years.

3.2.3.1 Near-Term Water Supply Capacity

Raleigh Water agreed to provide up to 1.75 mgd of wholesale finished water to the Town of Fuquay-Varina through 2035 via a new ILA signed in 2021. Raleigh Water currently provides periodic wholesale water distribution to the Town of Fuquay-Varina via an interconnection vault located at Ten Ten and Old Stage Roads. The Town of Fuquay-Varina also owns and operates a Swift Creek Pump Station on U.S. Highway 401 that conveys water from the City's 532 Pressure Zone to the Town. The Swift Creek Pump Station has a pumping capacity of 0.75 mgd. Recent hydraulic modeling demonstrated that Raleigh Water could provide up to 1.8 mgd to the Town of Fuquay-Varina with improvements at the pump station,

which will meet the revised ILA water agreement for Raleigh Water to provide up to 1.75 mgd to the Town. However, fire flow considerations will require new infrastructure to be constructed by both the Town of Fuquay-Varina and Raleigh Water. The immediate infrastructure improvements include a new 12 inch water main from the Dempsey E. Benton WTP to the interconnection vault at Ten Ten Road (Hazen, 2021b). Longer term infrastructure improvements include new elevated storage tanks operated by Raleigh Water and the Town of Fuquay-Varina.

3.2.3.2 Long-Term Water Supply Capacity

The water demand projections for Raleigh Water and member partners will require Raleigh Water to continue to plan for additional water supply capacity. Raleigh Water is obligated to provide future water supply capacity to their member partners to accommodate growth in the service area. Raleigh Water anticipates that service area demands will exceed water supply capacity in the next 20 years based on the projected water demand per Raleigh Water's 2022 LWSP and the current supply system safe yield.

The Town of Fuquay-Varina anticipates a maximum month water demand of 9.9 mgd and a maximum day demand of 12.6 by 2055. A significant portion of the Dempsey E. Benton WTP capacity and Lakes Benson and Wheeler supply would need to be dedicated to the Town of Fuquay-Varina to satisfy the Town's future water demand. To accommodate this demand, a 30 inch transmission line would need to be constructed between the Dempsey E. Benton WTP and the Town of Fuquay-Varina.

The impact of committing a large portion of the Dempsey E. Benton WTP capacity to meet the Town of Fuquay-Varina's water demand needs would have adverse consequences on the reliability of Raleigh Water's supply, treatment, and distribution operations. In 2016, Raleigh Water conducted a system vulnerability and reliability assessment for water supply, storage, and distribution infrastructure (Hazen, 2016a). The vulnerability analysis demonstrated significant operational and capacity issues if the Dempsey E. Benton WTP were removed from Raleigh Water's service area. Similarly, diverting most of the Dempsey E. Benton capacity away from Raleigh Water's service areas would negatively impact Raleigh Water's ability to reliably serve both existing and future demands, especially in the growing areas at the perimeter of the City's service area.

Raleigh Water is committed to maintaining supply reliability for their customers. To achieve this goal and simultaneously meet the Town of Fuquay-Varina's needs, Raleigh Water would be required to supplement the water supply provided by Lakes Wheeler and Benson. One option is the expansion of storage in Lakes Benson and Wheeler. A second option would be to construct a new reservoir. Both options would require an expansion of the Dempsey E. Benton WTP.

The option to expand the water supply storage of Lakes Benson and Wheeler to replace system capacity would require the construction of new dams on both lakes or raise the normal pool elevation at the existing dams. Raleigh Water initiated a study in 2022 to evaluate the feasibility of raising the normal pool elevation by 2-feet at Lakes Wheeler and Benson in conjunction with other structural repairs and improvements. An additional water supply yield of 2.5 mgd could be achieved if the dams were raised two feet for a total yield of 13.7 mgd based on the drought of record.

Construction of new dams for Lakes Benson and Wheeler would be extremely challenging, as major roadways and numerous homes are proximate to the shorelines of both lakes. The presence of the federally endangered dwarf wedgemussel in Swift Creek downstream of Lake Benson dam poses significant regulatory challenges. A second significant permitting effort (i.e., instream flow study) would be required for the construction of new dams in the Lakes Benson and Wheeler system.

A more likely scenario for Raleigh Water to assist in meeting the Town of Fuquay-Varina's water demand need is to develop a new reservoir on Middle Creek. It is anticipated that Raleigh Water would require the Town of Fuquay-Varina to partner in the development of this infrastructure. Middle Creek, a tributary to Swift Creek, is the drainage basin south of the Swift Creek basin. The confluence of Swift and Middle Creeks is near the confluence with the Neuse River at Smithfield in Johnston County. The dam for the proposed reservoir would be constructed on Middle Creek approximately 3.12 river miles downstream from the Wake-Johnston County line and 2.96 river miles upstream of U.S. Highway 50.

Figure 3-3 illustrates the proposed location and footprint of the dam. The proposed dam would be located in Johnston County. The impoundment would inundate land in both Johnston and Wake Counties. A raw water intake and pump station would be located at the site of the proposed dam. A 9 mile raw water transmission main would convey raw water to the Dempsey E. Benton WTP for treatment. A finished water main would convey water from the Dempsey E. Benton WTP along Highway 42 to the Town of Fuquay-Varina's water distribution connection point. An elevated storage tank and pump station would also be required infrastructure for this alternative.

A hydrologic analysis was conducted to determine the safe yield of the proposed reservoir. The proposed site would have a drainage area of approximately 82 square miles. The footprint of the reservoir would cover approximately 914 acres with a storage of 3,500 million gallons (11,100 acre-feet). The anticipated 50 year safe yield of the proposed reservoir is 22.6 mgd with a normal pool elevation of 218 feet and a minimum release of 3 cfs, 2 cfs, and 1 cfs for Tiers 1, 2, and 3, respectively. The footprint and normal pool elevation were determined using ArcMap software and the yield calculated using the Cape Fear Neuse Combined River Basin (CFNCRB) model revised for this EIS. The proposed yield of the reservoir would meet the Town of Fuquay-Varina's water supply need for the year 2055 in addition to water supply for Raleigh Water. Table 3-4 provides a summary of the proposed Middle Creek criteria for a Raleigh Water reservoir.

Alternative 1 was modeled with the CFNCRB model (refer to Section 5.14) assuming that the water demand for the Town of Fuquay-Varina would be satisfied by water supply in the Neuse River basin from Raleigh Water. The CFNCRB model assumed that the Town of Fuquay-Varina would continue to purchase water at the contracted amount from Harnett County. The CFNCRB model results in an interbasin transfer from the Neuse River basin to the Cape Fear River basin at an average in a maximum month of less than 2 mgd, which would not require an interbasin transfer certificate per General Statute § 143-215.22L.

An instream flow study would be required for the proposed reservoir per 15A NCAC 2K due to the presence of threatened and endangered species in Middle Creek (e.g., Atlantic pigtoe, Neuse River waterdog, and dwarf wedgemussel). A site-specific instream flow study would establish a tiered minimum flow release from the proposed Middle Creek Reservoir. For this analysis, a tiered minimum flow release of 3 cfs, 2 cfs, and 1 cfs for Tiers 1, 2, and 3, respectively, was used to calculate the safe yield. The proposed 3-2-1 tiered

minimum release was selected to replicate the tiered minimum flow release from Lake Benson dam per the Raleigh Water Biological Opinion (2006) for the Dempsey E. Benton WTP. The 3-2-1 cfs tiered minimum release from Lake Benson dam was approved by the USFWS via a Biological Opinion after a site-specific instream flow study and formal consultation regarding the federally endangered dwarf wedgemussel in Swift Creek.

Table 3-4: Criteria for Proposed Middle Creek Reservoir for Raleigh Water

Description	Criteria
Total reservoir storage	3,500 million gallons (11,100 acre-feet)
Normal pool elevation	218 feet MSL
Area inundated at normal pool elevation	914 acres
Drainage area	82 square miles
Minimum release	3-2-1 cfs (>70%, 40-70%, <40%)
Sedimentation rate	0.13 acre feet / yr / square mile drainage area
Reserve storage fraction	20%
Estimated active storage for safe yield	2,768 million gallons
Hydrologic period of record	1930 to 2020
Water supply safe yield (with 50 years of sedimentation)	22.6 mgd

The calculated supply yield is large for the proposed reservoir volume and drainage area. The high yield of the proposed reservoir is due to the capture of upstream wastewater discharges as inflow. The Town of Apex Water Reclamation Facility (WRF) discharges to Middle Creek approximately 18.7 river miles upstream of the proposed reservoir. The South Cary WRF, owned and operated by the Town of Cary, discharges to Middle Creek approximately 10.7 river miles upstream of the proposed reservoir. The Town of Fuquay Varina's Terrible Creek WWTP discharges to the Middle Creek basin approximately 8.1 river miles upstream of the proposed dam. The discharges are greater than North Carolina's guidance policy whereby a wastewater discharge must be at least five miles upstream of a raw water intake. The natural yield of this site without the wastewater discharge input would be significantly reduced. Under prevailing summer and fall conditions in 2055, the majority of the stored water in the reservoir contents would consist of wastewater discharged from the three aforementioned wastewater treatment facilities upstream of the proposed reservoir.

A proposed Middle Creek Reservoir will have a significant impact to property and transportation infrastructure. Approximately 1,100 acres of private property would need to be acquired to accommodate the reservoir inundation footprint and the 100-foot water supply watershed buffer area. Approximately 140 acres of property are designated for residential development. Fifty households, five farms, and four forestry tracts would be impacted. Approximately 733 feet of state highways, 3,703 feet of secondary roads, and two bridges would be impacted. The construction of one new bridge would be required.

A surface water reclassification process per 15A NCAC 2B .0100 and .0200 would be required to reclassify the Class C Nutrient Sensitive Waters (NSW) Middle Creek watershed as a WS-IV water supply watershed. Figure 3-3 also illustrates the surface water reclassification area. The reclassification area would extend into

the eastern municipal limits for the Town of Fuquay-Varina. Additionally, a proposed reservoir would have a significant impact on the development potential of the Middle Creek basin. The critical area is a one-half mile buffer as measured from the normal pool elevation. The protected area is 5 miles as measured from normal pool elevation. In the protected area, the low-density option limits impervious surface to 24 percent or 20,000 square foot lot excluding roadway rights of way (ROW) or one dwelling unit per half acre for single family residential development. Only the 24 percent impervious cover measurement is allowed for non-residential and all other residential development. The low-density option allows for higher density (e.g., 70 percent) in 10 percent of a jurisdiction's service area. The WS-IV high-density option limits built upon area to 24 to 70 percent in the protected area; however, the jurisdiction must assume responsibility for operation and maintenance for engineered stormwater controls.

In addition to an instream flow study, a second significant permitting challenge is the siting of the proposed reservoir in Johnston County and associated property acquisition. Per General Statute § 153A-15, the Town of Fuquay-Varina would need the consent of the Johnston County Board of Commissioners to acquire property for a dam and inundated properties. Consent from the Johnston County Board of Commissioners may be difficult due to the political impact of condemning property for water supply that would not be used by residents of Johnston County.

3.2.4 Summary

The Falls Lake reallocation process yielded an additional 14 mgd of water supply capacity for Raleigh Water. The time frame for completion of the reallocation process was approximately 6 years. However, the reallocation process was completed 12 years after initiating the environmental review for the proposed Little River Reservoir. Raleigh Water is in the process of constructing infrastructure (e.g., expansion of the E.M. Johnson WTP) to enable the full use of the recent Falls Lake conservation pool reallocation. Raleigh Water has an obligation and responsibility to their member partners to provide water and sewer service. Raleigh Water has stated to surrounding communities, including the Town of Fuquay-Varina, that Raleigh Water is not in the position to continue to be a long-term wholesale finished water provider for non-merger communities. Raleigh Water's obligation to member partners includes the on-going pursuit of additional water supply capacity alternatives to meet water demands post 2040.

The proposed reservoir on Middle Creek only partially meets the Town of Fuquay-Varina's project purpose and need. A proposed reservoir would provide a permanent water supply source to the Town of Fuquay-Varina. However, this alternative will not provide the water supply capacity in a time frame needed for the Town of Fuquay-Varina to address their water demand projections. The Town of Fuquay-Varina's water demand projections indicate a water supply shortfall by 2030.

A myriad of challenges are associated with permitting and constructing a new reservoir in North Carolina. A few of the challenges include a site-specific instream flow study to evaluate potential impact to threatened and endangered species, a surface water reclassification, consent from the Johnston County Board of Commissioners for acquisition of property outside of Wake County, and significant property acquisition. All of these challenges require years of time and significant expense. It is estimated that at least 20 to 30 years is required to permit and construct a new reservoir in North Carolina. However, this alternative was carried forward in the EIS for an environmental impact analysis.

Table 3-5 provides a summary of the larger reservoirs in North Carolina with the associated construction time frames and impoundment use. There are 6,662 impoundments and reservoirs in North Carolina per the Dam Inventory List from the Division of Energy, Mineral, and Land Resources. Approximately 480 reservoirs or impoundments in North Carolina are used for flood control, water supply, and recreation. Approximately one-half of the larger reservoirs in North Carolina were constructed in the early 1900s for hydroelectric power. The remaining half of North Carolina's largest reservoirs were constructed in the mid-1950s and 1960s. The most recent reservoir constructed in North Carolina is Randleman Lake, which finished construction in 2010. Randleman Lake was originally proposed in 1937 with engineering work continuing through 1987, at which point the USACE withdrew support. The current Randleman Lake is a smaller version of the original proposal and is designated for water supply.

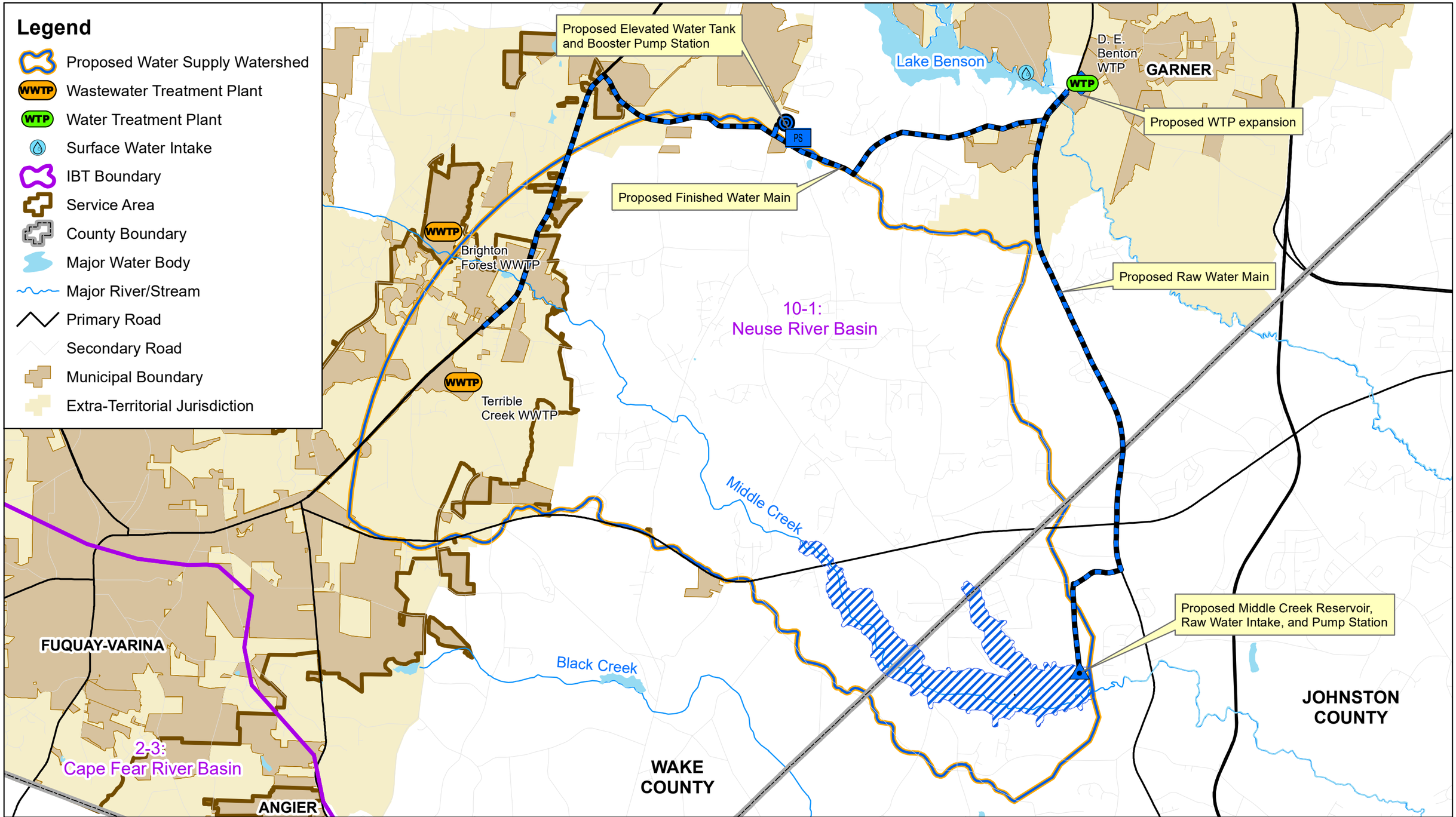
In 2011, DWR presented to the Environmental Review Commission (ERC) a list of North Carolina reservoirs that had been constructed within 20 years of 2009 (DWR, 2009). The presentation was in support of Randleman Dam. The examples provided by DWR included the Rocky River Lower Reservoir expansion (Charles L. Turner Reservoir) in 2009, Horse Creek Reservoir (off-line storage) in 2008, the Nicks Creek Reservoir modifications in 2002, the West Fork Eno Reservoir in 2000, the Macintosh Reservoir in 1993, Lake Howell in 1993, Stewarts Creek Reservoir expansion in 1992, and Back Creek Reservoir in 1991. The most recent 2009 Rocky River Lower Reservoir expansion project for Siler City started in 1989 with construction finished in 2009. The presentation by DWR highlighted the complexities and long time frames typically associated with constructing new reservoirs in North Carolina.

Table 3-5: Summary of Constructed Reservoirs and Impoundments In North Carolina

Impoundment	Construction Time Frame	Impoundment Use
W. Kerr Scott Dam	1947 to 1952	Hydropower, flood control, water supply
Lake Gaston	1963	Hydropower, water supply
Jordan Lake	1967 to 1982	Flood control, water supply
Santeelah Lake	1928	Hydropower
Lake Norman	1959 to 1964	Hydropower
Randleman Lake	Proposed in 1937 for flood control. Funds authorized in 1968. USACE withdrew support in 1987. Smaller reservoir constructed between 2004-2010 by the Piedmont Triad Regional Water Authority	Water supply
Falls Lake	1978 to 1983	Flood control, water supply
Lake Crabtree	1989	Flood control
Harris Lake	Early 1980s	Nuclear reactor cooling water
High Rock Lake	1926 to 1927	Hydropower
Tuckertown Reservoir	1962	Hydropower, water supply
Falls Reservoir	1919	Hydropower, water supply
Lake Tillery	1928	Hydropower, water supply
Blewett Falls Lake	Early 1900s	Hydropower, water supply
Badin Lake	1917	Hydropower, water supply
Lake Lure	1925 to 1927	Hydropower, water supply

Table 3-5: Summary of Constructed Reservoirs and Impoundments In North Carolina

Impoundment	Construction Time Frame	Impoundment Use
Lake James	1916 to 1923	Hydropower, water supply
Lake Rhodhiss	1925	Hydropower, water supply
Lake Hickory	1927	Hydropower, water supply
Lookout Shoals Lake	1915	Hydropower, water supply
Lake Norman	1959 to 1964	Hydropower, water supply
Mountain Island Lake	1924	Hydropower, water supply
Lake Wylie	1904	Hydropower, water supply
Buckhorn Reservoir	The original dam was constructed in 1974. A new dam 700 feet downstream of the existing dam finished construction in 1999 and expanded the operating level of the reservoir.	Water supply
Lake Michie	1924 to 1926	Water supply reservoir, hydropower until 1960
Little River Reservoir	Completed in 1988	Water supply
Rocky River Lower Reservoir Expansion	Expansion of existing reservoir, 1989 – 1999	Water supply
West Fork Eno	1993 – 2000	Water supply
Macintosh Reservoir	1971 – 1993	Water supply
Back Creek Reservoir	1985 – 1991	Water supply
Lake Howell	1985 – 1993	Water supply
Lakes Benson and Wheeler	Early 1950s; reactivation as water supply 1999 – 2006	Water supply



FUQUAY-VARINA
north carolina

Hazen

Figure 3-3: Surface Water, Purchase Finished Water from Raleigh Water (Alternative 1)

Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

3.3 Alternative 2 – Surface Water, Purchase Finished Water from Johnston County

The Town of Fuquay-Varina explored a surface water supply alternative with Johnston County. Johnston County is the adjacent county southeast of Wake County in the Neuse River basin (10-1). The western corner of Johnston County is approximately 7 miles east of downtown Fuquay-Varina. Johnston County provides water to approximately 38,000 retail accounts via County-owned distribution networks in sixteen water districts. Johnston County also supplies bulk finished water to 20 wholesale County customers as well as several communities in neighboring counties. Sixteen of these wholesale customers purchase water from Johnston County on a regular (i.e., daily) basis. Johnston County provides bulk finished water to approximately 48 percent of the County's population via the County administered water districts and another 18 percent of the County's population via wholesale customers. The remaining 34 percent of Johnston County's population is served by independent water supplies, other bulk finished water purchases, or private groundwater systems.

In 2022, Johnston County sold approximately 6.4 mgd (i.e., average day) of bulk finished water out of a total contract amount of 7.4 mgd, excluding emergency use contracts. The Town of Clayton, the most populous town in Johnston County, is also the County's largest wholesale customer with a 2022 purchase of approximately 3.8 mgd. Table 3-6 provides a summary of Johnston County's average sales and contract amounts. The Town of Fuquay-Varina purchased approximately 0.75 mgd from Johnston County in 2022.

Table 3-6: Summary of Johnston County Bulk Finished Water Sales Contracts

Purchaser	Average Day Sold, mgd [1]	Contract Amount, mgd	Contract Expiration Date	Contract Type
Aqua NC / Flowers Plantation	0.683	0.9539	2072	Regular
Aqua / Various Subdivisions	0.059	0.068	2039	Regular
Benson	0.117	0.09	2025	Regular
Raleigh Water	0	2.5	2031	Emergency
Clayton	3.806	5.25	----	Regular
Fork Township Sanitary District	0	0.15	2023	Emergency
Four Oaks	0.2752	0.3	----	Regular
Fuquay Varina	0.751	1.5	2049	Regular
Kenly	0.2498	0.295	----	Regular
Micro (County Line)	0.002	0.005	----	Regular
Pine Level	0.0209	0.037	----	Regular
Princeton	0.1462	0.175	----	Regular
Selma (County Line System)	0.046	0.215	----	Regular
Smithfield South Water District	0.0606	0	2024	Regular
Town of Selma	0.035	----	----	Emergency
Wayne County Water District	0	0.6	2028	Emergency
White Oak Plantation (CWS)	0.0299	----	2048	Regular
Willowbrook Development (CWS)	0.0136	----	----	Regular
Winston Plantation (CWS)	0.0122	----	----	Regular

Table 3-6: Summary of Johnston County Bulk Finished Water Sales Contracts

Purchaser	Average Day Sold, mgd [1]	Contract Amount, mgd	Contract Expiration Date	Contract Type
Winston Point (CWS)	0.0637	----	2048	Regular
Total	6.4	7.4 [3]	----	----

[1] Per Johnston County approved 2022 Local Water Supply Plan.

[2] Johnston County does not have a contract with Community Water Systems in the County's water service area. However, the water sold is tracked in the Local Water Supply Plan.

[3] Sum of water sales contracts excludes emergency contracts and several small contracts with undefined maximums.

Johnston County has signed ILAs with eight wholesale water providers for the purchase of bulk finished water. Table 3-7 summarizes Johnston County's wholesale water purchase contracts. The total contract amount is approximately 11.1 mgd excluding emergency use contracts. The largest bulk contracts are 3.5 mgd from the Town of Smithfield with a contract expiration date of 2033, 2.5 mgd from Raleigh Water with a contract expiration date of 2031, and 2.5 mgd from Harnett County with a contract expiration date of 2056. The ILA with Raleigh water is a short-term negotiated contract to assist Johnston County through water supply shortages until 2031. Johnston County does not anticipate a renewal of the ILA with Raleigh Water; however, there are three 1-year renewal periods allowed by the agreement. Hydraulic limitations in Harnett County's water distribution system during a peak day may reduce the available water capacity delivered to Johnston County to less than 1 mgd.

Table 3-7: Summary of Johnston County Water Supply Purchase Contracts

Seller	Average Day Purchased, mgd [1]	Contract Amount, mgd	Contract Expiration Date	Contract Type
Benson	0.0015	0.01	2025	Regular
Raleigh Water	0.6618	2.5	2031	Regular
City of Wilson	0.7412	1.5	2033	Regular
Fork Township Sanitary District	0	0.15	2022	Emergency
Fuquay-Varina	0	0	----	Emergency
Harnett County Regional Water System [2]	1.395	2.5	2056	Regular
Sampson County – Clinton	0.1296	0.5	2049	Regular
Smithfield	2.45	3.5 [3]	2033	Regular
Wayne County Water District	0.1897	0.6	2022	Regular
Total	5.6	11.1 [4]	----	----

[1] Per Johnston County's approved 2022 Local Water Supply Plan.

[2] Hydraulic limitations in the Harnett County water distribution system at peak day may limit the supply to Johnston County to 0.3 mgd.

[3] Johnston County has planned for 3 mgd from Smithfield out of a total contract amount of 3.5 mgd. The Town of Smithfield retains the right to reduce the contract amount by 1 mgd; however, Johnston County has planned for a maximum reduction of 0.5 mgd.

[4] Excluding emergency use contracts.

3.3.1 Existing Water Supply and Treatment Infrastructure

Johnston County owns and operates the 14 mgd Timothy G. Broome WTP and raw water intake at the Neuse River in Wilson Mills. The Town of Smithfield's raw water intake is located approximately 6 miles downstream of Johnston County's raw water intake. DWR considers the withdrawal between the two raw water intakes to be equivalent to a combined withdrawal due to the close proximity of the two intakes without significant tributary inflow. In 2018, Johnston County and Smithfield requested that DWR consider an increase in the withdrawal capacity for the two water systems. DWR approved an increase in the net withdrawal to 23.4 mgd. The maximum water supply available to Johnston County at the raw water intake is 17 mgd (DWR, 2018a). Johnston County is currently expanding the Timothy G. Broome WTP to 18 mgd with an anticipated completion date of 2025. Johnston County anticipates the ability to produce 18 mgd by managing the on-site raw water storage system (HDR, 2022).

3.3.2 Population and Water Demand Projections for Johnston County

Johnston County published a Water System Master Plan in 2018 (Hazen). The Water System Master Plan included an expansion of a previous 2005 hydraulic model using updated GIS data. The effort included extensive model calibration via field testing and water demand projections were developed as part of this effort. Water system improvements were identified for future system demands out to 2037 (i.e., a 20 year planning period with a base year of 2017).

Johnston County commissioned Hazen to update the water demand projections for long range water supply planning (Hazen, 2023). Water demand projections were based on a gallon per account analysis in lieu of a per capita analysis. Johnston County's service area is comprised of 16 water districts with distinct growth patterns. For several of the districts, the district population data does not correlate to the number of accounts due to the use of groundwater. Private groundwater use is not included in Johnston County's total water use projections. Furthermore, the water demand projections assumed that the ratio of commercial to residential water use would remain constant over the planning period. The evaluation relied on growth predictions from the OSBM and ACS census data.

Wholesale customers and industrial use were evaluated separately in the long-range water supply planning evaluation. The LWSP data was used to develop projections for the majority of wholesale customers that rely solely on Johnston County for water supply, as detailed billing data was unavailable for these communities. The Town of Clayton is Johnston County's largest wholesale customer. The Town of Clayton is forecasting significant growth as the urbanization of the Triangle metro region pushes south into northern Johnston County. The Town of Clayton hosts several major industrial users in the East Clayton Industrial Area (ECIA). Industrial demand comprises a significant portion of the Town of Clayton's total water demand. The ECIA has experienced significant growth in water demand over the last several years and the projected growth within the ECIA accounts for a large share of the water demand growth forecast in the town. Per the Town of Clayton's 2022 approved LWSP, the Town of Clayton anticipates a wholesale purchase of 8.55 mgd from Johnston County in 2030. The Town of Clayton's future water demand needs are incorporated into the Johnston County LWSP.

Table 3-8 summarizes the population and water demand projections for Johnston County based on the approved 2022 LWSP data. Johnston County is anticipating an increase in near-term growth between approximately 2 and 3.4 percent annually by 2030. After 2030, the annual growth rate is anticipated to decline to less than 3 percent annually. Per the long-range water supply planning effort, Johnston County will need to meet an average day water demand of 26 mgd in 2030 and approximately 44 mgd in 2055.

Table 3-8: Population and Water Demand Projections for Johnston County

	2022	2030	2040	2050	2055 [1]	2060
Service area population projections [2]	105,200	130,400	165,400	199,150	215,400	231,650
Annual percent growth [2]	1.95%	3.42%	2.66%	1.87%	1.53%	1.52%
Average day service area demand, mgd [2]	9.47	10.08	12.72	15.07	16.18	14.53
Water sales, mgd [2]	6.37	9.13	9.13	7.63	7.63	7.59
Future water sales, mgd [2]	----	6.80	17.40	17.40	20.15	22.90
Total average day water demand, mgd [2]	15.85	26.01	39.25	40.10	43.96	47.83
Total maximum day water demand [3]	20.39	30.85	45.36	47.33	51.89	56.13
Future water supply [2]	----	17.00	29.00	35.00	35.00	47.00
Total available water supply [2]	28.11	45.11	53.11	59.11	59.11	71.11

[1] Data interpolated from approved 2022 Local Water Supply Plan.

[2] Per Johnston County approved 2022 Local Water Supply Plan.

[3] Estimated maximum day demand with peaking factor of 1.48 from 2016 to 2022 LWSP data. Peaking factor was only applied to Johnston County service area demand.

3.3.3 Long Range Water Supply Planning

Johnston County requires significant infrastructure improvements to achieve an increase in water supply capacity. Johnston County is experiencing significant growth. Johnston County must also respond to the growth from communities purchasing bulk finished water from the County as a permanent water supply (e.g., the Town of Clayton). Johnston County's long range water supply planning effort included an evaluation of near and long-range water supply alternatives.

Johnston County's near term water supply solution is an expansion of the Timothy G. Broome WTP. Johnston County has listed the Timothy G. Broome WTP capacity as 17 mgd in the approved 2022 LWSP. A water treatment plant expansion to 18 mgd (on a max day only) combined with Johnston County's ILA for bulk finished water purchase yields a total system water supply capacity of 29.1 mgd. Johnston County's near-term water supply is contingent upon purchasing finished bulk water from Raleigh Water. Johnston County has sufficient capacity with the Timothy G. Broome WTP expansion and ILAs to serve Johnston County and honor bulk finished water sales contracts for the near-term.

Johnston County evaluated other near-term water supply solutions including an increase in wholesale purchases from Harnett County, the City of Dunn, Raleigh Water, and the City of Wilson. Based on Johnston County's Long-Range Water Supply Plan (Hazen, 2023b), the County does not anticipate a significant increase in purchased capacity from these communities. Any meaningful increase in purchases from these utilities would require significant infrastructure improvements for Johnston County to receive additional water. Johnston County has negotiated a regular purchase contract with Raleigh Water until 2031 to allow Johnston County additional time to plan and construct a larger infrastructure project. The primary issue with negotiating an extension of ILAs is that water supply capacity is a finite arrangement. Additionally, per General Statutes § 143-215.22G and 215.22L, an interbasin transfer certificate would also be required for Harnett County, the City of Dunn, and the City of Wilson if Johnston County were to acquire additional supply from these sources.

An expansion of Johnston County's existing raw water intake and a new raw water intake location in the Neuse River were explored as long-term water supply options. The proposed raw water intake location is located at Richardson Bridge Road, which is 35 stream miles downstream of Johnston County's existing intake and approximately 3 miles from the Wayne County line.

Alternative 2 was modeled with the CFNCRB model (refer to Section 5.14) assuming that the water demand for the Town of Fuquay-Varina would be satisfied by water supply in the Neuse River basin from Johnston County. The CFNCRB model assumed that the Town of Fuquay-Varina would continue to purchase water at the contracted amount from Harnett County. The CFNCRB model results in an interbasin transfer from the Neuse River basin to the Cape Fear River basin at an average in a maximum month of less than 2 mgd, which would not require an interbasin transfer certificate per General Statute § 143-215.22L.

Johnston County conducted an Environmental Assessment for the proposed Richardson Bridge Road raw water intake alternative (CH2M Hill, 2009), for which a FONSI was received in 2009. In 2022, the USGS developed a 7Q10 determination of 226 cfs for this location. Based on 20 percent of the 7Q10, the water withdrawal at this location is 29.2 mgd. Johnston County, in consultation with DWR, developed proposed operational guidelines for withdrawals at a proposed raw water intake at Richardson Bridge Road. Johnston County obtained final approval for a new raw water intake at Richardson Bridge Road in November 2024 (DWR, 2024).

Johnston County's final withdrawal schedule is summarized in Table 3-9. The schedule includes a regular schedule and a high flow skimming schedule based on the magnitude of the instream flow. Higher stream flows allow for a greater water withdrawal, or "skimming," during high stream flow events to off-stream storage. Johnston County would implement off-stream storage to augment water supply during low flow events. Several potential off-stream storage sites were identified in the long-range water supply planning effort. Johnston County owns one abandoned quarry site near Princeton adjacent to the Little River with sufficient volume for the 2050 water supply need. Once the withdrawal protocols are approved by DWR, Johnston County will move forward with a preliminary design to implement the Richardson Bridge Road raw water intake as its next water supply solution.

Table 3-9: Summary of Raw Water Withdrawal Operational Guidelines for Johnston County's Proposed Richardson Bridge Intake on Neuse River

Neuse River Flow [1, 2]	Schedule Type	Water Withdrawal Notes
> 198 cfs	Regular	Withdrawal allowed at raw water intake.
< 198 cfs	Regular	No withdrawal allowed at raw water intake.
Q > 903 cfs	High-flow skimming	Between June 16 – February 29, County may withdrawal up to 20% of total river flow.
Q > 903 cfs	High-flow skimming	Between March 1 and June 15 (spawning season), County may withdrawal up to 20% of the total river flow when the downstream gage flows exceeds 1,281 cfs and off-stream storage is greater than 70%.
Q > 903 cfs	High-flow skimming	Between March 1 and June 15 (spawning season), County may withdrawal up to 20% of the total river flow when the downstream gage flows exceeds 903 cfs and off-stream storage is less than 70%.

[1] *From Division of Water Resources letter to Johnston County on Proposed Lower Neuse River Intake Withdrawal Schedule (2024).*
[2] *Minimum passing flow as measured from the Richardson Bridge Road gage.*

3.3.4 Summary

Alternative 2 does not meet the Town of Fuquay-Varina's project purpose and need for a reliable permanent water supply source or water supply capacity in a time frame needed for the Town to address their water supply shortfall by 2030. Johnston County's identified long range water supply alternative, a new raw water intake at Richardson Bridge Road, will not yield sufficient water supply capacity for additional wholesale customers or water supply partners, including the Town of Fuquay-Varina. To support the Town of Fuquay-Varina, Johnston County would be required to develop a third water supply. Johnston County's current water supply planning efforts would be unable to meet both the Town of Fuquay-Varina's and the County's water demands before 2040.

Johnston County is moving forward with a concept design of the Richardson Bridge Road alternative to meet the County's long-term water supply needs. It is anticipated that Johnston County will require 7 to 10 years to develop the Richardson Bridge Road water supply (e.g., concept through final design, funding, and construction). Therefore, an anticipated start-up date for Johnston County's Richardson Bridge Road alternative is between 2031 and 2034. The Town of Fuquay-Varina will experience a water supply deficit by 2030. However, this alternative was carried forward in the EIS for an environmental impact analysis as a comparison to other alternatives.

Significant infrastructure improvements would be required to implement this alternative. Figure 3-4 provides an illustration of the proposed infrastructure improvements for the proposed Richardson Bridge Road intake. The proposed raw water intake at Richardson Bridge Road is approximately 3 miles from the Wayne County line. The raw water transmission main to the Johnston-County owned quarry is approximately 12 miles. A raw water pump station and intake at the quarry would need to be constructed to convey raw water to a proposed water treatment facility owned and operated by the Town of Fuquay-Varina. An additional

37 miles of raw water transmission main would be required along with a booster pump station. The proposed water treatment facility would be located in the Town of Fuquay-Varina's eastern urban services area.

Legend

- WWTP — Wastewater Treatment Plant
- WTP — Water Treatment Plant
- Surface Water Intake
- IBT Boundary
- Service Area
- County Boundary
- Major Water Body
- Major River/Stream
- Primary Road
- Municipal Boundary
- Extra-Territorial Jurisdiction

MORRISVILLE
RALEIGH
CARY
APEX
WAKE COUNTY
GARNER
KNIGHTDALE
WENDELL
ZEBULON
MIDDLESEX
BAILEY
SIMS
WILSON COUNTY
Neuse River Resource Recovery Facility
ARCHER LODGE
CLAYTON
HOLLY SPRINGS
Brighton Forest WWTP
D. E. Benton WTP
Little Creek WRF
Neuse River
FUQUAY-VARINA
Terrible Creek WWTP
Proposed Booster Pump Station
Proposed WTP
Proposed Finished Water Main
WILSON'S MILLS
KENLY
SELMA
MICRO
SMITHFIELD
PINE LEVEL
Proposed Raw Water Storage Facility with Intake and Pump Station
City of Sanford WTP
LEE COUNTY
ANGIER
Black Creek
210 WWTP
Johnston County WWTP
JOHNSTON COUNTY
2-3: Cape Fear River Basin
BROADWAY
SANFORD
PRINCETON
FOUR OAKS
Proposed Raw Water Main
Harnett County Regional WTP
HARNETT COUNTY
LILLINGTON
North Harnett WWTP
COATS
BENSON
10-1: Neuse River Basin
Cape Fear River
2-4: Cape Fear River Basin
ERWIN
A.B. Uzzle WTP
DUNN
Proposed Raw Water Intake and Pump Station
WAYNE COUNTY

SCALE
1 inch = 4 miles
0 2 4 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 3-4: Surface Water, Purchase Finished Water from Johnston County (Alternative 2)
Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

3.4 Alternative 3 – Surface Water, Town of Fuquay-Varina Independent Water Supply in Neuse River Basin

The construction of an independent water supply reservoir on Middle Creek for the Town of Fuquay-Varina was explored in this EIS. The dam for the proposed reservoir would be constructed on Middle Creek approximately 0.7 river miles downstream from the Wake-Johnston County line and 5.4 river miles upstream of U.S. Highway 50. Middle Creek is a tributary of Swift Creek. Middle Creek is located in southern Wake County and northern Johnston County. The confluence of Middle and Swift Creeks is downstream of the Town of Smithfield in Johnston County.

Figure 3-5 illustrates the proposed location and footprint of the dam. A raw water intake and pump station would be located at the site of the proposed dam. A raw water transmission main would convey raw water to a new water treatment facility owned and operated by the Town of Fuquay-Varina. Approximately 4.5 miles of finished water transmission main would be required to deliver finished water to the edge of the Town of Fuquay-Varina's distribution system.

Alternative 3 was modeled with the CFNCRB model assuming that the water demand for the Town of Fuquay-Varina would be satisfied by water supply in the Neuse River basin from the proposed reservoir. The CFNCRB model assumed that the Town of Fuquay-Varina would continue to purchase water at the contracted amount from Harnett County. The CFNCRB model results in an interbasin transfer from the Neuse River basin to the Cape Fear River basin at an average in a maximum month of less than 2 mgd, which would not require an interbasin transfer certificate per General Statute § 143-215.22L.

3.4.1 Proposed Middle Creek Reservoir

A hydrologic analysis was conducted to determine the safe yield of the proposed reservoir. The proposed site would have a drainage area of approximately 67.4 square miles. The footprint of the reservoir would cover approximately 334 acres with a storage of 700 million gallons (2,142 acre-feet). The anticipated 50 year safe yield of the proposed reservoir is 18 mgd with a normal pool elevation of 228 feet. The footprint and normal pool elevation were determined using ArcMap software and the yield calculated using the CFNCRB model developed for this EIS. The proposed yield of the reservoir would meet the Town of Fuquay-Varina's water supply need for the year 2055. Table 3-10 provides a summary of the proposed Middle Creek criteria for a Town of Fuquay-Varina owned and operated reservoir.

The calculated supply yield is large for the proposed reservoir volume and drainage area. The relatively high yield of the proposed reservoir is due to the capture of upstream wastewater discharges as inflow. The Town of Apex WRF discharges to Middle Creek approximately 18.7 river miles upstream of the proposed reservoir. The South Cary WRF, owned and operated by the Town of Cary, discharges to Middle Creek approximately 10.7 river miles upstream of the proposed reservoir. The Town of Fuquay Varina's Terrible Creek WWTP discharges to the Middle Creek basin approximately 8.1 river miles upstream of the proposed dam. The discharges are greater than North Carolina's guidance policy whereby a wastewater discharge must be at least five miles upstream of a raw water intake. The natural yield of this site without the wastewater discharge input would be significantly reduced. Under prevailing summer and fall conditions in

2055, the majority of the stored water in the reservoir contents would consist of wastewater discharged from the three aforementioned wastewater treatment facilities upstream of the proposed reservoir.

Table 3-10: Criteria for Proposed Middle Creek Reservoir for Town of Fuquay-Varina

Description	Criteria
Total reservoir storage	700 million gallons (2,142 acre-feet)
Normal pool elevation	228 feet MSL
Area inundated at normal pool elevation	334 acres
Drainage area	67.4 square miles
Minimum release	3-2-1 cfs (>70%, 40-70%, <40%)
Sedimentation rate	0.13 acre feet / yr / square mile drainage area
Reserve storage fraction	20%
Estimated active storage for safe yield	477 million gallons
Hydrologic period of record	1930 to 2020
Water supply safe yield (with 50 years of sedimentation)	18.0 mgd

An instream flow study would be required for the proposed reservoir per 15A NCAC 2K due to the presence of threatened and endangered species in Middle Creek (e.g., Atlantic pigtoe, Neuse River waterdog, and dwarf wedgemussel). A site-specific instream flow study would establish a tiered minimum flow release from the proposed Middle Creek Reservoir. A tiered minimum flow release of 3 cfs, 2 cfs, and 1 cfs for Tiers 1, 2, and 3, respectively, was used to calculate the safe yield for this analysis. The proposed 3-2-1 cfs tiered minimum release was selected to replicate the tiered minimum flow release from Lake Benson dam per the Raleigh Water Biological Opinion (2006) for the Dempsey E. Benton WTP.

A proposed Middle Creek Reservoir will have significant environmental impact to property and transportation infrastructure. Approximately 678.5 acres of private property would need to be acquired to accommodate the reservoir inundation footprint and the 100-foot water supply watershed buffer area. Approximately 39.5 acres of property are designated for residential development. Eight households, 8 farms, 5 forestry tracts, and one park (68.7 acres) would be impacted. Approximately 1,048 feet of state highways, 1,345 feet of secondary roads, and two bridges would be impacted.

A surface water reclassification process per 15A NCAC 2B .0100 and .0200 would be required to reclassify the Middle Creek watershed as a WS-IV water supply watershed. Similar to Alternative 1 (Purchase of Finished Water from Raleigh Water), a proposed reservoir would have a significant impact on the development potential of the Middle Creek basin. The critical area is a one-half mile buffer area as measured from the normal pool elevation. The protected area is 5 miles as measured from normal pool elevation. In the protected area, the low-density option limits impervious surface to 24 percent or 20,000 square foot lot excluding roadway ROW or one dwelling unit per half acre for single family residential development. Only the 24 percent impervious cover measurement is allowed for non-residential and all other residential development. The low-density option allows for higher density (i.e., 70 percent) in 10 percent of a jurisdiction's service area. The WS-IV high-density option limits built upon area to 24 to 70 percent in the protected area; however, the jurisdiction must assume responsibility for operation and

maintenance for engineered stormwater controls to handle the additional stormwater flow generated from greater impervious cover.

In addition to an instream flow study, a second significant permitting challenge is the siting of the proposed reservoir in Johnston County and associated property acquisition. Per General Statute § 153A-15, the Town of Fuquay-Varina would need the consent of the Johnston County Board of Commissioners to acquire property for a dam and inundated properties. Consent from the Johnston County Board of Commissioners may be difficult due to the political impact of condemning property for water supply that would not be used by residents of Johnston County.

3.4.2 Summary

Similar to the conclusions for Alternative 1 in Section 3.2, a proposed reservoir on Middle Creek only partially meets the project purpose and need. A proposed reservoir would provide a reliable permanent water supply source to the Town of Fuquay-Varina. However, this alternative will not provide the water supply capacity in a time frame needed for the Town of Fuquay-Varina to address their water demand projections. The Town of Fuquay-Varina's water demand projections indicate a water supply shortfall by 2030.

Per the aforementioned discussion in Section 3.2.4, construction of new reservoirs is challenging in North Carolina. A myriad of challenges are associated with permitting and constructing a new reservoir in North Carolina to include a site-specific instream flow study to evaluate potential impact to threatened and endangered species, a surface water reclassification, consent from the Johnston County Board of Commissioners for acquisition of property outside of Wake County, and significant property acquisition. All of these challenges require years of time and significant expense. It is estimated that at least 20 to 30 years is required to permit and construct a new reservoir in North Carolina. Refer to Section 3.2.4 for a detailed summary of reservoir history and construction time frames in North Carolina. However, this alternative was carried forward in the EIS for an environmental impact analysis.

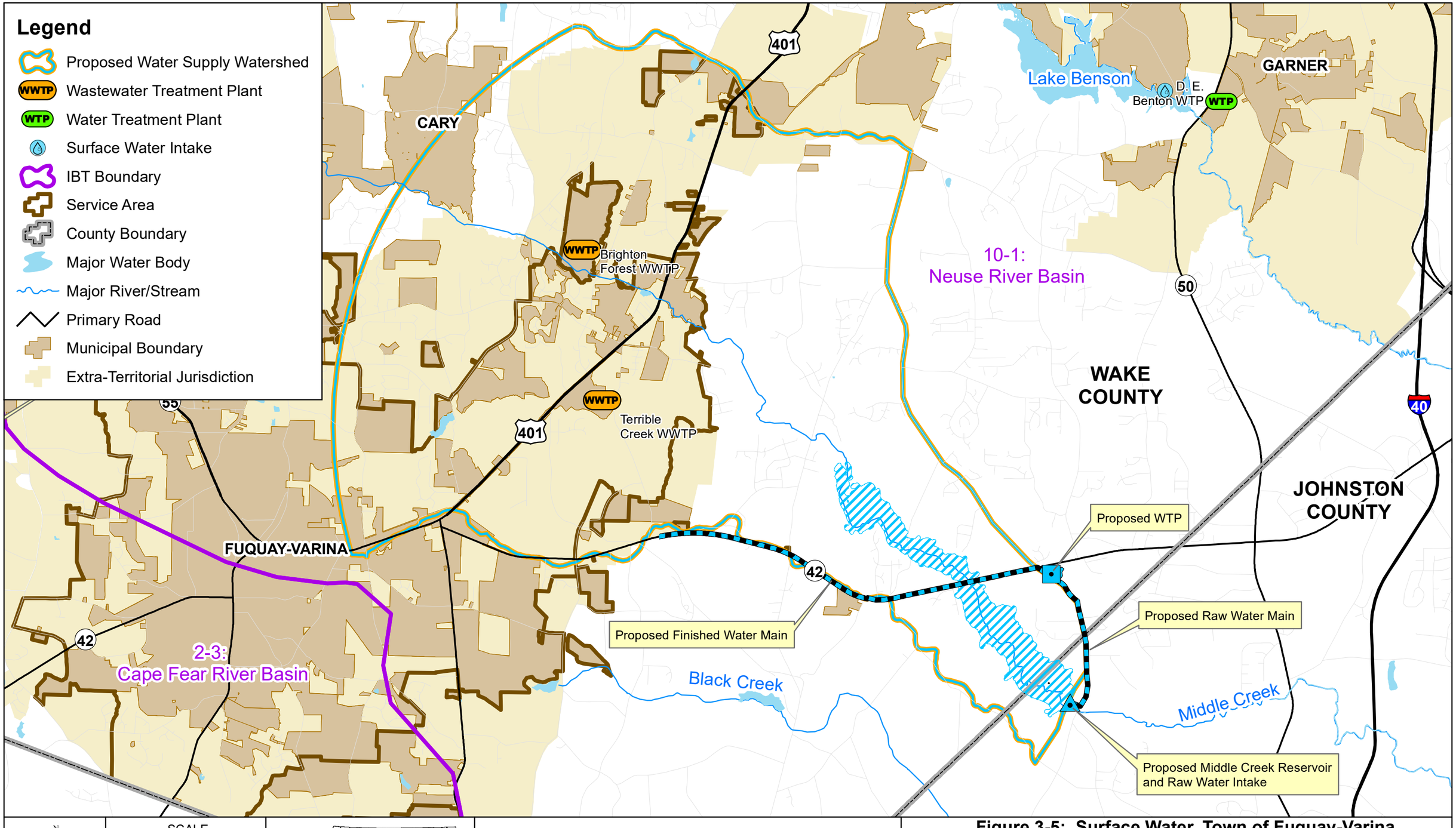


Figure 3-5: Surface Water, Town of Fuquay-Varina Independent Water Supply in Neuse River Basin (Alternative 3)

Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

3.5 Alternative 4 – Surface Water, Purchase Finished Water from City of Dunn

The Town of Fuquay-Varina evaluated the purchase of finished water from the City of Dunn as a surface water supply alternative. The City of Dunn is located in the southwest corner of Harnett County. The City of Dunn's municipal boundary is located in subbasin 2-4 (South River) of the Cape Fear River basin. The City of Dunn's customers (including wholesale customers) is 62 percent, 19 percent, and 19 percent located in subbasins 2-4 (South River, Cape Fear), 2-3 (Cape Fear), and 10-1 (Neuse), respectively.

The City of Dunn provides finished water wholesale to several surrounding communities on a regular basis. The City of Dunn sold approximately 1.5 mgd of finished water to Eastover Sanitary District, Harnett County, Sampson County Water District II, and the Towns of Benson and Falcon in 2022. The total contracted amount to these communities is 4.0 mgd. Table 3-11 provides a summary of the City of Dunn's average day sales and contract amounts in 2022.

Table 3-11: Summary of City of Dunn Bulk Finished Water Sales Contracts

Purchaser	Average Day Sold, mgd [1]	Contract Amount, mgd	Contract Expiration Date	Contract Type
Eastover Sanitary District	0.484	1.00	2031	Regular
Harnett County	0.03	1.00	2032	Regular
Sampson County WD II	0.214	0.6	2036	Regular
Town of Benson	0.671	1.2	2027	Regular
Town of Falcon	0.09	0.2	2030	Regular
Total	1.49	4.0	----	----

[1] *Per City of Dunn 2022 approved Local Water Supply Plan.*

3.5.1 Population and Water Demand Projections for City of Dunn

The City of Dunn's approved 2022 LWSP data was reviewed for population and water demand projections. Table 3-12 summarizes the City of Dunn's population and water demand projections from 2022 to 2060. The City of Dunn anticipates a modest increase in population of 0.2 percent annually over the next forty years. The City of Dunn also anticipates that more finished water will be sold to wholesale customers in the next 5 to 10 years. The average day water demand in 2050 is reported as approximately 5.7 mgd. A maximum day demand in 2050 was calculated to be 7.96 mgd. The City of Dunn has sufficient capacity to serve their existing customers, including wholesale customers, over the next 20-year planning period with the rated capacity of the A.B. Uzzle WTP at 8 mgd.

3.5.2 Existing Water Supply Treatment Infrastructure

The City of Dunn owns and operates a conventional WTP and associated transmission and distribution infrastructure. The A.B. Uzzle WTP is rated for a capacity of 8 mgd. The City of Dunn WTP is located in the neighboring Town of Erwin in Cape Fear subbasin 2-3. The City of Dunn's raw water intake and pump station is located approximately 0.5 miles northwest of the WTP on the Cape Fear River. The intake

structure has a capacity of 12 mgd and the raw water pump station has a firm pumping capacity of 10 mgd. The City of Dunn WTP infrastructure includes an NPDES permit (NC0078955) authorizing a discharge to Juniper Creek in the Cape Fear River Basin. Additionally, the City of Dunn owns and operates the Black River WWTP via NPDES permit NC0043176 discharging to the Cape Fear River.

Table 3-12: Population and Water Demand Projections for City of Dunn

	2022	2030	2040	2050	2055 [1]	2060
Population projections	12,088	12,330	12,576	12,828	12,956	13,084
Annual percent growth [2]	----	0.13%	0.20%	0.20%	0.15%	0.20%
Average day service area demand, mgd [2]	1.861	1.562	1.671	1.700	1.684	1.669
Water sales, mgd [2]	1.489	4.000	4.000	4.000	4.0	4.000
Total average day water demand, mgd [2]	3.35	5.562	5.671	5.700	5.684	5.669
Max day demand, mgd [3]	4.68	7.76	7.92	7.96	7.93	7.91

[1] Data interpolated from approved 2022 Local Water Supply Plan.

[2] Per City of Dunn approved 2022 Local Water Supply Plan.

[3] Maximum day demand estimated using a maximum day demand peaking factor of 1.40 based on the maximum between 2016 and 2022 per Local Water Supply Plan data.

3.5.3 Cape Fear River Instream Flow Characterization at Dunn

The instream low flow in the Cape Fear River was characterized to determine if 15A NCAC 01C .0408(2)(b)(1) requirements would apply to a proposed increase in withdrawal for water supply at the City of Dunn's raw water intake. The USGS published a Low-Flow Characteristics and Discharge Profiles for Selected Streams in the Cape Fear River Basin (Report 02-4094) in 1998 that documented a 7Q10 of 530 cfs (i.e., 342.5 mgd) at the Lillington gage. A 7Q10 value near the City of Dunn is not documented in the 1998 USGS report. However, DWR published a Cape Fear River Basin Water Supply Plan (2002) that estimated the available water withdrawal at the City of Dunn to be 69.8 mgd. It is anticipated that this available water withdrawal could decrease comparably to the Lillington and Sanford gages based on the recent droughts of record. Regardless of the anticipated decline in the 7Q10, sufficient water supply is available to the City of Dunn for future water supply expansions over the next planning period.

3.5.4 Capacity Evaluation

In 2019, the Town of Fuquay-Varina approached the City of Dunn to discuss the possibility of purchasing water treatment capacity in the A.B. Uzzle WTP. Hazen was commissioned by the Town of Fuquay-Varina to conduct a concept-level evaluation of the City of Dunn's water treatment infrastructure capacity and condition (2019b). A re-rate of the existing facilities was considered in addition to a facility expansion. A re-rate is defined as the ability of a treatment facility to treat additional water without a physical expansion of infrastructure (e.g., new unit processes or an extensive amount of equipment). The A.B. Uzzle WTP is currently operating in full compliance with local, state, and federal regulations.

The A.B. Uzzle WTP was originally constructed in 1968. Construction projects in 2002 and 2005 provided necessary process modifications and significant electrical modifications, respectively. An inspection of the infrastructure revealed that several unit processes are approaching the end of useful life, including the filter media and structural components in the sedimentation basins.

The technical evaluation considered a facility re-rate for additional capacity. The current design of the sedimentation basins and filters will not accommodate additional treatment capacity. Tube settlers are already installed in the sedimentation basins to maximize particle settling. The filter media appears to be shallow and therefore not favorable to high-rating the filters for capacity recovery. Therefore, re-rating the WTP was determined to be infeasible.

An expansion of the City of Dunn's WTP from 8 to 16 mgd was evaluated to accommodate the Town of Fuquay-Varina as a significant wholesale customer. The proposed infrastructure for the raw water intake and pump station included a new parallel 12 mgd raw water intake, a new parallel 12 mgd raw water pump station, and a new electrical service and emergency generator. The proposed City of Dunn WTP expansion improvements included a parallel conventional WTP with additional solids handling equipment, a new finished water clearwell, and access road improvements. The capacity of the raw water force mains were sufficient for a WTP expansion to 16 mgd. The Dunn WTP expansion was proposed to be located on the existing WTP site within the footprint of decommissioned sludge drying beds. Figure 3-6 provides an illustration of the proposed infrastructure route and booster pump station. The finished water transmission main length is approximately 18.4 miles from the A.B. Uzzle WTP to the edge of the Town of Fuquay-Varina's service area.

The results of the technical evaluation concluded that an additional 8 mgd was the maximum capacity that could be constructed on the existing Dunn WTP site. To accommodate the Town of Fuquay-Varina's 2055 water demand of 12.6 mgd, additional property would need to be acquired. Additional property would also need to be acquired to accommodate advanced treatment facility infrastructure if treatment of emerging contaminants is to be considered.

The City of Dunn's treatment infrastructure does not currently include a terminal raw water reservoir. The construction of a terminal reservoir would equalize flow and source water quality entering the WTP, thereby simplifying plant operation and provide a reduction in chemical costs. A.B. Uzzle WTP staff is currently challenged by fluctuating raw water quality. This alternative includes the construction of a terminal reservoir.

3.5.5 Summary

Alternative 4 does not meet the Town of Fuquay-Varina's project purpose and need for a reliable permanent water supply source or water supply capacity in a time frame needed for the Town to address their water supply shortfall by 2030. The City of Dunn's water supply capacity is fully allocated to the growth and development needs in the City of Dunn's service area and the obligations to their wholesale communities to provide bulk finished water. By 2040, the City of Dunn will have maximized the 8 mgd A.B. Uzzle WTP and raw water intake capacity. It is anticipated that the City of Dunn may start the planning process for additional water supply by 2030. Additionally, significant funding will also be required to upgrade the City of Dunn's aging infrastructure in addition to the necessary infrastructure required for a water capacity and raw water

intake expansion. However, this alternative was carried forward in the EIS for an environmental impact analysis as a comparison to other alternatives.

A purchase of water by the Town of Fuquay-Varina from the City of Dunn to satisfy the Town of Fuquay-Varina's water demands through 2055 would result in an IBT from the Cape Fear River basin to the Neuse River basin. The Town of Fuquay-Varina's water demand in 2055 will exceed the average day in a maximum month threshold threshold per General Statute § 143-215.22L as stated in Section 2 of this EIS. Therefore, an IBT certificate would be acquired for this alternative. A purchase of finished water from the City of Dunn is comparable to other Cape Fear River basin surface water source alternatives, including Harnett County, the City of Sanford, and water supply capacity from Jordan Lake, all of which require an interbasin transfer.

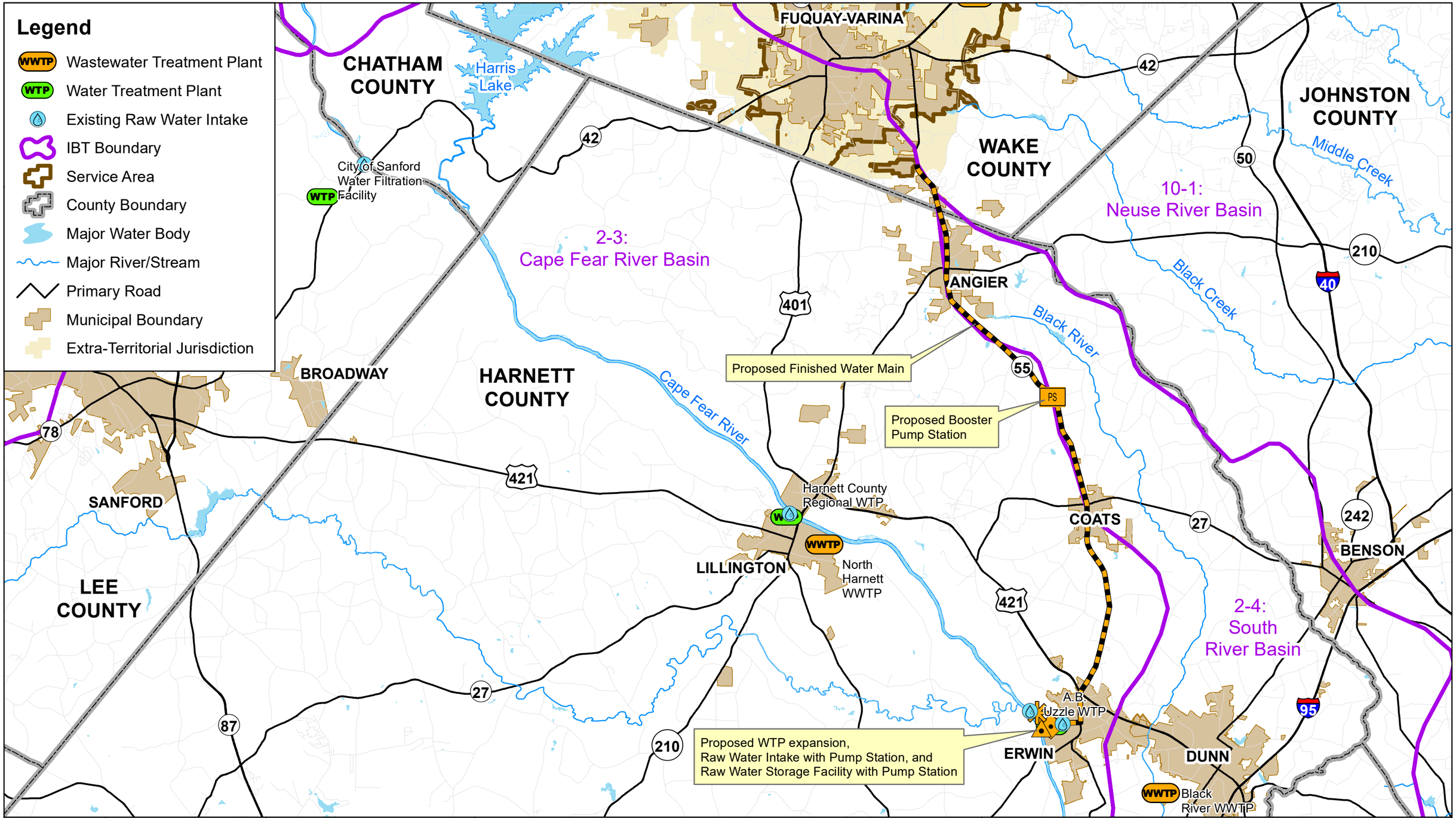


Figure 3-6: Surface Water, Purchase Finished Water from City of Dunn (Alternative 4)

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

3.6 Alternative 5 – Surface Water, Purchase Finished Water from Harnett County

Harnett County was evaluated as a surface water supply alternative for the Town of Fuquay-Varina to purchase water treatment capacity in lieu of a temporary ILA. The Harnett County Department of Public Utilities operates a regional water system providing service to over 100,000 people in Harnett County and surrounding communities. The Harnett County Department of Public Utilities serves the majority of Harnett County with the exception of the City of Dunn. The City of Dunn owns and operates a WTP independent of Harnett County.

The service area for Harnett County shares a border with southern Wake County and the Town of Fuquay-Varina's service area. Harnett County's service area encompasses the majority of Harnett County, a section of Cumberland County, and a section of Wake County at 89 percent, 8 percent, and 3 percent of the service area population, respectively, per Harnett County's approved 2022 LWSP. Approximately 85 and 15 percent of Harnett County's service area is located in subbasin 2-3 (Cape Fear) and 2-4 (South River), respectively. Harnett County's service area is comprised of 98.1 percent residential, 1.8 percent commercial, and 0.1 percent industrial and institutional based on the number of metered connections documented in Harnett County's 2022 LWSP.

Harnett County provides bulk finished water on a wholesale basis to fourteen customers, thirteen of which are served on a regular basis. Table 3-13 provides a summary of Harnett County's bulk finished water customers with the associated average day sold, contract amount, contract expiration date, and contract type. In 2022, Harnett County sold 12.75 mgd of wholesale finished water against a total contract amount of approximately 31 mgd. Harnett County provides permanent water service to 397 accounts at the southern end of the Town of Fuquay-Varina's service area near the Wake-Harnett County line. The 397 accounts are independent of the ILA with the Town of Fuquay-Varina. Harnett County provided approximately 1.5 mgd to the Town of Fuquay-Varina in 2022. The Town of Fuquay-Varina receives approximately 50 percent of finished water from Harnett County.

3.6.1 Existing Water Supply Treatment Infrastructure

Harnett County owns and operates the 42 mgd Harnett County Regional WTP located in the Town of Lillington. The WTP, raw water intake, and terminal reservoir for the Harnett County Regional WTP are located on the Cape Fear River. Harnett County's annual average withdrawal in 2022 was 21.4 mgd with a maximum day of 30.4 mgd. The Harnett County Regional WTP process water discharges to the Cape Fear River through the issuance of NPDES permit NC0007684. Harnett County's distribution system consists of 15 pressure zones. Per the Harnett County approved 2022 LWSP, Harnett County has purchased land for a new 10 mgd water treatment plant and raw water intake on the Cape Fear River near the Town of Erwin. The new raw water intake site became available when Harnett County purchased the Town of Erwin's water system. Per Harnett County's 2022 LWSP, a new intake and water treatment facility near the Town of Erwin is anticipated to supply the eastern portion of Harnett County and Johnston County at the intersection of Highway 210 and 50 and Highway 27 at the Johnston County Line. Harnett County has not initiated any studies to permit water infrastructure at this site.

Table 3-13: Summary of Harnett County Bulk Finished Water Sales Contracts

Purchaser	Average Day Sold, mgd [1]	Contract Amount, mgd	Contract Expiration Date	Contract Type
Town of Angier	0.575	1.44	2059	Regular
Bragg Comm / NTA Water	0.2135	0.80	2053	Regular
Campbell University [2]	0.07	0.25	2013	Regular
Town of Coats [2]	0.1495	0.30	----	Regular
City of Dunn	0	0.25	----	Emergency
East Moore Water District	1.3428	3.0	2042	Regular
Fort Bragg Water System [3]	3.114	8.0	2046	Regular
Town of Fuquay Varina	1.5155	2.0	2040	Regular
Town of Holly Springs	3.309	10	2048	Regular
Johnston County	1.3946	2.6	2056	Regular
Town of Lillington	0.4392	1.44	2021	Regular
Town of Linden	0.1415	0.25	2031	Regular
Town of Spring Lake [2]	0.3462	0.5	2006	Regular
Woodlake (master meter to community)	0.1363	0.14	1999	Regular
Total	12.75	30.97	----	----

[1] From Harnett County's 2022 Local Water Supply Plan (approved).

[2] Campbell University, the Town of Coats, and the Town of Spring Lake continue to purchase finished water from Harnett County per the 2021 approved LWSP.

[3] Harnett County supplies water to Fort Bragg on alternating days with Fayetteville PWC.

3.6.2 Cape Fear River Instream Flow Characterization at Lillington

The instream low flow at the Lillington gage was characterized to determine if 15A NCAC 01C .0408(2)(b)(1) requirements would apply to a proposed increase in withdrawal for water supply (Hazen, 2019c). The USGS published a Low-Flow Characteristics and Discharge Profiles for Selected Streams in the Cape Fear River Basin (Report 02-4094) in 1998 that documented a 7Q10 of 530 cfs (i.e., 342.5 mgd) at the Lillington gage (USGS, 1998). The USGS 1998 statistical analysis is based on a data set from 1982 to 1997. In 2002, DWR published a Cape Fear River Basin Water Supply Plan that estimated the water withdrawal yield at the Lillington gage to be 68.5 mgd, which is 20 percent of the published USGS 7Q10 value of 342.5 mgd (DWR, 2002).

USGS provided a revised 7Q10 statistic at the Lillington gage in October 2023 (2023b). USGS revised the 7Q10 at the Lillington gage to 288 cfs, which is 15.9 percent less than the published 7Q10 value of 342.5 cfs in the Cape Fear Water Supply Plan (DWR, 2002). The revised 7Q10 estimate results in a new available water withdrawal of 37.2 mgd at the Lillington gage without requiring an instream flow study per 15A NCAC 01C .04089(2)(b)(1). The revised available water withdrawal is 31.5 mgd lower than the published USGS value in 1998 and as reported by DWR in the 2002 Cape Fear Water Supply Plan.

3.6.3 Population and Water Demand Projections for Harnett County

Table 3-14 provides a summary of the population and water demand projections for Harnett County. The summarized data is based on Harnett County's approved 2022 LWSP data. Harnett County is anticipating an increase in near-term growth of approximately 1.5 percent annually through 2030. After 2030, the annual growth rate is anticipated to decline to 1.3 percent between 2030 and 2040 and less than 1.2 percent from 2040 to 2060. Wholesale growth is anticipated to increase to the full contract amount of approximately 31 mgd by 2030. Harnett County's 2022 LWSP documents that the County anticipates a WTP expansion by 2030 to accommodate fulfillment of the entire wholesale contract amount.

The water sales provided in Harnett County's LWSP are supported by a Hydraulic Analysis, Central and Northern Water Districts Report (Hazen, 2017). Harnett County's wholesale customers were included in the water demand calculations. Harnett County anticipates that the Town of Holly Springs, the Town of Fuquay-Varina, and Johnston County would purchase finished water up to the entire contract amount at 10 mgd, 2.0 mgd, and 2.5 mgd, respectively, by 2030. The Town of Coats, Campbell University, and Angier rely entirely on Harnett County's water system. These three communities do not have an alternate water supply source. Industrial water demand projections were also considered in the 2017 analysis. Harnett County published a comprehensive growth plan, Grow Harnett County (2015), that identified three potential industrial growth areas. Approximately 0.25 mgd of future maximum day demand was distributed to each of the three areas.

Table 3-14: Population and Water Demand Projections for Harnett County

	2022	2030	2040	2050	2055 [1]	2060
Service area population projections [2]	114,302	130,504	148,207	166,142	172,622	184,077
Annual percent growth	----	1.5%	1.3%	1.2%	1.07%	1.0%
Average day service area demand, mgd [2]	10.32	12.13	13.82	15.61	16.56	17.52
Water sales, mgd [2]	11.19	31.28	31.28	31.28	31.28	31.28
Total average day water demand, mgd [2]	21.52	45.41	45.10	46.89	47.84	47.9
Maximum day demand, mgd [3]	28.33	51.41	54.23	57.19	58.77	60.36

[1] Data interpolated from approved Local Water Supply Plan.

[2] Per Harnett County approved 2022 Local Water Supply Plan.

[3] Maximum day water demand calculated using a peaking factor of 1.66 applied to the County's service area. The peaking factor was based on the Hydraulics Analysis, Central and Northern Water Districts Report (Hazen, 2017).

3.6.4 Capacity Evaluation

Harnett County supplies finished water to the Town of Fuquay-Varina at two connection points. The primary connection to the Town of Fuquay-Varina is at the Wake County ground storage tank and booster pump station located at Fleming Road. This primary connection point is supplied from a 36 inch finished water transmission main. The transmission main is owned and maintained by Harnett County. The Towns of

Fuquay-Varina and Holly Springs have dedicated capacity allocations. A secondary connection point is at U.S. 401 near the Wake County and Harnett County border.

The capacity of the 36 inch transmission main is currently 12 mgd at the Wake County-Harnett County line. Harnett County's projected 2040 water demand through the existing 36 inch transmission main is 23.9 mgd, which is the sum of the contract amounts for the Town of Holly Springs at 10 mgd, the Town of Fuquay-Varina at 2 mgd, and the anticipated Harnett County water demand of 11.9 mgd. The recommendations from the 2017 Hydraulic Analysis, Central and Northern Water Districts Report (Hazen, 2017) included installing a third high service pump at Harnett County's Regional WTP to increase the pumping capacity to meet the anticipated 2040 demands.

The capacity of the existing 36-inch finished water transmission main with the aforementioned near-term improvements is not sufficient to meet growth needs greater than Harnett County's planned 2040 water demand of 23.9 mgd. Harnett County would need to provide an additional 11 mgd by 2050 to meet the projected maximum day water demand for the Town of Fuquay-Varina. A parallel finished water transmission main would need to be constructed from Harnett County's Regional WTP to the Fleming Road connection point to accommodate additional water demand from the Town of Fuquay-Varina.

Harnett County will require an expansion of the Regional WTP or the construction of a new 10 mgd WTP in the next 20-year planning period to meet Harnett County's current service area demands and existing wholesale contract obligations. Harnett County has not committed to providing the Town of Fuquay-Varina additional water supply greater than the 2 mgd until 2040 as stated in Harnett County's 2022 LWSP; therefore, Harnett County's wholesale obligations do not extend additional water supply to the Town of Fuquay-Varina. Based on Harnett County's 2022 LWSP projections, a Harnett County Regional WTP expansion to approximately 54 mgd is anticipated in the next 20-year planning period. Per the aforementioned 7Q10 analysis, Harnett County may need to conduct an instream flow study per 15A NCAC 01C .0408(2)(b)(1) to expand the Regional WTP and raw water withdrawal at the existing raw water intake location.

3.6.5 Summary

Alternative 5 does not meet the Town of Fuquay-Varina's project purpose and need. The Town of Fuquay-Varina has been unable to secure reliable permanent water supply capacity from Harnett County in lieu of the continuation of the temporary interlocal lease agreement. The Town of Fuquay-Varina's current interlocal agreement for 2 mgd expires in 2040. In 2022, the Town of Fuquay-Varina negotiated with Harnett County for an additional 2 mgd increase in water allocation until 2032. The Town of Fuquay-Varina's agreement with Harnett County is a temporary measure to provide water to the Town to mitigate the anticipated extended timing of construction for a water supply project. Harnett County has not committed to providing the Town of Fuquay-Varina with additional or permanent water supply greater than the interlocal agreement amount as stated in Harnett County's approved 2022 LWSP. Therefore, Alternative 5 does not provide water supply capacity in a time frame needed for the Town of Fuquay-Varina to address their water supply shortfall by 2030.

Harnett County's water supply capacity is fully allocated to the growth and development needs of the County's service area over the next 20-year planning period. Harnett County's water supply capacity also fulfills the existing obligations to the County's wholesale communities to provide bulk finished water. By 2040, Harnett County is anticipated to maximize the 42 mgd Regional WTP capacity (refer to Harnett County's water demand projections in Table 3-14). Based on the updated 7Q10 estimate at the Lillington gage, Harnett County may be required to conduct an instream flow study to further increase withdrawals per 15A NCAC 01C .0408(2)(b)(1).

A purchase of water by the Town of Fuquay-Varina from Harnett County to satisfy the Town's water demands through 2055 would result in an IBT from the Cape Fear River basin to the Neuse River basin. The Town of Fuquay-Varina's water demand in 2055 will exceed the average day in a maximum month threshold threshold per General Statute § 143-215.22L as stated in Section 2 of this EIS. Therefore, an IBT certificate would be acquired for this alternative. A purchase of finished water from Harnett County is comparible to other Cape Fear River basin surface water source alternatives, including City of Dunn, the City of Sanford, and water supply from Jordan Lake.

This alternative was carried forward in the EIS for an environmental impact analysis. Figure 3-7 provides an illustration of the infrastructure that would be required for this alternative. The infrastructure improvements include an expansion of the raw water intake, a new 13.3 mile parallel finished water transmission main, and finished water pumping improvements at the Harnett County Regional WTP.

Legend

- Wastewater Treatment Plant
- Water Treatment Plant
- Surface Water Intake
- IBT Boundary
- Service Area
- County Boundary
- Major Water Body
- Major River/Stream
- Primary Road
- Municipal Boundary
- Extra-Territorial Jurisdiction
- Harnett County Service Area

Harris Lake

WWTP Terrible Creek WWTP

FUQUAY-VARINA

WAKE COUNTY

JOHNSTON COUNTY

Middle Creek

10-1: Neuse River Basin

2-3: Cape Fear River Basin

ANGIER

Black Creek

LEE COUNTY

BROADWAY

Proposed Finished Water Main

Cape Fear River

Proposed WTP expansion, Raw Water Intake, and Pump Station

Harnett County Regional WTP

LILLINGTON

WWTP North Harnett WWTP

HARNETT COUNTY

2-4: South River Basin

COATS

BENSON

42 401 210 55 40 50 421 27

SCALE
1 inch = 2 miles
0 1 2 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 3-7: Surface Water, Purchase Finished Water from Harnett County (Alternative 5)
Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

3.7 Alternatives 6 and 7 – Surface Water, Raw Water from Jordan Lake

The use of B. Everett Jordan Lake (Jordan Lake) reservoir as a surface water supply option for the Town of Fuquay-Varina was evaluated as an alternative in this EIS. Alternative 6 considers water supply capacity in the Town of Cary/Apex raw water supply allocation in Jordan Lake. Use of the existing Cary/Apex raw water intake or a parallel raw water intake owned and operated by the Town was considered. Alternative 7 considers use of the Western Intake Partnership (WIP) raw water supply allocation in Jordan Lake.

A general description of Jordan Lake and the Triangle Water Supply Partnership, formerly the Jordan Lake Regional Water Supply Partnership, is discussed in Section 3.7.1. The regulatory discussion of water supply allocation in Jordan Lake supports the discussion for Alternatives 6 and 7. Alternatives 6 and 7 are discussed in the following Sections 3.7.2 and 3.7.3.

3.7.1 Jordan Lake Water Supply Partnership and Water Supply Allocation

3.7.1.1 Jordan Lake Reservoir

Jordan Lake is a USACE owned and operated reservoir. The reservoir is located in the eastern portion of Chatham County. Jordan Lake dam is sited on the Haw River immediately downstream of the confluence of the Haw and New Hope Rivers in Subbasin 2-2 (Haw River, Cape Fear). The majority of the reservoir's storage is in the New Hope basin, whereas the majority of the inflow to the reservoir arrives via the Haw River. Dam construction began in 1967 and the reservoir finished filling and went into service in 1982. The drainage area for the lake is approximately 1,700 square miles.

Jordan Lake is a multi-purpose reservoir providing low-flow augmentation, flood control, recreation, fish and wildlife habitat, and water supply. The State of North Carolina requested that the USACE include water supply in the total lake storage volume. The State of North Carolina subsequently purchased the water supply fraction of the total storage in Jordan Lake. Section 3.7.1.3 describes the procedures to be used by the State of North Carolina in allocating the Jordan Lake water supply storage. Local governments holding a water supply allocation must reimburse the State of North Carolina for the cost of the water supply storage as well as fund a portion of the annual reservoir operating and maintenance costs. The State of North Carolina then pays the USACE for these fees.

The Water Quality Pool low flow augmentation storage is used to maintain supporting uses in the Cape Fear River downstream of the dam via a minimum release at the dam. Under normal conditions the minimum flow target at Lillington is 600 cfs (i.e., approximately 388 mgd) with a +/- 50 cfs tolerance. The flow target at Lillington can be progressively reduced under increasingly severe drought conditions. The flow targets under Jordan Lake's drought plan are provided in detail in Appendix F and in Section 5.14. The published 7Q10 from USGS at the Lillington gage is 342.5 mgd (USGS, 1998). Under all conditions, the minimum release from Jordan Lake dam is no less than 40 cfs. The normal operating pool for Jordan Lake is at 216 feet MSL.

The Jordan Lake water supply storage is 45,800 acre-feet (15 billion gallons) of the total 140,400 acre-feet (45.7 billion gallons) of conservation storage. Conservation storage is defined as the sum of water supply

volume and low flow augmentation volume. The water supply storage provides a projected safe yield of 100 mgd during a severe drought and is an indication of average day supply availability (DWR, 2014). The 100 mgd safe yield estimate is based on an annual average day withdrawal rate. Maximum day withdrawal rates may exceed 100 mgd without jeopardizing the water supply pool's function as long as the annual average withdrawal is less than the 100 mgd allocation.

3.7.1.2 Triangle Water Supply Partnership (formerly Jordan Lake Regional Water Supply Partnership)

The Jordan Lake Regional Water Supply Partnership was created in 2009 by thirteen local governments and water systems (i.e., Partners) in the Triangle region via a signed Memorandum of Understanding. The purpose of the Partnership is to allow members to jointly plan for future water supply needs. Partners in 2009 included the Towns of Apex, Cary, Hillsborough, Holly Springs, Pittsboro, and Morrisville; Chatham County; the City of Durham; the City of Sanford; Orange County; Orange County Water and Sewer Authority (OWASA); Raleigh Water; and Wake County. The Partnership published Volume I: Regional Water Supply Needs Assessment in 2012 and Volume II: Regional Water Supply Alternatives Analysis in 2014. The City of Sanford declined continuing membership in the Partnership in 2014.

The Jordan Lake Regional Water Supply Partnership was superseded in 2018 by the Triangle Water Supply Partnership (TWP). The TWP is comprised of sixteen jurisdictions and water systems in the Triangle. Three new members include the Towns of Fuquay-Varina and Clayton in 2023 and TriRiver Water (e.g., City of Sanford) in December 2024. The other two members are Johnston County and Harnett County. The original members are Towns of Apex, Cary, Hillsborough, Holly Springs, Pittsboro, and Morrisville; Chatham County; the City of Durham; Orange County; OWASA; and Raleigh Water.

3.7.1.3 Jordan Lake Water Supply Allocation

The State of North Carolina requested inclusion of water supply storage in the Jordan Lake Dam project sufficient to supply 100 mgd (DWR, 2016b). Based on DWR precedence, the potential yield of the water supply pool has been assumed to be 100 mgd (DWR, 2014). Consequently, one percent of the storage in the water supply pool is assumed to be able to provide one million gallons of water per day. However, allocations are officially delineated as a percentage of water supply pool storage and are not guaranteed to provide a specific daily withdrawal rate.

General Statute § 143-354(a)(11) authorizes the EMC to allocate to local governments any water supply storage held by the State in federal reservoirs. The EMC adopted an administrative rule (15A NCAC 2G.0500) outlining specific procedures for allocating Jordan Lake water supply storage. The requirements include an application to provide information describing current water supply sources, projected water needs, and alternative water sources. DWR staff is responsible for evaluating the information and recommending the allocation amounts to the EMC. Level I allocations are made based on 20-year water need projections and if planned withdrawals begin within five years of receiving the allocation. Level II allocations are made based on longer-term needs of up to 30 years. The EMC has approved four rounds of allocations. The current rules limit the allocations to users outside of the Jordan Lake watershed to 50 percent of the water supply pool. Currently, 33 mgd, or 33 percent of the water supply pool, has been approved for diversion out of the Jordan Lake watershed (DWR, 2015a).

The process for Round 4 allocations was initiated in 2009 with a request from the Jordan Lake Partnership to DWR. Applications were submitted in November 2014. In 2015, DWR staff revised the CFNCRB model to evaluate the requests for additional Jordan Lake water supply allocation (DWR, 2016). The CFNCRB model uses the OASIS hydrologic model platform. The OASIS model platform is the same model platform used to evaluate alternatives in this EIS. The proposed withdrawals from the Round 4 applications were compared against the calibrated 2010 baseline scenario. The DWR Round 4 modeling results demonstrated that the proposed water withdrawals resulted in an increase in the percent of time that the normal pool operating level will be less than 216 feet, which may impact recreational activities (e.g., boat launching facilities). For the 2060 demand scenario, the DWR Round 4 modeling results anticipated the minimum water surface elevations to be approximately 2.4 feet lower than the minimum water levels projected with the 2010 baseline scenario and occurrence of the water surface elevation drops below 214 feet MSL increases from 10 to 15 percent of the time (DWR, 2016a). However, the Round 4 modeling by DWR indicated that Jordan Lake has buffering capacity for water supply storage and flow augmentation to withstand another historic drought with the proposed 2060 withdrawals (DWR, 2016a).

Table 3-15: Summary of Round 3 and 4 Water Supply Allocations from Jordan Lake

Jordan Lake Partner	Round 3 (2002), mgd	Round 4 (2017), mgd	Round 4 with 2019 Update, mgd
Town of Apex	8.5	10.6	10.6
Town of Cary	23.5	28.6	28.6
Town of Morrisville	3.5	3.5	3.5
Wake County (RTP South)	3.5	3.5	3.5
Sum of Cary-Apex-Morrisville-RTP	39	46.2	46.2
Chatham County (North) [1]	6	13	13
City of Durham [1]	10	16.5	16.5
OWASA [1]	5	5	5
Town of Pittsboro [1]	0	6	6
Sum of Western Intake Partners	21	40.5	40.5
Orange County WSA	1	1.5	1.5
Town of Holly Springs	2	2	2
Town of Hillsborough	0	1	1
Raleigh Water [2]	0	4.7	0
City of Sanford [3]	0	0	0
Total all Jordan Lake Partners	63	95.9	91.2

[1] Members of Western Intake Partnership.

[2] Raleigh Water rescinded the 4.7 mgd water supply allocation in March 2019 upon receipt of additional storage in the Falls Lake Reservoir.

[3] The City of Sanford declined continuing membership in the Jordan Lake Partnership in 2014.

DWR staff held public meetings in 2016 to discuss the Round 4 proposal for a revised water supply allocation. DWR staff recommendations were supported by the EMC. A Final Decision from the EMC was signed in 2017. Table 3-15 summarizes the Round 3 and 4 allocations in 2002 and 2017, respectively. Prior

to completing Round 4, the total allocation from Jordan Lake was 63 percent (i.e., approximately 63 mgd) of the water supply pool. The Round 4 allocation increased the total Jordan Lake allocation to 95.9 percent. Raleigh Water rescinded their 4.7 mgd allocation from Jordan Lake in March 2019 as a result of the Falls Lake Reallocation Process for additional storage in the Falls Lake reservoir (City of Raleigh, 2019). The revised Jordan Lake allocation is 91.2 mgd out of the total 100 mgd safe yield.

3.7.2 Alternative 6 – Raw Water Supply from Towns of Cary, Apex, and Morrisville

Alternative 6 evaluates the purchase of raw water supply from Towns of Cary, Apex, and Morrisville out of the Jordan Lake Round 4 water supply allocation for the three towns. The Towns of Cary, Apex, and Morrisville are located on the western side of Wake County adjacent to Chatham County. Approximately 29 percent, 65 percent, and 6 percent of the Town of Apex's service area is in the Neuse River basin (10-1), Haw River Basin (2-1), and Cape Fear River basin (2-3), respectively. The Town of Apex's service area is entirely in Wake County. For the Town of Cary, approximately 68 percent and 32 percent of the service area is in the Neuse River basin (10-1) and Haw River Basin (2-1), respectively. The Town of Cary serves the Town of Morrisville, the Wake County portion of Research Triangle Park South, and RDU International Airport in Wake County. Approximately 4 percent of the Town of Cary's service area is located in Chatham County.

Both the Towns of Cary and Apex supply bulk (wholesale) finished water to several customers in Wake County. Table 3-16 provides a summary of the average sales and contract amounts for both the Towns of Cary and Apex per the approved LWSPs. The Town of Apex has negotiated bulk finished water sales

Table 3-16: Summary of Towns of Apex and Cary Bulk Finished Water Sales Contracts

Purchaser	Average Day Sold, mgd [1]	Contract Amount, mgd	Contract Expiration Date	Contract Type
Town of Apex: [1]				
Feltonsville Community	0.008	0.014	----	Regular
Harnett County	0	----	----	Emergency
Holly Springs	0	----	----	Emergency
Merion Subdivision	0	0.026	2030	Emergency
Town of Cary: [2]				
City of Durham	0.081	----	2028	Emergency
Raleigh Water	0	----	2032	Emergency
Orange Water and Sewer Authority	0	----	2029	Emergency
RDU	0.322	0.40	2033	Regular
Town of Holly Springs	0.0	----	2045	Emergency

[1] Per Town of Apex 2021 approved Local Water Supply Plan.
[2] Per Town of Cary 2022 approved Local Water Supply Plan.

contracts to one community on a regular basis and three communities on an emergency basis. Per the 2021 approved LWSP, the Town of Apex sold approximately 0.008 mgd of bulk finished water out of a total

contract amount of 0.014 mgd. The Town of Cary has negotiated contracts with five communities. Only RDU is supplied on a regular basis. The other four contracts are solely to be used on an emergency basis. The Town of Cary sold approximately 0.322 mgd of bulk finished water out of a total contract amount of 0.40 mgd with RDU per the approved 2022 LWSP.

Table 3-17 summarizes the Towns of Apex and Cary's wholesale water purchase contracts. The Town of Apex has signed ILAs with two wholesale water providers for the purchase of bulk finished water on an emergency basis. The Town of Cary has signed ILAs with four wholesale water providers for the purchase of bulk finished water on an emergency basis. The Town of Apex and the Town of Cary do not have contracts to purchase a regular supply of water from a neighboring utility.

Table 3-17: Summary of Towns of Apex and Cary Water Supply Purchase Contracts

Seller	Average Day Purchased, mgd [1]	Contract Amount, mgd	Contract Expiration Date	Contract Type
Town of Apex [1]				
Harnett County	0	----	----	Emergency
Holly Springs	0	----	----	Emergency
Town of Cary [2]				
City of Durham	0	----	2028	Emergency
Raleigh Water	0.376	----	2032	Emergency
Orange Water and Sewer Authority	0	----	2029	Emergency
Town of Holly Springs	0	----	2045	Emergency

[1] Per Town of Apex approved 2021 Local Water Supply Plan.
[2] Per Town of Cary approved 2022 Local Water Supply Plan.

3.7.2.1 Existing Water Supply and Wastewater Treatment Infrastructure

The Towns of Cary and Apex jointly own a raw water intake at Jordan Lake and a 56 mgd Cary/Apex WTF. The expansion of the WTF from 40 to 56 mgd was completed in 2018. The Cary/Apex raw water intake is located on the eastern side of Jordan Lake at U.S. Highway 64. The raw water intake has a capacity of 82 mgd. Chatham County also uses the Cary/Apex raw water intake to withdrawal water for the 3 mgd Chatham County WTP. The Town of Cary operates two wastewater facilities in the Neuse (10-1) River basin, the 12 mgd North Cary WRF and the 12.8 mgd South Cary WRF. The Town of Apex owns and operates a 3.6 mgd WRF which discharges to Middle Creek in the Neuse (10-1) River basin. A portion of the water used by the Towns of Cary and Apex is returned to the Cape Fear River basin via the jointly-owned 18-mgd Western Wake Regional WRF.

The Towns of Cary and Apex secured an IBT Certificate for a 31 mgd transfer of water from the Haw River Basin to the Neuse River basin and 2 mgd from the Haw River basin to the Cape Fear River basin for a total transfer amount of 33 mgd (DWR, 2015a). A Consent Judgement was negotiated in 2018 (North Carolina Environmental Management Commission; North Carolina Department of Environmental Quality and Town of

Cary and Town of Apex v. The City of Fayetteville and the Public Works Commission of the City of Fayetteville and The Town of Eastover and Lower Cape Fear Water and Sewer Authority, 2018) that added a condition to the Towns of Cary/Apex IBT Certificate for a required amount of water returned, or discharged, to the Cape Fear and Haw River basins. The Consent Judgement stipulated a required discharge amount to equal the Neuse Basin Demand less the amount of 9.756 mgd. The Neuse Basin Demand is defined as the three-year running annual average daily amount for the three preceding calendar years of all finished water supplied from sources within the Haw River basin (2-1) and the Cape Fear River basin (2-3) used by the Towns of Cary and Apex in the Neuse River basin (10-1). The annual average daily (finished water) amount includes both billed and unbilled water per the American Water Works Association's (AWWA) Water Audits and Loss Control publication. The quantity of wastewater discharged to the Haw River basin (2-1) and the Cape Fear River basin (2-3) is defined as the annual average daily flow calculated as the three-year running annual average daily treated wastewater discharged by the Towns of Cary and Apex to the Haw River basin (2-1) and the Cape Fear River basin (2-3) during the three preceding calendar years.

3.7.2.2 Population and Water Demand Projections for Cary / Apex / Morrisville / Wake County

The Town of Cary published a Long Range Water Resources Plan (LRWRP) in 2018 that updated previous water resources studies for the Towns of Cary, Apex, and Morrisville (Jacobs, 2018). The LRWRP updated water use trends, evaluated population and land use trends, wastewater flow projections, and projected average and maximum day water demand percentile forecasts. The LRWRP also presented a strategic analysis of the partner's water supply out to 2065. The LRWRP identified the year 2065 for the Towns of Cary and Apex to reach the limit of potential development in the service area (i.e., build-out).

Table 3-18 summarizes population and water demand projections for the Towns of Cary, Apex, and Morrisville. The summarized data is based on the Town of Cary's approved 2022 LWSP. The Town of Cary's approved 2022 LWSP documents the water use projections from the LRWRP (Jacobs, 2018). The Towns of Cary and Apex are anticipating an increase in service area growth of less than 0.5 percent per year from 2030 to 2055. The Towns of Cary, Apex, and Morrisville will need to meet a maximum day water demand of 52.4 mgd in 2040 and 60.3 mgd in 2055. The 2050, 2055, and 2060 maximum day water demands were interpolated between the published 2045 and 2065 values from the LRWRP. The Towns of Cary, Apex, and Morrisville anticipate a total maximum day raw water withdrawal of 70.1 mgd in 2055.

3.7.2.3 Cary / Apex / Morrisville / Wake County Long Range Water Supply Planning

Per the Jordan Lake Round 4 allocations, the Towns of Cary, Apex, Morrisville, and Wake County have an allocation of 46.2 percent of the water supply pool (i.e., 46.2 mgd of supply). The Round 4 allocation is anticipated to meet the water supply needs in the service area until 2045. The LRWRP indicates that a Cary/Apex WTF expansion will be needed by 2045, as the maximum day water demands are anticipated to be approximately 56 mgd by 2045.

The Towns of Cary, Apex, and Morrisville developed a water resource portfolio in the LRWRP (Jacobs, 2018) that evaluated strategy and source options to manage future water supply needs. The water supply strategies include increasing water supply from the Jordan Lake allocation, increase water supply and

storage by increasing the Jordan Lake Water Supply Pool, developing water supply from Crabtree Creek with off-line storage, developing water supply from the Cape Fear River watershed, developing water supply from sources outside the Triangle, and purchasing additional water from neighboring communities. The Towns of Cary, Apex, and Morrisville anticipate that a combination of several strategies may reliably meet the collective water demand needs.

Table 3-18: Population and Water Demand Projections for the Towns of Cary, Apex, Morrisville, and RDU

	2022	2030	2040	2050	2055 [1]	2060
Service area population projections [2]	215,076	216,546	225,845	232,044	235,144	238,342
Annual percent growth [2]	----	0.72%	0.42%	0.27%	0.26%	0.26%
Average day service area demand, mgd [3]	20.55	23.50	26.50	29.35	32.4	32.40
Water sales, mgd [2]	0.32	0.40	0.40	0.40	0.40	0.40
Future water sales, mgd [2]	----	0	0	0	0	0
Total average day water demand, mgd [3]	20.82	23.90	26.90	29.75	32.8	32.80
Total average day water withdrawal, mgd [4]	----	33.4	39.8	44.1	45.75	47.4
Total maximum day water demand [5]	----	43.9	52.4	58.2	60.3	62.5
Total maximum day raw water withdrawal [5]	----	51.4	60.9	67.6	70.1	72.6
Total water supply allocation from Jordan Lake (Round 4)	46.2	46.2	46.2	46.2	46.2	46.2

[1] Data interpolated from approved 2022 Local Water Supply Plan.

[2] Per Town of Cary approved 2022 Local Water Supply Plan. Population projections are for the combined Town of Cary, Town of Morrisville, and Wake County/RTP South service areas.

[3] Total average day water demand per the approved 2022 Local Water Supply Plan. The 2022 Local Water Supply Plan references the Long Range Water Resources Plan Update: Prepared for Towns of Cary, Apex and Morrisville and Wake County (Jacobs, 2018). The projections in the approved 2022 LWSP represent the 75th percentile forecast found in the LRWRP Appendix F Section 3.12 and 3.13.

[4] The 2050, 2055, and 2060 average day water withdrawals were interpolated between the 2045 and 2065 reported LRWRP values.

[5] Maximum day demand and maximum day raw water withdrawal from the Long Range Water Resources Plan Update: Prepared for Towns of Cary, Apex and Morrisville and Wake County (Jacobs, 2018). The 2050, 2055, and 2060 maximum day demands were interpolated between the 2045 and 2065 reported LRWRP values.

3.7.2.4 Summary for Alternative 6, Raw Water Supply from Towns of Cary, Apex, and Morrisville

Alternative 6 does not meet the Town of Fuquay-Varina's project purpose and need for a reliable permanent water supply source or provide water supply capacity in a time frame needed for the Town to address their water supply shortfall by 2030. The Towns of Cary, Apex, and Morrisville require the full use of their water supply allocation per the LRWRP and as documented in the approved 2022 LWSP. The Round 4 allocations for the Towns of Cary, Apex, and Morrisville are anticipated to meet the water supply needs in the service area until approximately 2045. The Towns of Cary and Apex have developed a strategy of

additional water supply options, including increasing their water allocation in Jordan Lake and developing other water supply sources outside the Cape Fear River basin. Water supply capacity is not available for the Town of Fuquay-Varina in the current Cary/Apex allocation from Jordan Lake.

This alternative was carried forward in the EIS for an environmental impact analysis as a comparison to other alternatives. To assess the environmental impact of this alternative, it was assumed that a new raw water intake could be located adjacent to the raw water intake for the Towns of Cary and Apex. Figure 3-8 provides an illustration of the proposed infrastructure for this alternative. The infrastructure for this alternative includes a new raw intake at Jordan Lake adjacent to the Cary/Apex raw water intake, 17.5 miles of raw water transmission main, a booster pump station, and a new water treatment facility owned and operated by the Town of Fuquay-Varina. The proposed water treatment facility would be located on the western edge of the Town's municipal limits.

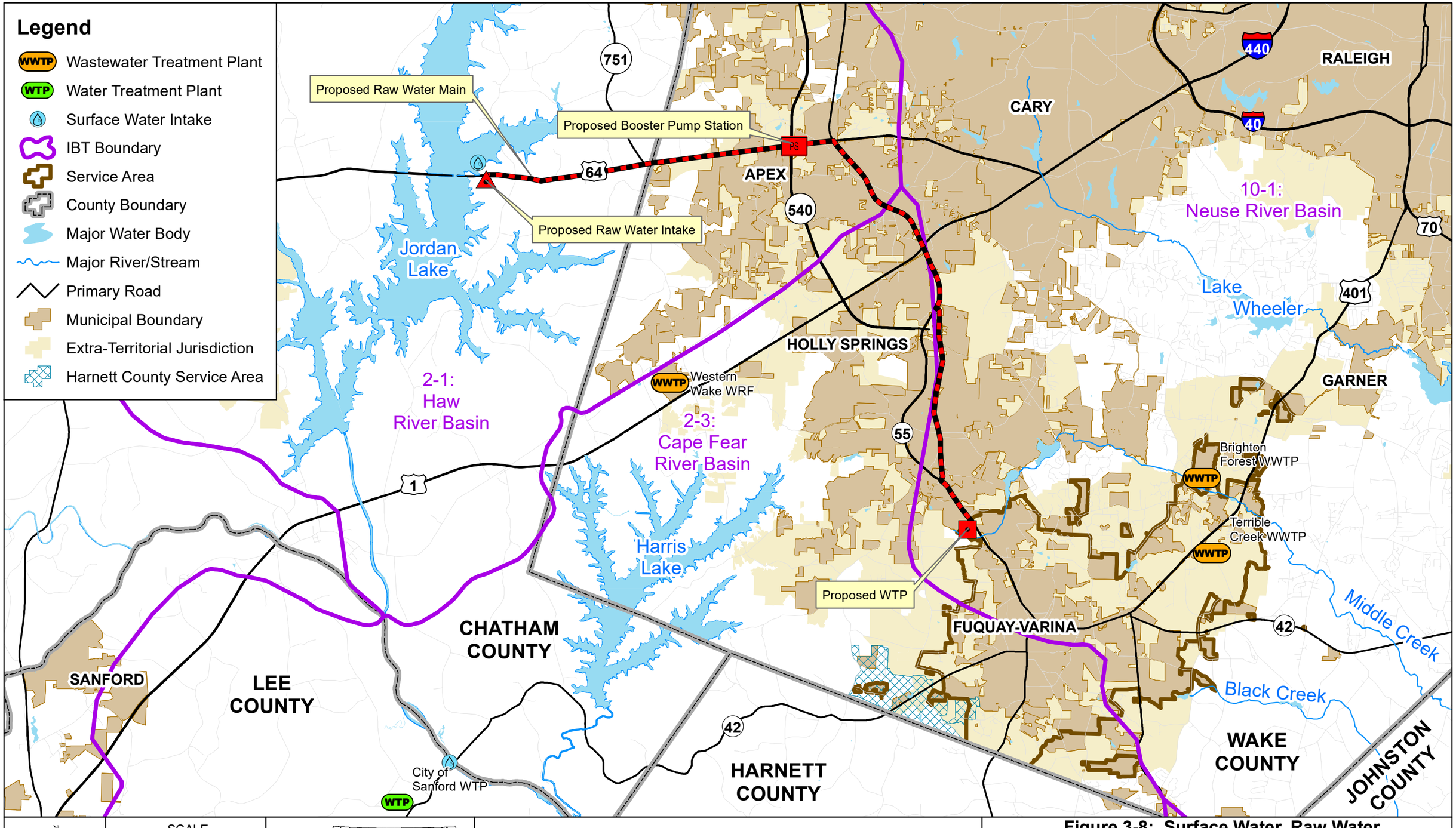


Figure 3-8: Surface Water, Raw Water from Jordan Lake (Cary/Apex) (Alternative 6)

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

3.7.3 Alternative 7 – Raw Water Supply from Western Intake Partners

Alternative 7 evaluates the Town of Fuquay-Varina meeting its water supply needs via the Western Intake Partners (WIP) out of Partnership's collective Round 4 allocation. The WIP consists of the City of Durham, the Town of Pittsboro, Chatham County, and OWASA. The Partnership was formed in 2014.

A Jordan Lake Partnership Western Intake Feasibility Study (Hazen, 2014a) was completed in 2014. The Feasibility Study evaluated the various options for a combined raw water intake and pump station, water treatment facility, and transmission infrastructure to meet the needs of individual partners as well as the collective group. The Feasibility Study also discussed various organizational models for future partnership structure and governance. The Feasibility Study recommended a regional water treatment facility as the preferred alternative. A Regional WTF would provide finished water to each Partner's distribution system. A formal Memorandum of Agreement for the Western Intake Partners was signed in 2019, which enabled the Partners to move forward with the engineering and permitting phase of the project.

The Partnership's service areas are situated over several counties and river basins. The Town of Pittsboro's service area is located solely in the Haw River basin (2-1) in Chatham County. The City of Durham's service area is located entirely within Durham County. Approximately 49 percent and 51 percent of the service area is in the Haw River basin (2-1) and Neuse River basin (10-1), respectively. The Chatham County North service area in Chatham County is 99 percent in the Haw River basin (2-1) and 1 percent in the Deep River basin (2-2). Approximately 95 percent and 5 percent of the OWASA's service area is located in Orange and Durham Counties, respectively. The entire OWASA service area is located in the Haw River basin (2-1).

All four Partners have connections with neighboring communities to include other Partners. The City of Durham provides bulk finished water to Chatham County North on a regular basis with a contract expiration date of 2035. Chatham County North provides water to five communities on an emergency basis, including the Town of Pittsboro, OWASA, and the City of Durham. The Town of Pittsboro provides water on a regular basis to Chapel Ridge. OWASA provides bulk finished water to four communities on an emergency basis.

3.7.3.1 Existing Water Supply and Wastewater Treatment Infrastructure

Each Partner owns and operates water treatment infrastructure independent of the Partnership. Chatham County owns and operates the 3 mgd Jordan Lake WTP. Chatham County uses the Cary/Apex raw water intake as the water supply source for the 3 mgd Jordan Lake WTP. The City of Durham's water treatment facilities use Lake Michie and the Little River Reservoir in Durham County as raw water sources. Lake Michie and the Little River Reservoir are located upstream of Falls Lake. The Town of Pittsboro owns and operates a 2 mgd water treatment plant on the Haw River. OWASA owns and operates the 20 mgd Jones Ferry Road WTP withdrawing from the Cane Creek Reservoir and University Lake.

3.7.3.2 Population and Water Demand Projections for Western Intake Partners

The population projections for each Partner are documented in the LWSPs and summarized in Table 3-19. The City of Durham is anticipating a growth rate of approximately 1 percent annually over the next thirty years. The population growth in the Chatham County North service area is expected to increase between

1 and 2.4 percent annually, with the largest increase in growth expected between 2030 and 2040. The Town of Pittsboro is anticipating high growth rates due to the Town's relatively small size and economic development in the Triangle metro region. The Chatham Park development and associated growth is included in the Town of Pittsboro projections. The Town of Pittsboro's growth is anticipated to be approximately 9 percent annually between 2020 and 2030, decline to 3.9 percent between 2030 and 2040, and then decline to less than 3.5 percent thereafter. The anticipated growth rate in the OWASA service area is less than 1.5 percent annually over the planning period.

Average day water demand projections and maximum day water demand projections are summarized in Table 3-20 for each of the four Partners. In 2055, the total average day water demand is anticipated to be 61.6 mgd for all four Partners. The Jordan Lake Round 4 allocations are also included in the table for reference. Based on the LWSP information and a Technical Memorandum for Western Intake Partnership Water Intake and Transmission Infrastructure: Water Capacity Requirements (Hazen, 2022b), the four Partners will collectively require the use of their Round 4 allocation from Jordan Lake to meet long-term water supply needs.

Table 3-19: Population Projections for Western Intake Partnership

	2022	2030	2040	2050	2055 [1]	2060
City of Durham [2]						
Service area population projections	321,414	329,421	372,423	415,425	436,926	458,426
Annual percent growth	----	0.70%	1.23%	1.10%	0.99%	0.99%
Chatham County North [3]						
Service area population projections	28,956	35,006	44,375	56,251	57,107	57,962
Annual percent growth	----	2.13%	2.40%	2.40%	0.30%	0.30%
Town of Pittsboro [4, 5]						
Service area population projections	4,817	11,167	16,133	22,733	27,417	32,100
Annual percent growth	----	9.2%	3.9%	3.5%	3.5%	3.5%
OWASA [6]						
Service area population projections	86,300	96,632	106,732	116,683	121,583	126,483
Annual percent growth	----	1.50%	1.00%	0.90%	0.81%	0.81%

[1] Data interpolated from approved Local Water Supply Plan.
[2] Per City of Durham approved 2022 Local Water Supply Plan.
[3] Per Chatham County approved North 2022 Local Water Supply Plan.
[4] Per Town of Pittsboro provisional 2022 Local Water Supply Plan.
[5] The Chatham Park development and associated growth is included in the Town of Pittsboro projections.
[6] Per OWASA 2022 approved Local Water Supply Plan.

Table 3-20: Water Demand Projections for Western Intake Partnership

Western Intake Partner	Round 4, mgd	2022	2030	2040	2050	2055 [1]	2060
City of Durham							
Total average day water demand, mgd [2]	----	30.2	34.0	32.3	36.9	39.17	41.3
Total maximum day water demand [3]	----	43.4	48.7	46.2	52.7	55.9	59.0
Total raw water supply [4]	----	44.4	49.6	49.6	49.6	49.6	49.6
Jordan Lake allocation / anticipated portion of WIP capacity	16.5	----	16.5	16.5	16.5	16.5	16.5
Chatham County North							
Total average day water demand, mgd [5]	----	2.6	4.4	5.2	6.3	6.4	6.5
Total maximum day water demand [5]	----	4.6	7.7	9.2	11.1	11.3	11.4
Total raw water supply [6]	----	7.0	7.0	8.5	8.5	8.5	8.5
Jordan Lake allocation / anticipated portion of WIP capacity	13.0	----	3.0	3.0	3.0	3.0	3.0
Town of Pittsboro							
Total average day water demand, mgd [7]	----	0.9	2.2	3.2	4.5	5.4	6.3
Total maximum day water demand [7]	----	1.2	3.1	4.4	6.2	7.5	8.7
Total raw water supply [8]	----	2.0	5.0	14.0	14.0	14.0	14.0
Jordan Lake allocation / anticipated portion of WIP capacity	6.0	----	6.0	6.0	6.0	6.0	6.0
OWASA							
Total average day water demand, mgd [9]	----	6.7	8.1	9.0	10.1	10.7	11.4
Total maximum day water demand [10]	----	9.5	11.5	12.7	14.2	14.2	16.0
Total raw water supply [11]	----	10.5	10.5	17.6	17.6	17.6	17.6
Jordan Lake allocation / anticipated portion of WIP capacity [12]	5.0	----	0.5	0.5	0.5	0.5	5.0

[1] *Data interpolated from Local Water Supply Plans.*

[2] *Per City of Durham 2022 approved Local Water Supply Plan.*

[3] *City of Durham maximum day peaking factor per Technical Memorandum for Western Intake Partnership Water Intake and Transmission Infrastructure: Water Capacity Requirements (Hazen, 2022b).*

[4] *Raw water supply includes 16.5 mgd from the Jordan Lake allocation, 5.2 mgd from Teer/Hanson Quarry, 10.5 mgd from Lake Michie, and 17.4 mgd from Little River Reservoir (2020 LWSP).*

[5] *Per a Technical Memorandum for Western Intake Partnership Water Intake and Transmission Infrastructure: Water Capacity Requirements (Hazen, 2022b). The average day and maximum day demands were interpolated for the years 2040 and 2060.*

Table 3-20: Water Demand Projections for Western Intake Partnership

Western Intake Partner	Round 4, mgd	2022	2030	2040	2050	2055 [1]	2060

[6] Raw water supply includes 13 mgd from Jordan Lake allocation and 4 mgd from City of Durham finished water wholesale contract (2020 LWSP). Per the Technical Memorandum for Western Intake Partnership Water Intake and Transmission Infrastructure: Water Capacity Requirements (2022b), Chatham County does not anticipate a renewal of the contract with the City of Durham upon expiration when new WIP WTP comes online in approximately 2030.

[7] Per Town of Pittsboro provisional 2022 Local Water Supply Plan.

[8] Raw water supply on provisional 2022 LWSP states raw water supply of 2.0 mgd. The 9.0 mgd Jordan Lake Allocation was added to the existing raw water supply from the Haw River. An additional 3.0 mgd is anticipated to be supplied from the Sanford WTP.

[9] Per OWASA 2022 approved Local Water Supply Plan.

[10] OWASA maximum day peaking factor per a Technical Memorandum for Western Intake Partnership Water Intake and Transmission Infrastructure: Water Capacity Requirements (Hazen, 2022b).

[11] Raw water supply includes 5 mgd Jordan Lake allocation, 2.1 mgd from expanded quarry reservoir, 8.5 mgd from Cane Creek, and 2 mgd from Morgan Creek (2020 LWSP).

[12] OWASA does not foresee a need for additional capacity from Jordan Lake via the Western Intake Partnership until 2060.

3.7.3.3 Western Intake Partners Water Supply Project

The WIP commissioned engineering and environmental study services in 2021 with the goal of having Phase 1 pumping, treatment, and distribution facilities by 2031. Phase 2 facilities are planned for 2050. The land on which the Regional WTF is to be built has been owned by OWASA since the early 1980s. The OWASA property is located at the corner of Seaforth Road and Pea Ridge Road. The final design capacity of the Regional WTF is still being determined by the WIP. The environmental review process will evaluate alternatives to the OWASA-owned WTF site and multiple sites for a raw water intake, raw water pump station, raw and finished water transmission mains, as well as booster pump stations to several of the Partner's distribution systems.

Table 3-21 summarizes the water treatment facility capacity with respect to the total maximum (summer) day water demand projections for the WIP. It is anticipated that a Phase 1 water treatment facility capacity between 20 and 26 mgd will be constructed, with phasing options as bid alternates. The facility capacity will be adjusted as planning and design progresses.

Table 3-21: Summary of Western Intake Partners Demand and Water Treatment Plant Capacity

	2020	2030	2040	2050	2055 [1]	2060
Total maximum day (summer)	0	20.1	23.2	26.2	28.5	30.8
Facility capacity, mgd [2]	----	26	26	42	42	42
Surplus facility capacity, mgd [3]	0	5.9	2.8	15.8	13.5	11.2

[1] Interpolated data.

[2] WIP facilities are presently in the PER stage and capacities may be adjusted.

[3] Surplus capacity applies to the water treatment facility and does not imply any surplus yield or water supply allocation.

3.7.3.4 Summary for Alternative 7, Raw Water Supply from Western Intake Partners

Alternative 7 does not meet the Town of Fuquay-Varina's project purpose and need for a reliable permanent water supply source or provide water supply capacity in a time frame needed for the Town to address their water supply shortfall by 2030. The WIP intends to fully use their Jordan Lake water supply allocations to meet water demand projections. In 2055, the total average day water demand is anticipated to be 61.6 mgd for all four Partners. The Partnership water treatment and transmission infrastructure is not anticipated to be operational until post 2031. The WIP has a combined 40.5 mgd of water supply allocation from Jordan Lake. Based on the analysis in Section 3.7.3.2, the Jordan Lake allocations are necessary to meet future water supply for the four Partners. The WIP is in the process of planning a significant infrastructure project for raw water intake, pumping, treatment, and distribution.

This alternative was carried forward in the EIS for an environmental impact analysis as a comparison to other alternatives. To assess the environmental impact of this alternative, it was assumed that a new raw water intake could be located adjacent to the proposed raw water intake on the western edge of Jordan Lake. Figure 3-9 provides an illustration of the proposed infrastructure for Alternative 7. In addition to a new raw water intake, the proposed infrastructure includes 23.7 miles of raw water transmission main, a booster pump station, and a new water treatment facility owned and operated by the Town of Fuquay-Varina. The proposed water treatment facility would be located on the western edge of the Town of Fuquay-Varina's municipal limits.

3.7.4 Alternatives 6 and 7 Summary

The application process for a water supply allocation in Jordan Lake is a lengthy and complicated process. The Round 2 application process started in 2000 with an EMC decision in 2002. The process for Round 4 allocations was initiated in 2009, applications were submitted in 2014, and a final decision from the EMC was in 2017 (e.g., 8 years). The majority of communities that were granted water allocation in Jordan Lake are located proximate to the Lake, have historically been using Jordan Lake as water supply, or have identified Jordan Lake as a future water supply source in water resources planning efforts.

In 2009 when the Jordan Lake Round 4 application process started, the Town of Fuquay-Varina population was 15,000 people with an associated water demand of 1.8 mgd. A prior planning study by Diehl and Phillips (1989) estimated a 2010 population of approximately 19,000 people and a 2020 population of 21,400 people. During the Round 4 Jordan Lake Allocation process, the Town of Fuquay-Varina had sufficient water supply as a wholesale customer to Raleigh Water, Johnston County, and Harnett County.

The growth in Wake County has been significant due to several factors. The I-540 interchange has been in the planning process since the mid-1990s with the initial stretch opening in 1999. The Triangle Expressway Southeast Extension connecting the Towns of Holly Springs and Garner is under construction after approximately 15 years of delay. More significantly is the recent economic development activity by the North Carolina Department of Commerce and the EDPNC. Founded as a non-profit in 2014, EDPNC is funded both by a contract with the North Carolina Department of Commerce and by private investment to provide economic development services to attract industry to North Carolina. EPDNC, in partnership with the North

Carolina Department of Commerce, has been highly successful in attracting new industry to the Piedmont region.

The Town of Fuquay-Varina is a secondary recipient of the growth in the Piedmont region. The Town of Fuquay-Varina has not gained new industry but is instead planning around the effects of residential and commercial growth to support surrounding communities' industrial growth. The Town of Fuquay-Varina's growth started to accelerate in 2016, at which point the Town commissioned the Water Capacity Study (WithersRavenel|Freese and Nichols, 2017).

Approximately 8.8 mgd of additional allocation is available out of the 100 mgd safe yield in Jordan Lake. It is unknown at this time when a Round 5 application process might be initiated. However, the communities with a long-term investment in the Jordan Lake allocation process for water resources planning and infrastructure may receive higher priority in a future allocation process. The Towns of Cary/Apex and the WIP (e.g., City of Durham, Chatham County North, OWASA, and the Town of Pittsboro) have demonstrated a purpose and need to be granted a water supply allocation in Jordan Lake. The remaining communities with water allocation have also demonstrated a purpose and need for the water supply.

A raw water supply from Jordan Lake would result in an IBT from the Cape Fear River basin (2-3) to the Neuse River basin (10-1). An IBT certificate would need to be acquired for either Alternative 6 or 7. Water supply from Jordan Lake is comparible to other Cape Fear River basin surface water source alternatives, including the City of Dunn, the City of Sanford, and Harnett County. The current Jordan Lake rules allow a transfer out of the Jordan Lake watershed to 50 percent of the 100 mgd water supply yield, or 50 mgd. Currently, 33 mgd is transferred out of the Cape Fear watershed by the Towns of Cary, Apex, and Morrisville (DWR, 2015a).

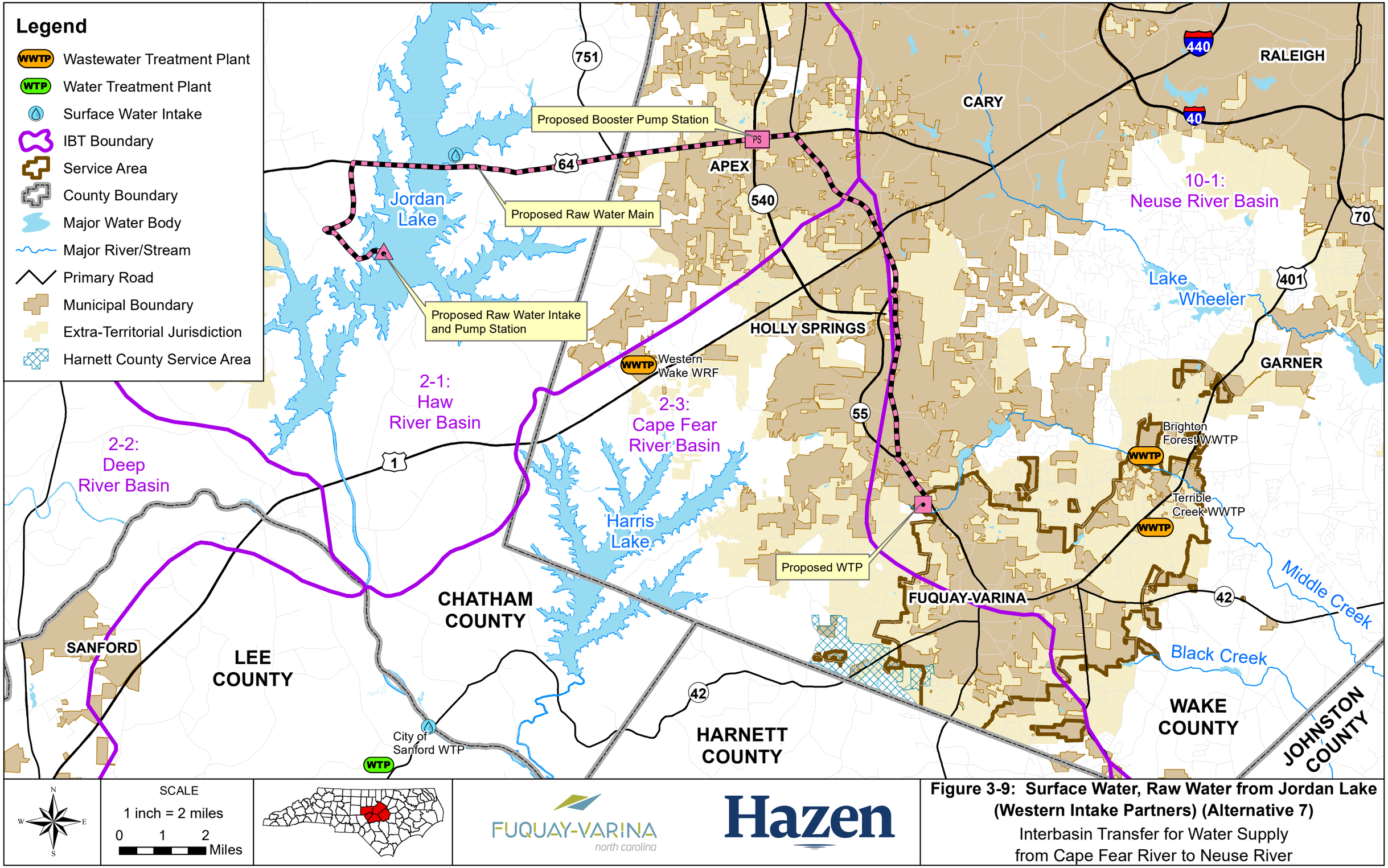


Figure 3-9: Surface Water, Raw Water from Jordan Lake (Western Intake Partners) (Alternative 7)

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

3.8 Alternative 8 – Surface Water, Town of Fuquay-Varina Raw Water Intake on Cape Fear River with Return of Water to Cape Fear River Basin

Alternative 8 explores the feasibility of a new Town of Fuquay-Varina owned and operated raw water intake located on the Cape Fear River at Lillington with a return of water to the Cape Fear River basin. An illustration of the infrastructure required for this alternative is provided in Figure 3-10. A proposed location for a raw water intake is on the north bank of the Cape Fear River across from the Harnett County Regional WTP and raw water intake. Approximately 12 miles of raw water transmission main would follow US 401 to the Town of Fuquay-Varina's service area. A proposed location of a new water treatment facility owned and operated by the Town of Fuquay-Varina would be in Wake County north of the Harnett-Wake County line.

Two options were considered for a return of water from the Town of Fuquay-Varina's Neuse River service area to the Cape Fear basin. The first option (Alternative 8A) consists of an effluent outfall to the Cape Fear River downstream of the proposed raw water intake, approximately 19 miles from the Terrible Creek WWTP. Alternative 8B consists of the former effluent outfall for the Town of Fuquay-Varina's now decommissioned Kenneth Branch WWTP. An outfall at Kenneth Creek would require an effluent force main approximately 6.5 miles from the Terrible Creek WWTP.

3.8.1 New Intake on Cape Fear River

A proposed raw water intake on the Cape Fear River at Lillington poses similar challenges as the alternative to purchase finished water from Harnett County (refer to the discussion in Section 3.6 for Alternative 5). Per the analysis for the Harnett County Alternative 5, the current USGS 1998 low-flow statistics for the Cape Fear preceded the record droughts that occurred in the mid-Atlantic region in 2002 and 2007 through early 2008. As determined by USGS, a revised 7Q10 at the Lillington gage is 288 cfs, which is 15.9 percent less than the published 7Q10 value of 342.5 cfs in the Cape Fear Water Supply Plan (DWR, 2002). The revised 7Q10 estimate results in a new available water withdrawal of 37 mgd at the Lillington gage without requiring an instream flow study per 15A NCAC 01C .0408(2)(b)(1).

3.8.2 Wastewater Return to Cape Fear River

The proposed infrastructure for Alternative 8 includes a return of water to the Cape Fear River. Per the DWR Guidance Document for facilities requesting a new or expanding NPDES discharge permit (DWR, 2019), utilities must document the associated population growth over a 20-year planning period. In this analysis, the 20-year planning period for a potential wastewater capacity project would be before the year 2045. Per Section 2.3, wastewater flow projections in the Cape Fear service area are anticipated to be between 3.4 and 6.3 mgd by 2045 and between 4.1 and 7.6 mgd by 2055 depending on the rate of growth in the Town of Fuquay-Varina's service area. The wastewater flow projection in the Neuse service area is anticipated to be between 3.3 and 6.3 mgd by 2045 and between 4.0 and 7.6 mgd by 2055. For Alternative 8, the following effluent disposal options were evaluated:

- Use of Town of Fuquay-Varina's existing 36-inch interceptor and ILA with Harnett County
- Use of Town of Fuquay-Varina's existing Terrible Creek WWTP in the Neuse River Basin

- Convey Neuse wastewater flow to Town of Holly Springs
- Convey Neuse wastewater flow to a new outfall in Cape Fear River basin (e.g., Kenneth Creek or Cape Fear River)

3.8.2.1 Use of Town of Fuquay-Varina 36-inch Interceptor and ILA with Harnett County

The Town of Fuquay-Varina previously owned and operated a 1.2 mgd Kenneth Branch WWTP in the Town's portion of the service area in the Cape Fear River basin. However, the Town of Fuquay-Varina decommissioned the Kenneth Branch WWTP in 2006 and rescinded the NPDES permit NC0028118 (NCDENR, 2008). The effluent outfall for the Kenneth Branch WWTP was located in the headwaters of Kenneth Creek. Kenneth Creek is a tributary to Neals Creek, which is tributary to the Cape Fear River upstream of the Town of Lillington. The Town of Fuquay-Varina deeded the property to the Wake County Public School System in 2022. The Wake County Public School System is currently constructing middle and elementary schools on this property. Monthly average effluent NPDES permit limits for the Kenneth Branch WWTP were 16 milligrams per liter (mg/L) biochemical oxygen demand (BOD), 30 mg/L total suspended solids (TSS), 5 mg/L of ammonia in summer (April 1 to October 31), and 13 mg/L of ammonia in winter (November 1 to March 31).

In lieu of ownership and operation of the Kenneth Branch WWTP, the Town of Fuquay-Varina signed an ILA with Harnett County for the treatment and effluent disposal of 2.6 mgd from the North Harnett Regional WWTP. The ILA expires in 2040 and automatically renews for an additional 40 years. The ILA specifies the Town of Fuquay-Varina's purchase of 2.6 mgd of wastewater allocation in the North Harnett Regional WWTP. Per the ILA, the Town of Fuquay-Varina does not have any right of ownership in the North Harnett Regional WWTP. Therefore, the Town of Fuquay-Varina does not own actual treatment capacity in the North Harnett Regional WWTP. The Town of Fuquay-Varina's ILA with Harnett County allows the Town to increase the Town's wastewater allocation in the North Harnett Regional WWTP by an additional 3.4 mgd, for a total of 6 mgd.

Harnett County is currently expanding the North Harnett Regional WWTP to accommodate capacity requests from member partners, which include the Town of Fuquay-Varina, the Town of Angier, and the Town of Lillington. Table 3-22 provides a summary of Harnett County's commitments in the North Harnett Regional WWTP to support the treatment facility expansion to 16.5 mgd. Harnett County issued a Letter of Intent (Harnett County, 2021) to the Town of Fuquay-Varina that confirms the Town of Fuquay-Varina's participation in the North Harnett Regional WWTP expansion project for an additional allocation of 3.4 mgd (Appendix C). The Town of Fuquay-Varina and Harnett County executed an amendment to the ILA in 2023 for the Town's purchase of an additional 3.4 mgd of capacity.

A final NPDES permit was issued to Harnett County in July 2023 with tiered effluent flow limits for the current WWTP capacity of 7.5 mgd and the proposed expansion to 16.5 mgd. A summary of the effluent NDPES permit limits for the North Harnett Regional WWTP is provided in Table 3-23. In the speculative effluent limits process, DWR maintained a fixed loading at the North Harnett Regional WWTP capacity of 7.5 mgd to develop effluent permit limits for the 16.5 mgd WWTP expansion, which resulted in stringent

effluent limits for BOD and ammonia. Harnett County re-allocated nutrients (e.g., nitrogen and phosphorus) between the County's South and North Regional WWTPs.

Table 3-22: Summary of Harnett County Wastewater Commitments in the North Harnett Regional Wastewater Treatment Plant

Partner Municipality to Harnett County [1]	Current Capacity, mgd	Current Use, mgd	Committed Not Yet Tributary, mgd [2]	Total Use (Including Committed), mgd	Requested Allocation, mgd	Total Capacity, mgd
Fuquay-Varina	2.6	1.5	0.65	2.15	3.4	6
Lillington	1.2	0.85	0.02	0.87	0.5	1.7
Angier	1.08	0.75	0.55	1.30	1.25	2.33
Harnett Regional Water	2.62	2.5	0.50	3.0	3.85	6.47
Total	7.5	5.6	1.72	7.32	9.0	16.5

[1] Data from Fact Sheet for NPDES Permit NC0021636 (North Harnett Regional WWTP) Section 8. Antidegradation Review. Fact Sheet dated July 10, 2023. Data reported in Fact Sheet as submitted with Engineering Alternatives Analysis by MBD Consulting Engineers, P.A. in April 2025.

[2] The definition of "committed but not yet tributary flow" is wastewater flow that is permitted but not yet discharging to a sewer system and treated at a wastewater treatment facility.

Table 3-23: Summary of NPDES Effluent Permit Limits for Harnett County's North Harnett Regional WWTP

Parameter [1]	Effluent Limit at 7.5 mgd		Effluent Limit at 16.5 mgd	
	Monthly Limit	Weekly Limit	Monthly Limit	Weekly Limit
Carbonaceous biochemical oxygen demand, summer (April 1 to October 31), mg/L	5.0	7.5	----	----
Carbonaceous biochemical oxygen demand, winter (November 1 to March 31), mg/L	10.0	15.0	----	----
Carbonaceous biochemical oxygen demand, mg/L	----	----	2.1	3.1
Total suspended solids, mg/L	30	45	15	22.5
Ammonia, summer (April 1 to October 31), mg/L	1.0	3.0	0.5	1.5
Ammonia, winter (November 1 to March 31), mg/L	2.0	6.0	0.9	2.7
Total nitrogen (April 1 to October 31), lb/season	59,968 (4.5 mg/L at 7.5 mgd)		115,550 (4.0 mg/L at 16.5 mgd)	
Total phosphorus (April 1 to October 31), lb/season	19,989 (1.5 mg/L at 7.5 mgd)		38,517 (1.3 mg/L at 16.5 mgd)	

[1] Per NPDES permit and Fact Sheet for the North Harnett Regional WWTP, NPDES Permit NC0021636.

The Town of Fuquay-Varina's ILA with Harnett County also included a 15-mile interceptor to convey wastewater flow from the Town's service area in the Cape Fear River basin to the North Harnett Regional WWTP. A 36-inch interceptor was constructed from the former Kenneth Branch WWTP site. The Town of Fuquay-Varina owns the 36-inch diameter interceptor segment in Wake County. The Town of

Fuquay-Varina's ownership of the interceptor terminates at the meter vault at the Wake and Harnett County line. Harnett County owns the remaining 42 and 48-inch diameter interceptor segments from the meter vault to a pump station located on the north side of the Cape Fear River. The pump station pumps wastewater to the North Harnett Regional WWTP on the south side of the Cape Fear River.

The Town of Fuquay-Varina and Harnett County interceptor was designed and constructed in accordance with applicable design criteria per the Minimum Design Criteria for the Permitting of Gravity Sewers (DWR, 1996) to meet the capacity needs of the proposed project in 2000. The hydraulic capacity of the Town of Fuquay-Varina's allocation in the interceptor is 6 mgd average day flow with a hydraulic peak flow of 12 mgd as stated in the ILA. The capacity of the 36-inch diameter interceptor was confirmed with a hydraulic model.

Per the DWR Guidance Document for facilities requesting a new or expanding NPDES discharge permit, utilities must document the associated population growth over a 20-year planning period (DWR, 2019). The 20-year planning period for a potential wastewater project would be before the year 2045. Per Section 2.3, wastewater flow projections in the Cape Fear River basin service area are anticipated to be between 3.4 and 6.3 mgd by 2045 and between 4.1 and 7.6 mgd by 2055 depending on the rate of growth in the Cape Fear portion of the Town of Fuquay-Varina's service area.

The Town of Fuquay-Varina's wastewater allocation of 6 mgd in the North Harnett Regional WWTP will satisfy the Town's wastewater capacity needs in the Cape Fear service area over the next 20-year planning period per DWR guidance (2019). Harnett County is expanding the North Harnett Regional WWTP from 7.5 to 16.5 mgd to accommodate capacity requests from member partners. The Town of Fuquay-Varina may need additional wastewater capacity post 2045 depending on the rate of growth in the Cape Fear service area between 2045 and 2055.

3.8.2.2 Use of Town of Fuquay-Varina's Terrible Creek WWTP in the Neuse River Basin

Wastewater flow in the Town of Fuquay-Varina's Neuse River service area is conveyed to either the Terrible Creek WWTP or the Brighton Forest WWTP. The Terrible Creek WWTP was expanded to a maximum month capacity of 3 mgd in 2018. The Terrible Creek WWTP NPDES permit contains tiered effluent flow limits for 3 and 6 mgd. The NPDES permit for the Terrible Creek WWTP is provided in Appendix C. The 2022 average day flow from the Terrible Creek WWTP was approximately 1.3 mgd. The Brighton Forest WWTP has a permitted capacity of 0.117 mgd and serves single family homes in the Brighton Forest Subdivision. The Terrible Creek and Brighton Forest WWTPs discharge to receiving streams in the Neuse River basin.

The Town of Fuquay-Varina's Terrible Creek WWTP expansion to 6 mgd will satisfy the Town's wastewater capacity needs in the Neuse service area over the next 20-year planning period per DWR guidance (2019). The wastewater flow projection in the Neuse service area is anticipated to be between 3.3 and 6.3 mgd by 2045. The Town of Fuquay-Varina may not require an expansion of the Terrible Creek WWTP post 2045, as a range of wastewater flow projections is predicted to be between 4.0 and 7.6 mgd by 2055 depending on the rate of growth. If an expansion of the Terrible Creek WWTP is necessary post 2045, the Town of

Fuquay-Varina will be able to meet the annual mass load of 68,065 pound per year (lb/yr) total nitrogen per the NPDES permit with conventional activated sludge treatment technology.

3.8.2.3 Convey Neuse Wastewater Flow to Town of Holly Springs

The Town of Holly Springs Utley Creek WRF has a treatment capacity of 6 mgd with a discharge to Utley Creek in the Cape Fear River basin. The NPDES permit for the Utley Creek WRF contains tiered effluent maximum month flow limits for 6 mgd and 8 mgd. The Utley Creek WRF currently discharges an average day effluent flow of approximately 3.1 mgd.

In 2015, Hazen prepared a Wastewater Treatment Capacity Expansion Alternatives Analysis for the Town of Fuquay-Varina (Hazen, 2015) that evaluated wastewater alternatives to plan for growth in the Neuse River portion of the Town's service area. The 2015 study evaluated the Town of Fuquay-Varina's existing collection system infrastructure in the Neuse River basin to determine the most technically feasible method of transferring approximately 1.0 mgd of wastewater flow from the Neuse River service area to the Town of Holly Spring's Utley Creek WRF. The Town of Fuquay-Varina's Basal Creek and Northwest Regional Pump Stations have an approximate combined average daily flow of 0.5 mgd and are the two largest of the Town of Fuquay-Varina's pump stations geographically proximate to the Town of Holly Spring's Utley Creek WRF. This alternative consisted of a transfer of flow to Utley Creek WRF via upgrading these two pump stations and installing a new force main approximately 3.2 miles to convey wastewater to the Utley Creek WRF.

The Town of Holly Springs completed a Wastewater Master Plan that evaluated wastewater flow projections, timing of the next WWTP expansion, and infrastructure needs through build-out (Hazen, 2021a). The results of the study concluded that the Town of Holly Springs will need to start planning the next WWTP expansion in the next few years. The Master Plan indicated that the current WWTP capacity of 6 mgd will be exceeded by 2027. The Town of Holly Springs initiated a study to expand the Utley Creek WRF discharge to a capacity of 15 mgd, which considers the full build-out of the service area based on current CAMPO data. Build-out is anticipated to be post 2055. The Town of Holly Springs does not have any additional wastewater capacity for the Town of Fuquay-Varina due to the accelerated pace of growth in the Holly Springs service area.

3.8.2.4 Convey Neuse Wastewater Flow to a New Outfall in Cape Fear River Basin

The Town of Fuquay-Varina's collection system has been designed based on the hydrologic basin boundary between the Neuse and Cape Fear River basins. To capture a sufficient quantity of wastewater in the Neuse River for treatment or discharge, effluent flow would need to be collected at the terminus of the Town of Fuquay-Varina's collection system in the Neuse River basin, which is the Terrible Creek WWTP. Either raw influent or treated effluent would have to be pumped from the Terrible Creek WWTP to a WWTP site for treatment or to an effluent outfall for discharge, respectively, in the Cape Fear River basin.

The possibility of a new outfall in the Cape Fear River basin was considered to minimize the amount of the interbasin transfer. Treated effluent from the Terrible Creek WWTP would be pumped over the Cape Fear and Neuse River basin hydrologic ridge line (i.e., Alternative 8, Option A) and discharged in the Cape Fear River basin. Figure 3-10 provides the location of the proposed effluent outfall across the river from the North

Harnett Regional WWTP downstream of Highway 210. The distance between the Terrible Creek WWTP and the Cape Fear River is approximately 19 miles. A second Alternative 8 Option B would be a discharge to Kenneth Creek in the Town of Fuquay-Varina's jurisdiction (i.e., Wake County). The Town of Fuquay-Varina previously had a permitted NPDES discharge to Kenneth Creek prior to the decommissioning of the Kenneth Branch WWTP. The former Kenneth Branch WWTP effluent outfall is 12.5 river miles to the confluence with the Cape Fear River.

3.8.3 Summary

Alternative 8 only partially meets the Town of Fuquay-Varina's project purpose and need. A new intake on the Cape Fear River would provide a permanent water supply source to the Town of Fuquay-Varina. Similar to other alternatives, Alternative 8 will not provide the water supply capacity in a time frame needed for the Town of Fuquay-Varina to address their water demand projections. The Town of Fuquay-Varina's water demand projections indicate a water supply shortfall by 2030. However, this alternative was carried forward in the EIS for an environmental impact analysis. The proposed raw water intake, transmission main, and effluent outfall to the Cape Fear River would require easements in Harnett County. Consent for easement acquisition would be needed from the Harnett County Board of Commissioners per General Statute § 153A-15.

The challenges associated with a new raw water intake on the Cape Fear River for the Town of Fuquay-Varina are equivalent to the challenges that are faced by Harnett County for an expansion of the Harnett County Regional WTP. An instream flow study will be required for a new raw water withdrawal per 15A NCAC 01C .0408(2)(b)(1). The 7Q10 has decreased in the Cape Fear River at Lillington over the past 20 years due to the droughts between 2000 and 2010. Based on applicable project experience with other instream flow studies, particularly streams with habitat for sensitive species, the anticipated time frame for the completion of a detailed instream flow study is 5 to 7 years with a potential cost of greater than $1 million. Examples of engineering fees and time frames associated with large instream flow study projects are provided in Table 1-2 in Section 1.5.4. Four of the five projects are specific to the Mid-Atlantic region.

A return of treated effluent to the Cape Fear River may offset the impact of the proposed withdrawal. A total maximum withdrawal of 13 mgd is required to meet the projected maximum day water demand for the Town of Fuquay-Varina, which is equivalent to an annual average withdrawal of 8.4 mgd. A proposed 11 mgd withdrawal would be supplemented by the Town of Fuquay-Varina's contractual amount to purchase 2 mgd from Harnett County. A wastewater return of 6 mgd would be required per the interbasin transfer calculations in Section 2 of this EIS. The Town of Fuquay-Varina has sufficient wastewater capacity in the Town's Neuse River service to support future wastewater capacity needs over the 20-year planning period for wastewater. It is also likely that the Town of Fuquay-Varina will have sufficient wastewater capacity in the Cape Fear service area over the 20-year planning period for wastewater depending on the rate of growth. Refer to Sections 5.14 and 5.15 for a discussion of water quantity and quality of a return of water to the Cape Fear River basin, respectively.

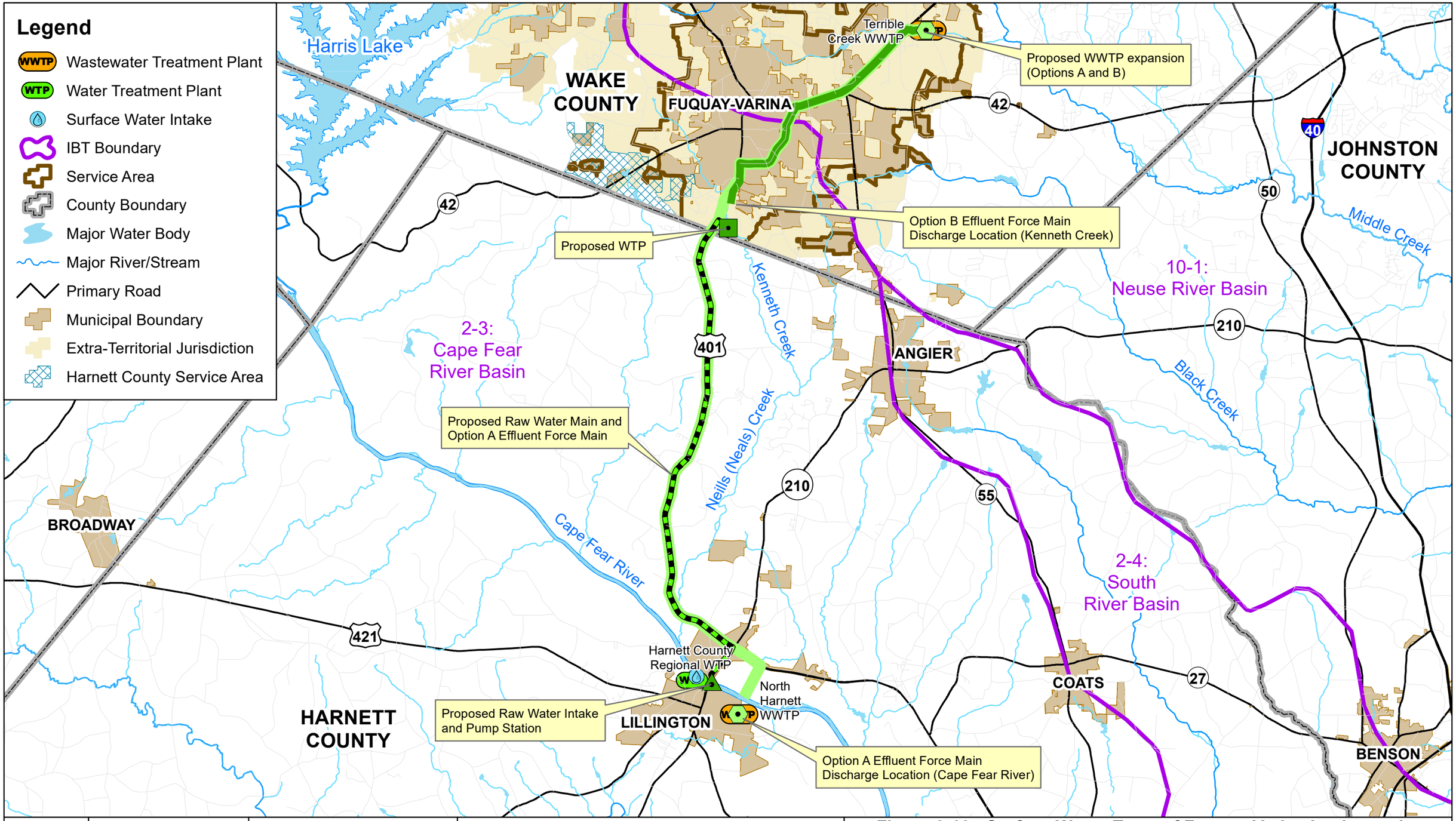


Figure 3-10: Surface Water, Town of Fuquay-Varina Intake on the Cape Fear River with Return of Water to Cape Fear Basin (Alternative 8)

Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

3.9 Alternative 9A and 9B – Surface Water, Purchase Finished Water from City of Sanford

The Town of Fuquay-Varina explored the possibility of partnering with the City of Sanford for finished water capacity. Alternatives 9A and 9B evaluate the purchase of finished water from the City of Sanford with and without a return of water to the Cape Fear River. Alternatives 9A and 9B assume that all the produced wastewater flow in the Neuse River portion of the service area would be treated and discharged via the Terrible Creek WWTP. An illustration of the proposed infrastructure for this alternative is provided in Figure 3-11. The proposed infrastructure improvements for water supply include a replacement of the existing raw water intake, approximately 16.3 miles of finished water transmission main, and an expansion of the City of Sanford's WTP. The City of Sanford is the lead local entity for the design of the entire project with the Partners participating in the process.

The City of Sanford is located in Lee County. Lee County is located west of Harnett County and south of Chatham County. The City of Sanford provides water service to approximately 21,000 retail accounts. Approximately 99 percent and 1 percent of the City's service area is in Lee County and Chatham County, respectively. Approximately 40 and 60 percent of the City of Sanford's service area is in the Deep River (2-2) and Cape Fear River basins (2-3), respectively.

The City of Sanford, the Town of Pittsboro, and Chatham entered into a water and wastewater merger agreement in 2023. This regionalization effort of water and sewer services led to a change in branding as TriRiver Water. In 2024, TriRiver Water announced a water and wastewater merger with Siler City. For consistency throughout this environmental document, the lead utility for Alternative 9A and 9B is referenced as the City of Sanford.

Table 3-24 provides a summary of the City's 2023 average sales and contract amounts from the approved 2023 LWSP. The City of Sanford sold approximately 0.9 mgd of bulk finished water out of a total contract amount of 2.3 mgd in 2023 to Chatham County, Goldston-Gulf, the Town of Broadway, and Carolina Trace. The City of Sanford has emergency purchase contracts with Chatham County North.

Table 3-24: Summary of City of Sanford Wholesale Water Sales Contracts

Purchaser	Average Day Sold, mgd [1]	Contract Amount, mgd	Contract Expiration Date	Contract Type
Chatham County Asbury	0.46	1.5	2024	Regular
Chatham County North Water System	0	0.5	----	Emergency
Goldston-Gulf	0.1	0.25	2020	Regular
Town of Broadway	0.1	0.3	2012	Regular
Utilities, Inc. (Carolina Trace)	0.22	0.289	1996	Regular

[1] *Per City of Sanford approved 2023 Local Water Supply Plan.*

The City of Sanford is not subject to an interbasin transfer. The Cork Rule per 15A NCAC 02E .0401(b) is applicable to the City's system (refer to Section 1.5). The annual average water demand in 2022 for Sanford was 7.3 mgd with a maximum day demand of 10.4 mgd. The City of Sanford's water balance is provided in Appendix C.

When the Town of Fuquay-Varina approached the City of Sanford, the City was in the process of investigating a water plant expansion as a result of growth in the City's service area, growth in the region, and interest from other regional partners. The Triangle area is experiencing an increase in economic activity due to the promotion of economic development (e.g., new industry) and the area's high ranking live and work metrics (U.S. News, 2023). Specifically, Chatham County has successfully promoted new industry to the Moncure Industrial Park. Water and wastewater services for industry in Moncure Park will be provided by the City of Sanford.

The City of Sanford has developed ILAs with neighboring municipalities for the purchase of finished water. The City of Sanford has negotiated finished water supply contracts with the Town of Pittsboro, the Town of Holly Springs, and the Town of Fuquay-Varina. The City of Sanford's WTP expansion project to provide finished water to regional communities is only a portion of the water supply portfolio for the City's partners. Per Section 3.7, the Town of Pittsboro and Chatham County use other water supply sources, including the development of a new water supply source in Jordan Lake and operation of existing water treatment facilities. The Town of Holly Springs has an ILA with Harnett County for the purchase of finished water. Table 3-25 provides a summary of the anticipated maximum day water demand projections for the communities participating in the Sanford WTP expansion project.

Table 3-25: Summary of Maximum Day Water Demand Projections for City of Sanford and Regional Partners

Municipality	2025	2030	2040	2050	2055
Sanford [1]	12.4	13.1	14.3	15.7	16.4
Pittsboro	0	3.0	3.0	3.0	3.0
Fuquay-Varina	6.0	6.0	6.0	10.0	11.0
Holly Springs	4.0	4.0	4.0	6.0	6.0
Total	22.4	26.1	27.3	34.7	36.4

[1] *Water demand projections based on approved 2023 Local Water Supply Plan.*

3.9.1 Existing Water Supply and Treatment Infrastructure

The City of Sanford owns and operates the Sanford WTP with a raw water intake and pump station adjacent to, and upstream of, the bridge at U.S. Highway 42. The Sanford WTP was originally constructed in 1970 with a capacity of 6 mgd. An expansion of the WTP to 12 mgd occurred in 1990.

3.9.2 Cape Fear River Instream Flow Characterization at the City of Sanford Raw Water Intake

The instream low flow at the City's raw water intake was characterized to determine if 15A NCAC 01C .0408 requirements would apply to a proposed increase in withdrawal for water supply. The USGS 1998 low-flow statistics for the Cape Fear River basin precede the record droughts that occurred in the mid-Atlantic region in 2002 and 2007 through early 2008. The published USGS 1998 low-flow 7Q10 statistic at the Sanford raw water intake is 308 cfs for an available water supply of 61.6 mgd (i.e., 20 percent of the 7Q10). The USGS performed a low-flow statistical analysis for the Cape Fear River at the location of the Sanford WTP raw water intake in October 2023 at the request of DWR (2023a). The revised 7Q10 estimate at the City's raw water intake is 283 cfs (i.e., 183 mgd). The revised 7Q10 estimate results in a new allowable water withdrawal of 37 mgd at the raw water intake without requiring an instream flow study per 15A NCAC 01C .0408. The revised allowable water withdrawal is 24.6 mgd lower than the published USGS value in 1998 and the 2002 Cape Fear Basin Water Supply Plan (DWR, 2002).

3.9.3 Proposed Improvements to Sanford Water Filtration Facility

The City of Sanford is pursuing an expansion to 30 mgd to accommodate the participation of regional partners and the City's service area growth. The City of Sanford commissioned a preliminary engineering evaluation (Hazen, 2021c) for a WTP expansion to 18 mgd, 24 mgd, and 30 mgd. The City of Sanford received Drinking Water State Revolving Fund money for the expansion of the City's WTP. The Engineer's Report and Environmental Information Document (ER/EID) was submitted in April 2023 for the 30 mgd expansion.

Infrastructure improvements will be required for the proposed expansion to 30 mgd. The existing raw water intake structure will be replaced with a pair of new cylindrical wedge-wire intake screens installed farther out in the river to accommodate low river flow. The new screens will include a removable spool piece that will allow the screens to be dropped down to a minimum operable level. This design consideration is in anticipation of the future possibility that Buckhorn dam could be lowered or removed. The existing intake screens will be demolished. Other improvements include a parallel raw water transmission main and a new raw water pump station adject to the existing pump station. The Preliminary Engineering Report (PER) did not recommend an expansion of the City's terminal reservoir (i.e., raw water storage reservoir), for which the DWR Public Water Supply Section concurred in March 2021. The City of Sanford pumps raw water from the Cape Fear River into the terminal reservoir to allow a few days of raw water storage prior to treatment. The WTP expansion will include additional sedimentation basins, filtration, chemical feed facilities, finished water pumping improvements, and residuals handling improvements. The WTP infrastructure will be designed to accommodate future expansions on the existing WTP site.

Per- and polyfluoroalkyl substances (PFAS) are a group of manufactured chemicals dissolvable in water and are not removed using conventional drinking water treatment processes. Perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) are both long-chain PFAS and are the most studied PFAS chemicals to date. PFOA and PFOS are no longer produced in the United States, these compounds continue to be imported via internationally produced consumer products and materials (EPA, 2017). EPA finalized National Primary Drinking Water Regulation Maximum Contaminant Levels (MCL) for six PFAS compounds in April 2024. PFOA, PFOS, perfluorohexane sulfonate (PFHxS), perfluorononanoic acid

(PFNA), and hexafluoropropylene oxide dimer acid (HFPO-DA, or GenX) are contaminants with individual MCLs.

The City of Sanford has assessed treatment technologies for managing future regulated contaminants. Granular activated carbon (GAC) treatment for PFAS compounds is included in the design of the 30 mgd WTP capacity expansion, as GAC is proven technology for the removal of long-chain PFAS. A Technical Memorandum outlining rapid small scale carbon tests (RSSCTs) for carbon and PFAS for the City of Sanford is provided in Appendix C. The Sanford WTP design will also include accommodations for physical and hydraulic footprint for future advanced treatment of other emerging contaminants, such as advanced oxidation processes (AOP) with ultraviolet light or ozone.

3.9.4 Summary

Alternative 9 satisfies the Town of Fuquay-Varina's project purpose and need. A regional partnership with the City of Sanford provides a reliable permanent water supply source to the Town of Fuquay-Varina in a time frame needed for the Town to address their water supply shortfall by 2030. This alternative eliminates the Town of Fuquay-Varina's temporary interlocal agreements for water and the associated reliability issues with water delivery. The revised 7Q10 estimate of 37 mgd at the City of Sanford's raw water intake will be sufficient for the City of Sanford's service area, the Town of Fuquay-Varina, and the City of Sanford's other regional partners until 2055. The City of Sanford has elected to pursue an expansion to 30 mgd in a first phase to accommodate the participation of regional partners until approximately 2040. The design of the City of Sanford's WTP expansion includes provisions for future expansion opportunities. This alternative was carried forward in the EIS for an environmental impact analysis.

A purchase of water by the Town of Fuquay-Varina from the City of Sanford will be sufficient to satisfy the Town's needs from 2025 through 2055. This proposed alternative will result in an IBT from the Cape Fear River basin to the Neuse River basin. The Town of Fuquay-Varina's purchased amount from the City of Sanford will exceed a 2 mgd average day in a maximum month IBT threshold per General Statute § 143-215.22L by 2055; therefore, an IBT certificate will be required. A purchase of finished water from the City of Sanford is comparible to other Cape Fear River basin surface water source alternatives, including City of Dunn, the Harnett County, and water supply capacity from Jordan Lake. A discussion of the proposed interbasin transfer with respect to water resources is provided in Section 5.14.

The City of Sanford is not party to the Town of Fuquay-Varina's IBT request. Per General Statute § 143-215.22L, the IBT applicant is defined as the entity that owns the water system at the point of the basin transfer. The Town of Fuquay-Varina will own the finished water transmission line crossing the Cape Fear basin to the Neuse River basin. Therefore, the Town of Fuquay-Varina is the applicant in this case. The City of Sanford has obtained construction-related permits for the WTP expansion and raw water intake improvements. Construction of the WTP expansion is on-going.

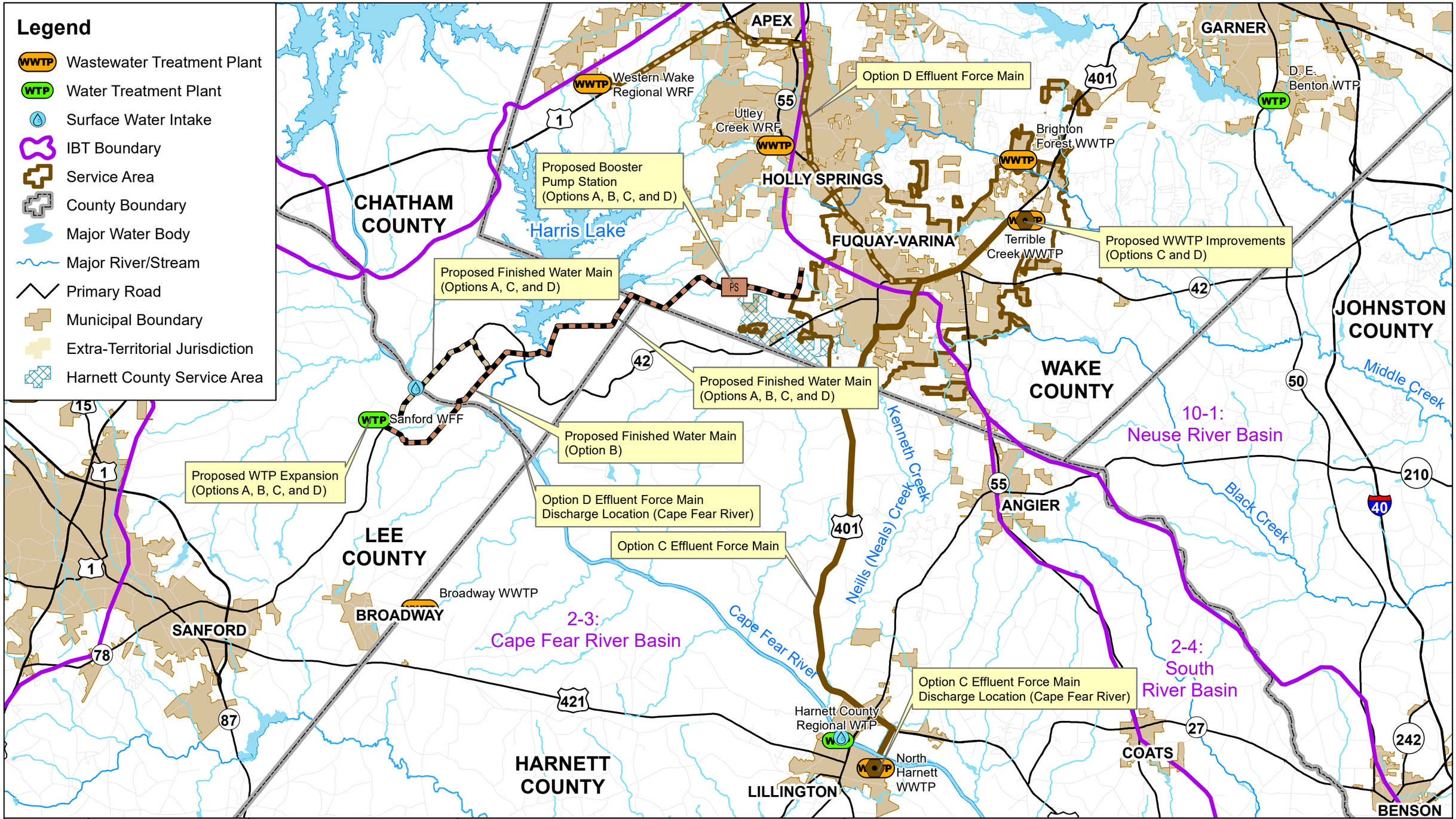


Figure 3-11: Surface Water, Purchase Finished Water from City of Sanford with Optional Return of Water to Cape Fear Basin (Alternative 9)

Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

3.10 Alternative 9C – Surface Water, Purchase Finished Water from City of Sanford with Return of Water to the Cape Fear River

Alternative 9C is the same alternative as Alternative 9A and 9B for water supply. Alternative 9C also includes the possibility of a new outfall at the Cape Fear River to minimize the amount of the interbasin transfer. Similar to Alternative 8A, treated effluent from the Terrible Creek WWTP would be pumped over the Cape Fear and Neuse River basin hydrologic ridge line and discharged at the Cape Fear River. The distance between the Terrible Creek WWTP and the Cape Fear River is approximately 19 miles (refer to Figure 3-11). A discharge to the Cape Fear River would require easements in Harnett County. Consent for easement acquisition would be needed from the Harnett County Board of Commissioners per General Statute § 153A-15. This alternative was carried forward in the EIS for an environmental impact analysis. Refer to Sections 5.14 and 5.15 for a discussion of water quantity and quality of a return of water to the Cape Fear River basin, respectively.

3.11 Alternative 9D – Surface Water, Purchase Finished Water from City of Sanford with Return of Water to the Cape Fear River via the Western Wake Regional Water Reclamation Facility

Alternative 9D is the same as Alternative 9A and 9B for water supply. Alternative 9D also includes a return of water to the Cape Fear River via the Western Wake Regional WRF. A new pump station at the Terrible Creek WWTP would be required to pump untreated (influent) wastewater to the Western Wake Regional WRF via a new force main. The Towns of Cary, Apex, Morrisville, and Wake County/RDU (i.e., Western Wake Regional Partners) are joint partners in the Western Wake Regional WRF in part due to a condition of the Towns' IBT Certificate to return water to the Cape Fear River basin. The Western Wake Regional WRF operates via NPDES permit NC0088846. The facility is currently permitted for 18 mgd with tiered effluent limits for an expanded capacity of 30 mgd.

The Town of Fuquay-Varina approached the Town of Cary to assess the possibility of returning water to the Cape Fear River basin via the Western Wake Regional WRF. The distance between the Terrible Creek WWTP and the Western Wake Regional WRF is approximately 18.6 miles (Figure 3-11). The Towns of Cary and Apex have commissioned a consulted to develop a Wastewater Master Plan. The Wastewater Master Plan will reassess the anticipated population growth and wastewater needs for the Western Wake Regional Partners to update the 2018 LRWRP. Per personal communication from the Town of Cary to the Town of Fuquay-Varina, the Towns of Cary and Apex anticipate an expansion of the Western Wake Regional WRF in the next ten years. This email communication is provided in Appendix C. Per the email correspondence, the Western Wake Regional WRF and associated infrastructure was designed to "*serve long-term growth and economic development of Western Wake County portions of Cary, Apex, Morrisville, and Wake County's portion of Research Triangle Park*" (Fuquay-Varina, 2023). Per the Town of Cary, the Western Wake Regional Partners permitted the capacity of the Western Wake Regional WRF to meet the long term needs of the Partners; therefore, additional capacity is not available to other communities. However, this alternative was carried forward in the EIS for an environmental impact analysis.

3.12 Alternative 10 – Interbasin Transfer Minimization, Groundwater

The use of groundwater as a water supply source was evaluated as an IBT minimization alternative. This analysis assumes that groundwater would be a water supply source for the water demand in the Town of Fuquay-Varina's Neuse River basin service area in lieu of a surface water source. The Town of Fuquay-Varina's Cape Fear service area would be served by finished water purveyors in the Cape Fear River basin. Per USGS, more than 50 percent of the U.S. population uses groundwater for potable water supply (2001). According to the North Carolina Groundwater Association (NCGA) and DWR, approximately 50 percent of North Carolina's population also depends on groundwater as a water supply source for potable water (NCGA, 2021; DWR, 2020). There are approximately 16,000 public water supply wells in North Carolina.

Groundwater classifications are codified in NCAC Title 15A Subchapter 2L. Sources of groundwater intended for potable consumption are classified as Class GA groundwater. Class GA groundwater is characterized as having a chloride concentration of less than 250 mg/L, so treatment may not be needed to improve quality. Class GSA groundwater is characterized as having a chloride water quality concentration greater than 250 mg/L. Treatment of Class GSA groundwater is required to improve quality for potable use. A Class GC designation is assigned for groundwaters in which water quality is degraded and cannot be improved with treatment. Class GC designations are determined by the EMC on a case by case basis per 15A NCAC 02L .021.

3.12.1 Well Yield

North Carolina is divided into three physiographic provinces consisting of the Coastal Plain, the Piedmont, and the Blue Ridge. The Town of Fuquay-Varina service area spans the fall line boundary between the Piedmont and Coastal Plain Physiographic Provinces. Groundwater in the Blue Ridge and Piedmont has not been traditionally considered for large water supply sources due to readily available surface water supplies and low groundwater yields. The difficulty of groundwater management in the Blue Ridge and Piedmont Provinces is due to the shallow and unconfined permeable layers of the regolith-bedrock aquifer system, which are therefore vulnerable to contamination (Daniel and Dahlen, 2002).

The geology of the Blue Ridge and Piedmont Provinces may be characterized as a complex and fractured system of metamorphic and igneous rocks contained in a complex two-part, regolith-fractured crystalline rock aquifer system (Daniel and Dahlen, 2002). The rock system has been subject to uplift, weathering, and erosion over time, which has resulted in a complex and fractured system. The regolith provides the bulk of the water storage within the Blue Ridge and Piedmont groundwater system. At the base of the regolith is the transition zone that grades into unweathered bedrock. Groundwater flows through the empty spaces between soil grains and rock fractures. The complex distribution of rock fractures does not facilitate a streamlined approach for mapping rock fractures and associated groundwater movement (USGS, 2002).

The protection of public water supplies in North Carolina is addressed in 15A NCAC Subchapter 18C. Specifically, Section 15A NCAC 18C .0402 defines well construction and protection requirements for water supply wells and yield determination. Wells must be located so that the drawdown of a well does not interfere with the required yield of another well. The combined yield of all water system wells must provide the average daily demand for the system in a 12-hour period. Per 15A NCAC 18C .0402, a 24-hour

production test must be conducted on public supply wells prior to acceptance. Per the Administrative Code, a minimum of a 100 foot radius is required around every public water supply well for well point protection.

Extensive studies on the water supply yields in the Blue Ridge and Piedmont Provinces have been on-going since the mid-1980s (Daniel, 1990; Daniel and Dahlen, 2002; USGS, 2002). In 2002, Daniel and Dahlen published a Water Resources Investigations Study that summarized a preliminary hydrogeological assessment of the groundwater resources of Blue Ridge and Piedmont Provinces. The study was initiated in 1999. The data indicated highly variable well yields, even within the same hydrogeologic unit, and sustainable yields were difficult to determine. Average well yields in the Piedmont Province range from 12 to 24 gallons per minute (gpm) with a mean of 18.23 gpm (Daniel and Dahlen, 2002).

An earlier study by Daniel (1990) tested a theory that specific geologic, topographic, and construction techniques of wells could be statistically related to well yield. In the late 1980s, the Town of Cary evaluated supplementing the Town's existing water supply with additional wells as an alternative to developing an independent water supply. The Town of Cary had used a multi-well system until 1970, at which point the Town purchased water wholesale from a neighboring supplier. Site selection of the new wells was carefully considered based on optimum hydrogeologic conditions. Wells were spaced 800 to 1,000 feet apart in a manifolded system. The daily average production was 49,640 gpd (i.e., 34.5 gpm) per well. It was concluded that a well system was more cost effective for smaller systems if one high yield well could be obtained for every four wells drilled. Additionally, the short-term production tests produced considerably higher well yields than the actual long-term yields.

In May 2022, USGS in conjunction with Wake County Environmental Services, published an Assessment of Well Yield, Dominant Fractures, and Groundwater Recharge in North Carolina. This study characterized the fractured rock aquifer system to assess the sustainability of groundwater for the purpose of water use decisions. USGS inventoried all of the wells in Wake County and conducted a graphical analysis of well construction (e.g., well depth) to identify the correlation between well yield and well depth. Maximum well yield varied across Wake County, ranging from 0.1 to 150 gpm with a median well yield of 10 gpm. The 75th percentile of the well yield data from USGS was 20 gpm. USGS stated that new well yields will likely range between zero and the maximum value of 150 gpm.

Extensive land area will be required for a well field system to meet the water demand in the Town of Fuquay-Varina's Neuse service area based on the published well yields for the Piedmont Province. An average well yield of 20 gpm/day was assumed based on the 75th percentile of well yields for Wake County (USGS, 2022). Well spacing was estimated at 1,000 feet. Daniel and Dahlen (2002) noted that an increase in groundwater pumping decreases well yields and promotes interference between cones of depression associated with closely spaced pumping wells.

A summary of the groundwater system requirements to support a potable groundwater supply system for the Town of Fuquay-Varina's Neuse service area is provided in Table 3-26. Approximately 8,500 acres of land would be required to site 362 wells to meet an average day water demand of 5.21 mgd in 2055 for the Town of Fuquay-Varina's Neuse service area using a 20 gpm/day well yield. Figure 3-12 provides an illustration of a generalized well field footprint. This generalized footprint assumes that contiguous properties can be acquired to amass sufficient acreage for one large well field to promote wellhead protection.

Additional property would be needed outside of Wake County to support a well field of this magnitude. Property would need to be acquired in Wake and Harnett Counties to satisfy the wellhead protection requirement. Per General Statute § 153A-15, the Town of Fuquay-Varina is required to procure permission from the Harnett County Board of Commissioners prior to any property acquisition in Harnett County.

Table 3-26: Summary of System Requirements to Support a Groundwater Supply for Town of Fuquay-Varina Neuse Service Area

Year	Average Day Demand in Town of Fuquay-Varina Neuse Service Area, mgd	Number of Required Wells at 20 gpm/day [1, 2]	Wellfield Area Required, acres at 20 gpm/day [3, 4]
2025	2.21	154	3,600
2035	3.21	223	5,200
2045	4.20	292	6,800
2055	5.21	362	8,500

[1] Well productivity based on Daniel and Dahlen (2002), Daniel (1990), and USGS (2022).

[2] Number of wells represents a 12-hour average.

[3] Estimated land area required assuming 1,000 feet spacing between wells (Daniel, 1990). It was assumed Town would acquire entire wellhead protection area.

[4] A 30% increase in land area was assumed to account for roads, wetlands, streams, existing structures, and buffer areas.

3.12.2 Contamination Risk

The contamination risk to well fields is well documented in the literature. Per Daniel and Dahlen (2002), groundwater management is difficult in the Blue Ridge and Piedmont Provinces due to the fractured rock aquifers. The most permeable layers of the regolith-bedrock aquifer system are shallow and unconfined, and therefore vulnerable to contamination from land activities. Per Huffman and Miner (1996), well contamination is at the entry point at cone of depression. Contamination sources include pesticides, fertilizers, animal waste, landfills, septic tanks, and industrial spills (USGS, 2001). If contamination occurs in fractured rock aquifers, remediation is difficult. Contaminants tend to become trapped in narrow fractures (Daniel and Dahlen, 2002).

3.12.3 Groundwater Quality

Daniel and Dahlen (2002) reported an extensive range of groundwater quality data for the Piedmont region. The average total hardness as calcium carbonate ($CaCO_3$) was reported as 120 mg/L (i.e., moderately hard water) with a 95th percentile of 357 mg/L (i.e., very hard water). Total iron and manganese was reported to average 3.8 mg/L and 1 mg/L, respectively. The 95th percentile total iron and manganese was reported as 12 mg/L and 3.96 mg/L, respectively. Total dissolved solids averaged 227 mg/L. Nitrite and nitrate averaged less than 5 mg/L with a 95th percentile of 20 mg/L. Private utilities with groundwater systems in Wake County have reported iron and manganese water quality issues with produced groundwater.

Harden et al. (2009) published a study characterizing groundwater quality in the Piedmont and Blue Ridge Physiographic Provinces. The study grouped and evaluated analytical data based on regional geozones to

characterize groundwater quality in bedrock aquifers in the Piedmont and Blue Ridge Provinces. The authors used data from 79 wells representing 8 out of 10 geozones. The authors concluded that significant differences in overall ionic chemistry between geozones were not evident. Pollutants that exceeded MCLs for at least one geozone included aluminum, arsenic, fluoride, iron, lead, manganese, nitrate, pH, uranium, and zinc. The most common exceedances occurred for radon, pH, manganese, iron, and zinc. Nitrate and zinc exceedance are generally indicative of contamination from local land use and well-casing materials.

Additional literature was reviewed for potential water quality issues. Arsenic occurs naturally in groundwater statewide and has been detected in wells. A 2003 study by DWR (formerly the Groundwater Section) indicated that southeastern Wake County has a low probability of arsenic occurrence in groundwater. A 2007 study (DWR, 2007) concluded that the majority of arsenic detections occurred in areas underlain by rocks of the Carolina terrane. A few of the counties located in the Carolina terrane rock formation include the north and west half of Durham County, Orange County, Chatham County, Granville County, the northwest corner of Moore County, and Randolph County.

A study of private well groundwater quality sampling occurred between 2008 and 2009 and between 2018 and 2019 (DWR, 2021). The data was collected by the North Carolina Department of Human Health Services and analyzed by the State Laboratory for Public Health. The data was provided to DWR. The data indicated that private Wake County wells exceeded groundwater quality standards at 0.62 percent, 1.9 percent, and 5.4 percent for arsenic, copper, and lead, respectively. Iron, manganese, and zinc exceeded secondary groundwater standards at 23.91 percent, 22.68 percent, and 1.37 percent respectively. A 2015 study (DWR, 2015b) indicated a low susceptibility of radon in groundwater in Wake County in the vicinity of the Town of Fuquay-Varina's service area. Based on these available studies, groundwater quality in the proposed well field area appears to be variable.

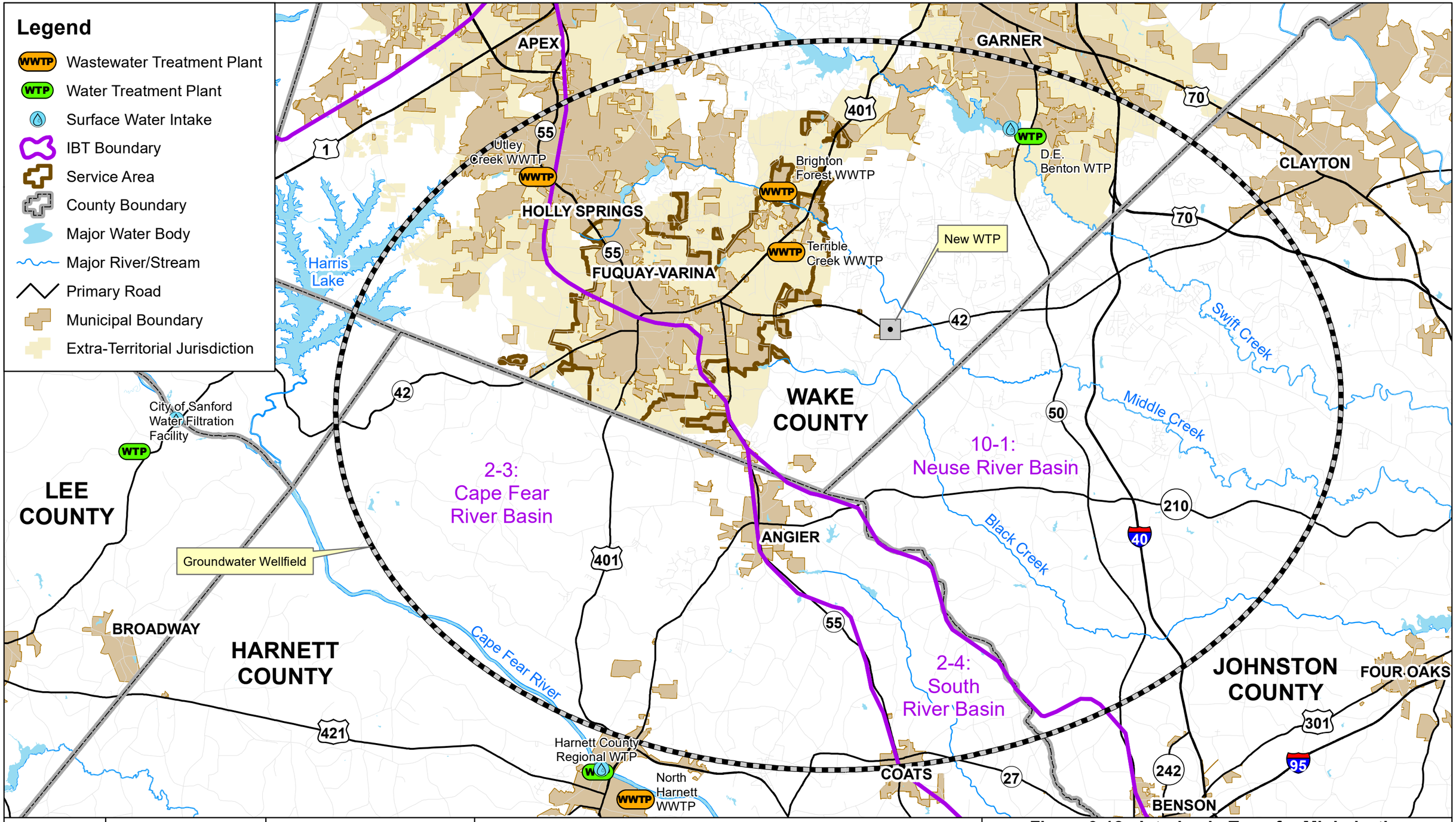
3.12.4 Treatment

Based on the literature review of groundwater quality in the Piedmont Province, it is anticipated that full-scale treatment of produced groundwater would be required. Water quality from multiple wells will be variable; however, it is uncertain if blended water would meet the federal and state standards for finished water quality prior to distribution. Treatment facilities would include ion exchange for softening and greensand filtration for iron and manganese removal. Continuous disinfection via chlorine addition per 15A NCAC 18C .0402 is required. Chemical addition for corrosion control and fluoride may also be necessary. Given the extensive network of wells, a regional chemical addition and treatment facility would be more economical than treatment at individual wells.

The Town of Fuquay-Varina anticipates the continued purchase of surface water from Harnett County. A potential water quality issue can be associated with mixing a surface water supply source with a groundwater source. Mixing waters of different water qualities in water distribution systems is generally not recommended due to the potential for adverse chemical reactions that could occur in the distribution system. Mixing surface water and groundwater may cause pipe corrosion, scale deposition, sloughing of scale, or taste and odor issues. Extensive water quality modeling or demonstration testing would be required to confirm the impacts from mixing finished water from other sources and produced groundwater.

3.12.5 Summary

Alternative 10 does not meet the Town of Fuquay-Varina's project purpose and need for a reliable permanent water supply source or water supply capacity in a time frame needed for the Town to address their water supply shortfall by 2030. The development of a groundwater water supply source presents unique challenges due to the technical infeasibility and high capital and operation and management costs. The 2022 USGS study in Wake County (USGS, 2022) supports the conclusion that limited well yield is available for large water supply systems. Alternative 10 would require that the Town of Fuquay-Varina continue to purchase water from Harnett County to supply finished water to the Town's Cape Fear service area. The use of groundwater in the Piedmont physiographic region is not a cost effect solution. Significant land acquisition would be required to site the number of wells required to meet the Town of Fuquay-Varina's water demand in addition to constructing treatment infrastructure to address quality concerns. Wellhead protection for contamination presents a significant vulnerability concern for this alternative. However, this alternative was carried forward in the EIS for an environmental impact analysis.



SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 3-12: Interbasin Transfer Minimization, Groundwater (Alternative 10)

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

3.13 Alternative 11 – Interbasin Transfer Minimization, Water Reuse

For this alternative, the Town of Fuquay-Varina explored the various forms of water reuse for IBT minimization. Water reuse is the practice of treating and recovering wastewater for various applications in a community. Water reuse, water recycling, recycled water, and reclaimed water are used interchangeably. Common water reuse terminology is defined as follows:

- Non-potable reuse includes all applications of recycled water for purposes other than producing drinking water or augmenting drinking water supplies (e.g., landscape irrigation, agricultural irrigation, indoor toilet flushing, and cooling towers or other industrial uses).
- Indirect potable reuse (IPR) includes the planned augmentation of a drinking water source with purified recycled water into either a groundwater source (groundwater augmentation) or suitably sized surface water storage (surface water augmentation). Either of these two options provides an environmental buffer (aquifer or surface water reservoir) prior to introduction to the drinking water supply.
- Direct potable reuse (DPR) is the introduction of purified water directly into a drinking water treatment plant, with or without blending with a raw water supply (raw water augmentation), or directly into a drinking water distribution system (treated water augmentation).
- There are situations in which an upstream treated wastewater effluent provides a portion of the available raw water supply.

Water reuse regulation in the United States is under the jurisdiction of individual states. There are no federal regulations that govern the quality or quantity of reclaimed water. EPA has published technical guidance on reuse practices throughout the country to aid states that do not have reuse regulations or require assistance with implementation of their reuse programs (EPA 2004; EPA, 2012). However, the EPA does not currently have a plan for applying federal regulations to water reuse and is likely to continue to defer to states and the existing federal Safe Drinking Water Act (SDWA) regulations to protect human health.

Individual states regulate allowable non-potable reuse uses and the amount of treatment required to meet each of those uses. Currently, 45 states have specific water reuse regulations or regulations that influence water reuse practices. The remaining five states (e.g., Conneticut, Kentucky, Louisiana, New York, and Maine) have mechanisms to either permit water reuse sytems on a case-by-case basis.

3.13.1 Evolution of Expanding Reuse Applications

The most common use for reclaimed water in the U.S. is directed toward non-potable applications. Forty states allow irrigation on agricultural land, of which 21 states allow irrigation on food crops intended for human consumption. Common drivers for non-potable reuse include offsetting potable water use and potential increases in drinking water infrastructure capacity, managing wastewater flows at locations that do not have a means of disposing of treated effluent, and managing nutrient loading to environmental waters by diverting flow to land-based applications (e.g., irrigation). Irrigation is the most common form of non-potable reuse in the U.S. (EPA, 2012).

Each reuse case must be individually considered to ensure that the system meets the desired objectives. For example, the seasonality of irrigation demands may mean that less recycled water is needed by customers during the winter months, leaving the non-potable distribution system as non-revenue generating during those periods, which in turn impacts the volume of wastewater discharged to the environment. Non-potable reuse has been typically limited to sites relatively close to wastewater facilities due to the expense of installing significant new buried infrastructure.

Upstream wastewater discharges influencing downstream water supply has been a part of normal operation for the majority of public water supplies. This form of reuse occurs due to upstream utilities discharging into water bodies that downstream users then withdrawal for water supply. Other than providing dilution and travel time between a wastewater outfall and a drinking water intake, there is no additional treatment required beyond conventional drinking water treatment. North Carolina does not have a code or regulation defining this situation. DWR has historically provided guidance to water systems that a wastewater treatment facility located 5 miles upstream of a raw water intake provides a reasonable opportunity to respond to a spill of untreated wastewater.

A few utilities have enhanced their systems to IPR practice to improve the source water quality for their drinking water facilities. Examples include the Clayton County Water Authority (Georgia) E.L. Huie Jr. Constructed Treatment Wetlands and the Upper Occoquan Service Authority Regional Water Reclamation Plant discharging to the Occoquan Reservoir. California and Arizona have several notable examples of planned IPR via groundwater augmentation. For example, the Los Angeles Montebello Forebay spreading grounds have included surface spreading of treated effluent along with surface water since the 1960s. Beginning with Orange County Water District in 1976, a number of utilities utilize reverse osmosis treatment for groundwater injection including the Groundwater Replenishment System, West Basin Municipal Utility District's Edward C Little Facility, Water and several others.

A significant application of reclaimed water is the offset of potable water supply to meet the demand of a growing population. An increasing number of communities are considering the use of reclaimed water as a significant benefit to the public and the environment. Given the U.S. trends for managing water supply and drought recovery, it is anticipated that IPR will become more widely implemented and accepted over the next 10 year planning horizon and DPR will likely become a part of normal water supply considerations in the 30 to 50 year planning horizon. Direct potable reuse has been adopted in Texas under emergency drought conditions (e.g., Wichita Falls and Big Spring) (EPA, 2016). El Paso Water Utilities are currently in design of a DPR system for treated water augmentation (El Paso, 2018). At the same time, California is in the process of finalizing regulations to allow permitting of DPR facilities (California 2017, California, 2023).

It is anticipated that a consensus regarding the appropriate level of technology for IPR and DPR applications could be achieved in 10 years. Industry studies indicate that either a combined membrane (microfiltration and reverse osmosis) and ultraviolet (UV) AOP or an ozone with flocculation/sedimentation, biofiltration, activated carbon, and dual disinfection process will be the cornerstone DPR applications (NWRI, 2013; WRF, 2013a; WRF, 2018). Dual-disinfection approaches could potentially become more widely adopted in the next 15 to 20 years as the number of approved water reuse application types increase or as the use of highly treated recycled water is implemented for raw food crops.

3.13.2 North Carolina Reclaimed Water Regulations

Reclaimed water is regulated via the 02T and 02U rules. Disposal of treated effluent that does not serve as a water resource (i.e., reducing the use of potable water via surface water or groundwater) is governed by 15A NCAC 02T. Disposal of treated effluent that serves as a water resource is governed by 15A NCAC 02U. The 02U rules allow for Type 1 and 2 effluent standards for special irrigation uses (i.e., direct or indirect irrigation of food crops). The 02T rules restrict public access to reclaimed water areas. Public access is allowed for effluent treated to more stringent disinfection 02U standards. Table 3-27 provides a summary

Table 3-27: Effluent Quality Requirements for Various Effluent Disposal Techniques

Water Quality Parameter	Reclaimed Water (2T Rules)	High Rate Infiltration (2T Rules)	High Rate Infiltration (Alternate Criteria) [1]	High Rate Infiltration (Alternate Criteria) [1]	Reclaimed Water Type 1 (2U Rules) [2, 4]	Reclaimed Water Type 2 (2U Rules) [3, 5]
	Monthly Average (Daily Maximum)					
Biochemical oxygen demand	≤ 10 mg/L	≤ 10 mg/L	≤ 10 mg/L (≤ 15 mg/L)	≤ 10 mg/L (≤ 15 mg/L)	≤ 10 mg/L (≤ 15 mg/L)	≤ 5 mg/L (≤ 10 mg/L)
Total suspended solids	≤ 4 mg/L	≤ 15 mg/L	≤ 5 mg/L (≤ 10 mg/L)	≤ 5 mg/L (≤ 10 mg/L)	≤ 5 mg/L (≤ 10 mg/L)	≤ 5 mg/L (≤ 10 mg/L)
Ammonia	≤ 4 mg/L	≤ 4 mg/L (≤ 6 mg/L)	≤ 4 mg/L (≤ 6 mg/L)	≤ 4 mg/L (≤ 6 mg/L)	≤ 4 mg/L (≤ 6 mg/L)	≤ 1 mg/L (≤ 2 mg/L)
Fecal coliform or *E. coli* (Type 2)	≤ 14/100 mL	≤ 14 /100 mL	≤ 14/100 mL (≤ 25/100 mL)	≤ 14/100 mL (≤ 25/100 mL)	≤ 14/100 mL (≤ 25/100 mL)	≤ 3/100 mL (≤ 25/100 mL)
Nitrate	NA	≤ 10 mg/L	≤ 10 mg/L	≤ 10 mg/L	N/A	N/A
Turbidity	10 NTU	NA	NA (10 NTU)	NA (10 NTU)	NA (10 NTU)	NA (5 NTU)
Total nitrogen	≤ 4 mg/L	NA	≤ 7 mg/L	≤ 4 mg/L	N/A (≤ 4 mg/L) [4]	N/A
Total phosphorus	≤ 2 mg/L	NA	≤ 3 mg/L	≤ 2 mg/L	N/A (≤ 1 mg/L) [4]	N/A
Coliphage	NA	NA	NA	NA	N/A	≤ 5/100 mL (≤ 25/100 mL)
Clostridium perfingen	NA	NA	NA	NA	N/A	≤ 5/100 mL (≤ 25/100 mL)

[1] Alternative Design Criteria per DWQ memo dated October 27, 2006. Alternative design criteria requires different property setbacks depending on effluent nitrogen and phosphorus quality.

[2] Public access allowed in 02U Rules. Special irrigation uses are permitted, such as direct or indirect irrigation of food chain crops. Food chain crops that will be peeled, skinned, cooked, or thermally processed before consumption are subject to Type 1 reclaimed water standards.

[3] Public access allowed in 02U Rules. Food chain crops that will not be peeled, skinned, cooked, or thermally processed before consumption are subject to Type 2 reclaimed water standards.

[4] Wetlands augmentation is a potential use of Type 1 reclaimed water if total nitrogen and phosphorus is reduced. Wetland augmentation is limited to pine flat and hardwood flat wetlands.

[5] The design criteria for Type 2 effluent quality must be a log 6 or greater reduction of E. coli, log 5 or greater reduction of Coliphage, and log 4 or greater reduction of Clostridium perfringens.

of reclaimed water standards in North Carolina. The use of 02U reclaimed water applications requires stringent treatment requirements to achieve the regulated effluent quality for disinfection, turbidity, and oxygen consuming wastes (e.g., ammonia and biochemical oxygen demand).

3.13.3 Reclaimed Water Use Assessment for Town of Fuquay-Varina

The Town of Fuquay-Varina has not implemented a reclaimed water program. Approximately 404 homes and businesses have installed a separate potable water meter exclusively for irrigation use. Irrigation meters are dispersed over the Town of Fuquay-Varina's service area with the largest fraction located in the Neuse River basin. The number of 2019 residential and commercial irrigation accounts is 295 and 109, respectively, or approximately 1.8 percent and 0.8 percent of total accounts. The range in average annual residential irrigation use by decade is between 116 and 298 gpd/meter. Table 3-28 provides a summary of the Town of Fuquay-Varina's residential and non-residential irrigation account use and percent of total accounts sorted by decade of home construction.

Table 3-29 summarizes the Town of Fuquay-Varina's single-family residential annual, summer, and winter use per meter sorted by decade of home construction. The single-family residential meter demand over the period of record ranges from 106 to 156 gpd/meter based on 2019 billing records. The summer and winter residential water demand per meter did not yield substantial differences in water use prior to 1999. Post-2000, approximately 14 to 22 gpd/meter more water is used in the summer months and 12 to 18 gpd per meter less water is used in the winter months. Homes constructed between 2010 and 2019 comprise 41 percent of the total number of residential accounts, which is the largest percentage of residential home construction in the Town of Fuquay-Varina's history.

The Town of Fuquay-Varina's single family account use was also compared to a 2016 survey of annual water use per single family residential account by the Water Research Foundation (2016c). The survey consisted of 26 utilities, of which 23 utilities provided full data sets for analysis. A random sampling approach was used to select the households for the survey. The Water Research Foundation research included an analysis of billed consumption. The average single family residential metered use per day was 241.1 gpd/meter compared to the Town of Fuquay-Varina's average of 145 gpd/meter. The minimum and maximum account use from the Water Research Foundation Study was reported as 120.5 and 479.5 gpd/meter, respectively. The Town of Fuquay-Varina's residential metered use is not excessive compared to the surveyed utilities.

Table 3-28: Summary of Residential and Non-Residential Irrigation Account Use by Decade of Construction

Account Records for Year of Home Construction [1]	Number of Irrigation Accounts	Number of Residential Irrigation Accounts	Residential Irrigation Percent of Total Accounts	Residential Irrigation Account Use (gpd/meter), Annual	No. Non-Residential Irrigation Accounts	Non-Residential Irrigation Account Use (gpd/meter), Annual	Non-Residential Irrigation Percent of Total Accounts
No Record	75	1	0.1%	0	74	1,090	6.4%
Homes constructed prior to 1950	2	1	0.3%	298	1	171	0.3%
Homes constructed between 1950 – 1959	6	5	1.4%	180	1	144	0.3%
Homes constructed between 1960 – 1969	4	3	1.2%	116	1	147	0.4%
Homes constructed between 1970 – 1979	1	0	0.0%	0	1	127	0.7%
Homes constructed between 1980 – 1989	2	1	0.0%	0	1	503	0.2%
Homes constructed between 1990 – 1999	37	33	2.1%	128	4	835	0.3%
Homes constructed between 2000 – 2009	217	197	4%	182	20	1,164	0.5%
Homes constructed between 2010 – 2019	60	54	0.9%	165	6	924	0.1%
Total	404	295	1.8%	172	109	390	0.8%

[1] *Based on 2019 water billing records.*

The difference in water use between the summer and winter months was calculated to evaluate the potential to offset potable water use with a reclaimed water program via the 02T Rules. The 2019 billing data for single-family residential annual, summer, and winter use per meter was sorted by decade. The Town of Fuquay-Varina's water use in the summer and winter season was calculated using the Town's per capita metric of 2.36 people per account and the 2025 and 2055 population projections. The resulting difference in water use by decade was summed over the entire data record. The difference in water use between the summer and winter months is 1.8 percent and 2.3 percent of the average day water demand in 2025 and 2055, respectively. This evaluation demonstrates that the overall irrigation use is a fraction of the Town of Fuquay-Varina's water demand and therefore does not contribute to a substantial offset in potable water use. A statistically significant difference was not found at a confidence level of 0.05 if the overall per capita use of 85 gpcd is offset annually by the average summer difference in per capita use at 3.1 gpcd per Table 3-29.

Table 3-29: Single-Family Residential Meter Demand by Decade of Construction

Account Records for Year of Home Construction	Number of Single-Family Accounts [1, 2]	Single-Family Residential Meter Use (gpd/meter) – Annual [3]	Single-Family Residential Meter Use (gpd/meter) – Summer [4]	Single-Family Residential Meter Use (gpd/meter) – Winter [5]	Difference in Per Capita day, Summer	Difference in Per Capita day, Winter
Homes constructed prior to 1950	293	118	126	113	----	----
Homes constructed between 1950 – 1959	293	106	111	101	3.09	-2.92
Homes constructed between 1960 – 1969	208	117	122	114	2.42	-2.63
Homes constructed between 1970 – 1979	97	111	111	112	1.99	-1.48
Homes constructed between 1980 – 1989	372	122	124	121	0.04	0.30
Homes constructed between 1990 – 1999	1,322	129	136	123	0.55	-0.51
Homes constructed between 2000 – 2009	3,668	156	170	144	2.84	-2.50
Homes constructed between 2010 – 2019	4,350 [6]	149	169 [7]	128	5.93	-5.00
	10,598 (Total)	145 (Average)			3.10 (Average)	-2.86 (Average)

[1] Single-family residential meters per 2019 water billing data. Data was edited to remove extreme high and low data, lots with no houses or under construction, and negative billing values.

[2] Excludes irrigation meters.

[3] Residential meter use is an average of the 2019 billing data.

[4] Summer months defined as April to September.

[5] Winter months defined as October to March.

[6] Homes constructed between 2010 and 2019 comprise 41 percent of the total number of residential accounts, which is the largest percentage of residential home construction in the Town's history.

[7] The increased summer residential use for residential homes constructed between 2010 and 2019 may be due to irrigation for new landscaping.

The Town of Fuquay Varina's Community Vision Land Use Plan (2022) illustrates the planned land uses in the Town's service area (e.g., municipal limits and ETJ) and Urban Services Area. The majority of the Town of Fuquay-Varina's service area is comprised of large lot, small lot, and mixed density residential uses. Commercial land uses comprise another substantial fraction of the land use. Rural residential land use is designated in the Town of Fuquay-Varina's Urban Services Area. The Town of Fuquay-Varina does not have outdoor golf courses in the Cape Fear portion of the Town's service area that would offset potable use via reclaimed water irrigation. Additionally, agricultural land uses are not identified in the Town of Fuquay-Varina's Urban Services Area in the Community Vision Land Use Plan.

In the last several years, the Town of Fuquay-Varina has seen a change in the ratio of residential and commercial use in the service area. The Town of Fuquay-Varina has seen a change from new construction of residential single-family homes to construction of multi-family complexes and increased commercial businesses to support residential development. The Town of Fuquay-Varina expects this change in land use to continue per the Town's Community Vision Land Use Plan.

Additionally, the Town of Fuquay-Varina does not have industry that would provide a use for reclaimed water. Only one industry is currently permitted to discharge up to 25,000 gpd to the Town of Fuquay-Varina's collection system. The Town of Fuquay-Varina does not have a planned industrial park or other land use mechanism for significant industrial growth.

3.13.4 North Carolina Indirect Potable Reuse Legislation

The North Carolina Legislature passed Session Law 2014-113 (Senate Bill 163) in 2014. The Session Law modifies General Statute § 143-355.5 to allow a local water system to combine reclaimed water with a raw source water for potable water supply (i.e., surface water augmentation, or IPR). This legislation requires reclaimed water to be treated to the highest reclaimed water effluent standards established by the EMC prior to surface water augmentation. Additionally, five days of engineered storage are required, the reuse quantity must not exceed a maximum blend of 20 percent wastewater to raw water over a 24-hour period, and water conservation and efficiency measures must be met. Session Law 2014-113 Section 2(b) prohibits the direct distribution of reclaimed water as potable water.

The highest treatment level for reclaimed water treatment in North Carolina is currently Type 2 reclaimed water (i.e., 02U Rules). To date, utilities in North Carolina have not moved forward with the option to use reclaimed water for surface water augmentation. Therefore, the question of an applicable reclaimed water treatment standard for surface water augmentation has not been presented to the EMC. The EMC will likely require reclaimed water to be treated to a higher standard of care (e.g., advanced treatment technologies and/or dual disinfection) prior to permitting reclaimed water use for surface water augmentation.

Several states have already implemented regulations or guidance for utilities that require IPR or DPR to supplement potable water supply. It may be likely that DEQ investigates requirements from other states to adopt rules for treatment. Several states are very prescriptive in the regulatory approach, with mandated treatment processes, monitoring of individual pollutants of concern, and specific program requirements. Other states are less prescriptive and offer more flexibility to approve IPR/DPR systems on a case-by-case basis. However, several states have similar regulatory approaches, as follows:

- Microbial risk based on 1 per 10,000 annual per capita risk of infection, which drives pathogen log removal requirements.
- Multi-barrier approaches.
- Treated water meets EPA and any additional state primary or secondary MCLs.
- Approaches for unregulated chemicals as health risk and indicators of treatment performance.

- Sampling and monitoring approaches.

3.13.5 Potable Reuse Assessment for Town of Fuquay-Varina

Wastewater in the Town of Fuquay-Varina's service area is treated at the Terrible Creek WWTP in the Neuse River basin and the North Harnet Regional WWTP in the Cape Fear. Approximately 5 percent of accounts consist of residential units on septic systems in the service area. Effluent from the Terrible WWTP would most likely need to be treated with advanced treatment infrastructure. The resulting highly treated effluent would then need to be pumped to engineered storage. The nearest water treatment facility is the Raleigh Water Dempsey E. Benton WTP. A terminal reservoir would need to be constructed at the Dempsey E. Benton WTP to comply with the 20 percent blend and 5-day engineering storage requirements per Session Law 2014-113.

3.13.6 Summary

Alternative 11 does not meet the Town of Fuquay-Varina's project purpose and need for a permanent water supply source or water supply capacity in a time frame needed for the Town to address their water supply shortfall by 2030. Water reuse for IBT minimization is not a feasible alternative for the Town of Fuquay-Varina and does not meet the purpose and need. Therefore, this alternative was not carried forward in the EIS for an environmental impact analysis. The analysis demonstrates that the use of reclaimed water to offset potable water demand does not contribute to an offset in potable water use. A reclaimed water program will not alter the water demand projections or IBT projections over the planning period.

Reclaimed water use for surface water augmentation faces significant challenges. DEQ has not adopted rules to specify the standard of treatment required to implement Session Law 2014-113. In addition to the significant capital and operating costs to operate advanced treatment infrastructure, non-regulatory hurdles (e.g., social considerations and market drivers) will influence the feasibility of potable reuse applications. Social drivers such as minimizing water use restrictions, water supply reliability, recreation, public perception, and public acceptance are significant factors for potable reuse applications.

3.14 Alternative 12 – Interbasin Transfer Minimization, Additional Conservation Measures

General Statute § 143-215.22L(d) requires the application to evaluate conservation and drought management in the transfer request. Conservation must be considered in many forms, including a conservation analysis related to the amount of the transfer request and conservation related to overall water use. The applicant's water conservation measures must be equal to the most stringent water conservation measures in the source basin. Drought management measures must be as least as stringent as the most severe level of drought experienced in the region.

Additional water conservation was considered in this EIS as an alternative to offset potable water use. An offset of potable water use has the potential to reduce the average day demand required from the preferred alternative. The water conservation measures evaluated herein include an analysis of the Town of Fuquay-Varina's per capita consumption, reclaimed water, water pricing, leak detection, public education, and non-revenue water. This section also includes a discussion of the Town of Fuquay-Varina's water conservation ordinance compared to other utilities in the source basin.

3.14.1 Per Capita Consumption

The Town of Fuquay-Varina has experienced a general decline in overall per capita demand since 2002. Purchased per capita use in 2002 was 110.6 gpcd and declined to 75.4 gpcd in 2022. Data collected in a 2016 national survey by the Water Research Foundation (2016c) published an average total per capita use of 96 gpcd. Per a USGS study published in 2017, domestic 2015 water use by state ranged from 35 to 184 gpcd, with the national average at 82 gpcd (USGS, 2017). The Town of Fuquay-Varina's total per capita use is comparable to utilities in the region and around the country. Refer to Section 2 of this EIS and Appendix B for detailed summaries of the Town of Fuquay-Varina's historic data and trends.

The decline in per capita demand in the Town of Fuquay-Varina's service area mimics trends observed in other utilities in North Carolina and across the U.S. In the mid-1990s, water demand trends began to exhibit patterns that were not typical of historic trends. This phenomenon is attributed to two factors. The first factor is the 1992 U.S. Energy Policy Act, which prompted new industrial standards for low flow plumbing fixtures and building code changes. Low-cost, high-efficiency plumbing fixtures and appliances became commercially available in the mid-1990s and have been widely used thereafter for new and replacement installations across the country, which has led to reduced residential water consumption. The second factor contributing to decreased water demand is the on-going long-term transition away from manufacturing to less water-consuming service industries. During the past few decades, traditional manufacturing industries have been declining in North Carolina, resulting in an overall decrease in industrial water consumption from 2000, which has consequently reduced the overall system water demand.

Water conservation efforts in the region play a large role in the development of future per capita water demand projections with the increased efficiency of indoor plumbing fixtures and appliances (AWWA, 2011). As more homes are renovated or as new construction is built to newer building codes, water use on a per capita basis should decline. Over time, the volume of more efficient plumbing fixtures and appliances will have an impact on average day use and overall per capita demand. Water use per meter may also be

dependent on the year in which the home was built. Typically, homes from the 1970s may not have undergone extensive renovations and may exhibit a higher residential meter demand (USGS, 2017). Homes from the 1950s and 1960s have a higher probability of renovation and therefore may exhibit a lower residential meter demand. Newer homes would be expected to exhibit lower residential meter demands due to the newer plumbing codes and more water efficient appliances. Typically, the difference between current and future per meter water use represents the anticipated decline in overall residential water demand.

The age of home analysis discussed in Section 3.13 summarizes the single-family residential annual, summer, and winter water demand per meter sorted by decade of home construction. The single-family residential meter demand over the period of record ranges from 106 to 156 gallon per day (gpd) per meter. The summer and winter residential water demand per meter did not yield substantial differences in water use prior to 1999. Annual average water use prior to 1999 ranges from 111 gpd/meter to 129 gpd/meter. Annual average water use post-2000 falls between 149 and 156 gpd/meter. The Town of Fuquay-Varina's total annual average residential water use is 145 gpd/meter.

The age of homes analysis was inconclusive as to how much per capita demand could be saved from home renovations and appliance updates. The majority of the growth in the Town of Fuquay-Varina is post-2000 construction, and therefore subject to newer building codes for increased efficiency. The homes constructed prior to 1989 comprise less than 20 percent of the total number of accounts. Homes constructed between 2010 and 2019 comprise 41 percent of the total number of residential accounts.

The Town of Fuquay-Varina's single family account use was also compared to a survey of annual water use per single family residential account for 26 utilities by the Water Research Foundation (2016c). The survey included utilities from fourteen states representing multiple geographic regions to include North Carolina, Georgia, Canada, Washington, Oregon, California, Pennsylvania, Arizona, Texas, Colorado, Florida, Illinois, Nevada, and Connecticut. The average single family residential metered use per day was 241.1 gpd/meter compared to the Town of Fuquay-Varina's average of 145 gpd/meter. The minimum and maximum account use from the Water Research Foundation Study (2016c) was reported as 120.5 and 479.5 gpd/meter, respectively. The Town of Fuquay-Varina's residential metered use is not excessive compared to the random sampling of surveyed utilities.

A total per capita total use of 85 gpcd for the Town of Fuquay-Varina was carried forward in the water demand projection analysis over the planning period. The planning unit demand must account for the wider range of conditions that may occur over the 30-year IBT certificate period. These extenuating conditions may include periods of hot dry weather or more typical non-revenue water ratios as the Town's distribution system ages. The Town of Fuquay-Varina's total per capita use is comparable to national per capital use trends and are less than, or comparable to, regional per capita use trends.

3.14.2 Summary of Reclaimed Water Analysis

Section 3.13 of this EIS provided a detailed evaluation of the potential of reclaimed water to offset potable water use. The analysis demonstrated that the use of reclaimed water for irrigation to offset potable water demand does not contribute to a substantial offset in potable water use. The analysis determined that irrigation is not a viable alternative, as agricultural land is not identified in the Town of Fuquay-Varina's

Urban Services Area. Irrigation will not substantially alter the water demand projections or IBT projections over the planning period. Additionally, the Town of Fuquay-Varina's single family residential account use is comparable to other utilities around the country, which indicates that residential water use is not excessive in the service area.

3.14.3 Water Consumption Charges

The Town of Fuquay-Varina has implemented a uniform rate structure for water consumption charges inside and outside corporate limits. The minimum base water rate increases based on meter size (i.e., larger meters are charged a higher minimum base rate). Water users pay a rate per 1,000 gallons consumed beyond the minimum base rate. Therefore, customers are charged for the water consumed based on actual metered use. The rate structure applies to base water meters and irrigation meters. Per the Town's Code of Ordinances Part 5, Chapter 1, Article B, water users outside of corporate limits are assessed rates double of the corporate limit rate. The Town of Fuquay-Varina's rate structure does not inhibit water conservation. Per Sections 2 of this EIS, the Town of Fuquay-Varina exhibits some of the lowest total per capita water use rates in the Cape Fear River basin.

3.14.4 Leak Detection

In July 2018, the Town of Fuquay-Varina initiated a conversion of the Town's monthly drive-by Automated Meter Reading (AMR) system to an advanced meter reading system, or Advanced Metering Infrastructure (AMI) system. The AMI system provides hourly reading through a fixed radio network. The Town of Fuquay-Varina has approximately 250 miles of water line, over half of which is greater than 20 years old. The AMI system provides Town of Fuquay-Varina staff real-time usage information to enhance and promote water conservation, reduce water leaks in the system, and improve operational efficiency.

Town of Fuquay-Varina staff receive leak alerts from the AMI system that staff investigates daily. The conversion to the AMI system provides 720 water meter readings in each billing cycle in lieu of the one monthly reading currently collected with the existing AMR technology. Therefore, the Town of Fuquay-Varina's customers are more informed about water use in the monthly water bill. The AMI system will assist with minimization and control of spikes in water use, which will ultimately help control the maximum month and maximum day demand and associated peaking factors.

3.14.5 Public Education

The Town of Fuquay-Varina maintains a webpage for water conservation tips. The webpage may be accessed from the Town of Fuquay-Varina's Public Utilities menu. The Town of Fuquay-Varina provides tips for indoor and outdoor water conservation measures. The website also provides several links to references related to rainwater harvesting, drought-tolerant native plants, and Raleigh Water's usage calculator.

The Town of Fuquay-Varina offers online services to their residents via an online services webpage: https://www.fuquay-varina.org/372/Online-Services. Town of Fuquay-Varina customers have the opportunity to sign up and view and pay for consumption through *eUtilities.* Alternatively, customers can receive detailed daily consumption and notifications of high water usage periods (e.g., leaks) via the on-line service *eMeters*.

Currently, the Town of Fuquay-Varina has 18,043 active utility accounts. Approximately 16,800 customers, or 93 percent of total customers, have registered for the Town's *eUtilities* and *eMeters* online services. Similar to the AMI system, this service will help minimize and control spikes in water use to assist with reducing the maximum month and maximum day demand and associated peaking factors.

3.14.6 Non-Revenue Water

An analysis of non-revenue water was conducted using billed versus purchased water data. Purchased water includes the non-revenue fraction of water use. Non-revenue water is the percent of water not billed to customers and includes water for firefighting, flushing, water leakage, or theft. The Town of Fuquay-Varina's percentage of non-revenue water has declined since 2002 at 15.7 percent to 3.0 percent in 2023. The average national water loss is 16 percent (Wiant, 2017; EPA, 2013). The Town of Fuquay-Varina has not conducted a formal water audit but has plans to commission an audit in fiscal year 2025/2026.

Over the last ten years, water use has increased with growth and the Town of Fuquay-Varina's distribution system has extended to approximately 100 miles. In general, the percentage of non-revenue water has declined as a result of newer infrastructure and greater use. The Town of Fuquay-Varina averages 2,500 feet of waterline replacement per year. Recent projects have replaced 2-inch galvanized waterline with 6-inch polyvinyl chloride (PVC) waterline to increase water quality, quantity, and pressure in the system. The Town of Fuquay-Varina Board of Commissioners currently funds $500,000 per year towards waterline replacement and increased the annual amount to $1,000,000 per year in fiscal year 2024/2025.

3.14.7 Comparison of Cape Fear River Basin Utilities Water Conservation Measures

Per General Statute § 143-215.22L, water conservation of the IBT applicant must be equal to the most stringent water conservation measures in the source basin. The applicant is required to minimize the transfer to the extent practicable. An evaluation of existing water conservation protocols in the Cape Fear River basin (i.e., source basin) was conducted as part of this minimization alternative.

The Town of Fuquay-Varina Board of Commissioners passed a Water Conservation Ordinance in January 2008 that went into effect in May 2008. The ordinance mandates year-round water conservation measures (Code of Ordinances Part 5, Chapter 1, Article C) and stage 1 through 3 water conservation mandates. The Town of Fuquay-Varina has not made any changes to the ordinance since 2008. The ordinance applies to all users connected to the Town of Fuquay-Varina's water system inside and outside corporate limits. The Town of Fuquay-Varina has not implemented Stage 4 or 5 restrictions.

Table 3-30 provides a summary of the Town of Fuquay-Varina's most significant water conservation measures compared to the Towns of Apex and Cary and OWASA. The Towns of Cary and Apex have the most restrictive Stage 1, 2, and 3 requirements in the Cape Fear River basin as a result of the Cary/Apex IBT. The Town of Cary adopted a revised conservation ordinance in July 2009 with a modification in January 2010. The most recent water conservation ordinance for the Town of Apex is dated April 2010. OWASA's conservation measures are contained in the 2018 Water Shortage Response Plan.

The Town of Fuquay-Varina has proposed modifications to the Town's water conservation ordinance to be more equivalent to water conservation measures for the Towns of Cary, Apex, and OWASA. The Town of Cary, the Town of Apex, OWASA, and the Town of Fuquay-Varina require mandatory year-round irrigation restrictions limited to irrigation three days per week on alternating days by street address. None of the four communities limit indoor or outdoor water use on a year-round basis. In a Stage 1 water shortage restriction, the Town of Fuquay-Varina currently allows outdoor irrigation on alternating limited days. The Town of Fuquay-Varina has proposed limiting irrigation to one day per week in Stage 1 to be consistent with the Stage 1 water conservation measures for the Towns of Cary and Apex. The Town of Fuquay-Varina has also proposed a prohibition on irrigation in Stage 2 water restrictions to be consistent with the Towns of Cary and Apex. The Town of Fuquay-Varina has also proposed no new turf watering permits issued in Stage 1 restrictions and limiting indoor water use in Stages 2 and 3 to be consistent with the Towns of Cary and Apex.

Table 3-31 provides a summary of the water conservation measures for communities in the Cape Fear River basin as a comparison to the Towns of Fuquay-Varina, Apex, and Cary. The list of conservation measures in Table 3-31 is not exhaustive. Each community has nuances and/or exceptions to water conservation ordinances and policies that cannot be reflected in a summary table. Appendix D provides an extensive summary of water conservation measures for each community. The applicable code, ordinance, or policy is referenced for each water conservation measure. Water conservation stages or levels are meant to be additive. For example, restrictions in Stage 1 are also required in Stage 2 unless superseded by a more stringent requirement.

Table 3-30: Summary of Water Shortage Response and Conservation Measures for Towns of Fuquay-Varina, Apex, and Cary

	Water Shortage Response Stages	Outdoor Spray Irrigation	Hand watering, drip irrigation, subsurface irrigation, athletic field maintenance	Other outdoor water use (e.g., pressure washing, car washing, filling/topping off swimming pools)	New Turf Watering Exception Permits	Indoor Water Use Restrictions
Fuquay-Varina	Mandatory year-round	Three days per week	Allowed	Allowed	Allowed	None
Apex	Mandatory year-round	Three days per week	Allowed	Allowed	Allowed	None
Cary	Mandatory year-round	Three days per week	Allowed	Allowed	Allowed	None
OWASA	Mandatory year-round	Three days per week	Allowed	Allowed	Allowed	Commercial only
Fuquay-Varina	Stage 1	~~Three days per week~~ **One day per week**	Allowed	Business Only, No pool filling, Wash vehicles at home Monday to Friday only	~~Allowed~~ **No new permits issued, permits issued prior to water shortage can continue**	Reduce consumption by 10%
Apex	Stage 1	One day per week	Allowed	Allowed	No new permits issued, permits issued prior to water shortage can continue	Limit indoor water use
Cary	Stage 1	One day per week	Allowed	Allowed	No new permits issued, permits beginning more than 14 days after stage 1 date rescinded	None
OWASA	Stage 1	Three days per week	Allowed	Allowed	Allowed	Reduce consumption by 10%
Fuquay-Varina	Stage 2	~~One day per week, Night only~~ **Prohibited**	~~One day per week, Night only~~ **Allowed on alternate days**	Recycled Car Wash Only, Therapy Pools Only	Prohibited	~~Reduce consumption by 20%~~ **Limit indoor water use**
Apex	Stage 2	Prohibited	Allowed	Allowed	Prohibited	Limit indoor water use
Cary	Stage 2	Prohibited	Allowed	Allowed	Prohibited	None
OWASA	Stage 2	One day per week	Allowed	Prohibited	Only exceptions allowed	Reduce consumption by 15%

Table 3-30: Summary of Water Shortage Response and Conservation Measures for Towns of Fuquay-Varina, Apex, and Cary

	Water Shortage Response Stages	Outdoor Spray Irrigation	Hand watering, drip irrigation, subsurface irrigation, athletic field maintenance	Other outdoor water use (e.g., pressure washing, car washing, filling/topping off swimming pools)	New Turf Watering Exception Permits	Indoor Water Use Restrictions
Fuquay-Varina	Stage 3	Prohibited	Prohibited	Prohibited	Prohibited	~~Reduce consumption by 30%~~ **Limit indoor water use**
Apex	Stage 3	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited
Cary	Stage 3	Prohibited	Prohibited	Prohibited	Prohibited	Limited to normal Tier 1 indoor winter use
OWASA	Stage 3	Prohibited	Allowed	Prohibited except for pool filling	Prohibited	Reduce consumption by 20%
Fuquay-Varina	Stage 4/5	Not adopted	Not adopted	Not adopted	Not adopted	Not adopted
Apex	Stage 4/5	Prohibited	Prohibited	Prohibited	Prohibited	Limit indoor water use
Cary	Stage 4/5	Prohibited	Prohibited	Prohibited	Prohibited	Reduce normal winter use by 15%
OWASA	Stage 4/5	Prohibited	Prohibited	Prohibited	Prohibited	Reduce consumption by 20%

Notes: **Green text** indicates proposed changes to Town of Fuquay-Varina conservation measures.

Table 3-31: Summary of Water Conservation Measures for Communities in Cape Fear River Basin

Water Conservation Measure	Fuquay-Varina	Apex	Asheboro	Brunswick County	Burlington	Cary	Clinton	Durham	Fayetteville PWC	Holly Springs	OWASA	CFPUA / Wilmington	Greensboro	Jacksonville	Mebane	Pittsboro	Sanford	Burgaw	High Point
General																			
Public education and outreach	X					X	X			X	X				X				
Public notice	X																	X	
Rate adjustment during drought					X		X						X						X
Water conservation plans for large users								X			X								
Native planting requirement		X		X															
Low flow toilet install program																	X		

Table 3-31: Summary of Water Conservation Measures for Communities in Cape Fear River Basin

Water Conservation Measure	Fuquay-Varina	Apex	Asheboro	Brunswick County	Burlington	Cary	Clinton	Durham	Fayetteville PWC	Holly Springs	OWASA	CFPUA / Wilmington	Greensboro	Jacksonville	Mebane	Pittsboro	Sanford	Burgaw	High Point
Mandatory Year-Round Restrictions																			
Mandatory alternate day watering or other day of the week restrictions	X (three days per week)	X (three days per week)				X (three days per week)		X	X		X					X			
Irrigation system must be operated properly (e.g., no watering of impervious surface)		X				X		X	X	X	X					X			
Irrigation rain sensors		X				X		X			X					X			
Irrigation surcharge allowed		X																	
No improper connections or unauthorized use		X				X		X	X										
Limit indoor water use											X (Commercial only)	X (voluntary)							

Table 3-31: Summary of Water Conservation Measures for Communities in Cape Fear River Basin

Water Conservation Measure	Fuquay-Varina	Apex	Asheboro	Brunswick County	Burlington	Cary	Clinton	Durham	Fayetteville PWC	Holly Springs	OWASA	CFPUA / Wilmington	Greensboro	Jacksonville	Mebane	Pittsboro	Sanford	Burgaw	High Point
Stage 1 Water Conservation																			
No washing down outdoor areas unless by business with license	X																		
Alternate day watering or other day of week restrictions	X (three days per week; proposed 1 day per week)	X (one day per week)				X (one day per week)				X		X							X
Only wash vehicles at home on weekends	X		X (voluntary)																X
New and existing pools cannot be completely filled	X		X (voluntary)					X	X										
Irrigation limited to once/week		X				X		X			X								
Hand watering permitted	X	X				X		X		X		X							

Table 3-31: Summary of Water Conservation Measures for Communities in Cape Fear River Basin

Water Conservation Measure	Fuquay-Varina	Apex	Asheboro	Brunswick County	Burlington	Cary	Clinton	Durham	Fayetteville PWC	Holly Springs	OWASA	CFPUA / Wilmington	Greensboro	Jacksonville	Mebane	Pittsboro	Sanford	Burgaw	High Point
No new landscape permits	X (Proposed)	X				X												X	
Limit vehicle washing and outdoor area washdown	X	X	X (voluntary)	X	X (voluntary)	X	X (voluntary)		X		X (discret-ionary)		X (voluntary)	X (voluntary)	X (voluntary)			X	X
Limit indoor water use	Reduce consumption by 10%	X (voluntary)	X (voluntary)	X	X (voluntary)		X (voluntary)	X	X		X	X	X (voluntary)	X (voluntary)	X (voluntary)			X	X
Installation of low-flow fixtures		X	X (voluntary)	X	X (voluntary)	X							X (voluntary)	X (voluntary)				X	X
Limited hours for lawn watering	X		X (voluntary)	X	X (voluntary)	X		X		X	X	X	X (voluntary)	X (voluntary)				X (no specific hours)	
No pool filling	X			X					X				X (voluntary)						X
No use of fire hydrants for any other purpose other than fire fighting									X			X							
No intentional wasting of water														X (voluntary)					X

Table 3-31: Summary of Water Conservation Measures for Communities in Cape Fear River Basin

Water Conservation Measure	Fuquay-Varina	Apex	Asheboro	Brunswick County	Burlington	Cary	Clinton	Durham	Fayetteville PWC	Holly Springs	OWASA	CFPUA / Wilmington	Greensboro	Jacksonville	Mebane	Pittsboro	Sanford	Burgaw	High Point
Stage 2 Water Conservation																			
Alternate day watering or other day of the week restrictions	X (one day per week, night only; proposed prohibition)								X	X	X (once per week)	X		X				X	
No washing of any vehicles except at commercial car wash facilities recycling water	X		X	X	X			X		X	X			X	X			X	X
No new landscape permits	X		X			X													
No water for swimming pools	X	X	X (permit req'd)	X						X (new)				X (new)	X (new)				X
Limited water for swimming pools					X	X				X		X		X	X			X	

Table 3-31: Summary of Water Conservation Measures for Communities in Cape Fear River Basin

Water Conservation Measure	Fuquay-Varina	Apex	Asheboro	Brunswick County	Burlington	Cary	Clinton	Durham	Fayetteville PWC	Holly Springs	OWASA	CFPUA / Wilmington	Greensboro	Jacksonville	Mebane	Pittsboro	Sanford	Burgaw	High Point
No watering by irrigation systems, hand water	X (one day per week, night only; proposal to allow for alternate days)	X		X		X		X					X (1 d/wk irrigation allowed)						X
No use of fire hydrants for any other purpose other than fire fighting	X	X		X						X				X	X				
No intentional wasting of water		X	X		X	X			X					X				X	
Limited hours for lawn watering	X		X		X		X					X			X			X	X
No outdoor area washdown unless public health and safety issue	X		X	X			X	X	X	X	X	X (weekend only, residential)		X	X			X	

Table 3-31: Summary of Water Conservation Measures for Communities in Cape Fear River Basin

Water Conservation Measure	Fuquay-Varina	Apex	Asheboro	Brunswick County	Burlington	Cary	Clinton	Durham	Fayetteville PWC	Holly Springs	OWASA	CFPUA / Wilmington	Greensboro	Jacksonville	Mebane	Pittsboro	Sanford	Burgaw	High Point
Limit indoor water use	Reduce consumption by 20%; proposed limits on indoor water use	X	X	X	X		X	X	X			X			X			X	X
Mandatory reductions in commercial and industrial use				X					X	X									
Irrigation surcharge													X						

Table 3-31: Summary of Water Conservation Measures for Communities in Cape Fear River Basin

Water Conservation Measure	Fuquay-Varina	Apex	Asheboro	Brunswick County	Burlington	Cary	Clinton	Durham	Fayetteville PWC	Holly Springs	OWASA	CFPUA / Wilmington	Greensboro	Jacksonville	Mebane	Pittsboro	Sanford	Burgaw	High Point
Stage 3 Water Conservation																			
No watering by irrigation systems	X	X	X	X	X	X	X (survival only)	X	X	X	X	X	X	Note 1	X			X	
No washing of any vehicles, inc. commercial	X	X	X	X		X		X			X		X					X	X
All permits for new vegetation are revoked	X					X													
No hand watering	X	X	X			X						X						X	
No non-essential commercial or public use		X	X	X	X	X	X	X	X			X						X	
No outdoor area washdown		X	X	X		X		X	X		X	X	X					X	
No recreational use	X		X	X	X	X		X		X			X					X	
Mandatory reductions in	X (discret-ionary)		X	X	X			X	X	X			X						

Table 3-31: Summary of Water Conservation Measures for Communities in Cape Fear River Basin

Water Conservation Measure	Fuquay-Varina	Apex	Asheboro	Brunswick County	Burlington	Cary	Clinton	Durham	Fayetteville PWC	Holly Springs	OWASA	CFPUA / Wilmington	Greensboro	Jacksonville	Mebane	Pittsboro	Sanford	Burgaw	High Point
commercial and industrial use																			
No new taps or hydrants approved / constructed			X					X											
POTW monitoring of residential water use						X													
No intentional wasting of water									X			X	X						
Limit indoor water use	Reduce consumption by 30%; proposed limits on indoor water use					X			X	X			X						
No use of fire hydrants except fire fighting												X	X						
No outdoor water use except fire fighting										X									X

Table 3-31: Summary of Water Conservation Measures for Communities in Cape Fear River Basin

Water Conservation Measure	Fuquay-Varina	Apex	Asheboro	Brunswick County	Burlington	Cary	Clinton	Durham	Fayetteville PWC	Holly Springs	OWASA	CFPUA / Wilmington	Greensboro	Jacksonville	Mebane	Pittsboro	Sanford	Burgaw	High Point
Stage 4/5/6 Water Conservation																			
Outdoor water use for only fire protection and/or other public health and safety measures		X	X		X	X	X	X	X	X	X	X	X	X	X				
Industrial use prohibited / restricted		X			X				X										
No water in swimming pools		X			X	X		X	X		X	X	X	X	X				
Limit residential use			X		X	X	X	X	X	X		X	X	X					
No vehicle washing					X	X		X	X	X		X	X						
No outdoor area washdown									X			X	X						
Irrigation limits													X						

Table 3-31: Summary of Water Conservation Measures for Communities in Cape Fear River Basin

Water Conservation Measure	Fuquay-Varina	Apex	Asheboro	Brunswick County	Burlington	Cary	Clinton	Durham	Fayetteville PWC	Holly Springs	OWASA	CFPUA / Wilmington	Greensboro	Jacksonville	Mebane	Pittsboro	Sanford	Burgaw	High Point
Mandatory reductions in commercial and industrial use										X			X						
No new taps or hydrants approved / constructed													X						

[1] *City of Jacksonville has implemented the same as conservation measures for Stages 2 and 3.*

3.15 Summary of Infrastructure and Cost Opinion for Alternatives

Opinions of probable project costs were prepared for each alternative on a concept-level basis. The cost opinions were developed in accordance with the guidelines of the Association for the Advancement of Cost Engineering (AACE) International for a Class 5 level of estimation. A Class 5 estimate is based on concept screening (e.g., parametric models, capacity factors). In addition to parametric costs, recent design and construction cost experience were used as applicable. The expected accuracy range for a Class 5 level of estimation is +100 percent to -50 percent. The exception is a Class 3 estimate was used for Alternatives 9A and 9B. A Class 3 estimate is based on semi-detailed unit costs and line items with an estimation range of -20 percent to +30 percent.

To meet the purpose and need, the Town of Fuquay-Varina requires that infrastructure start construction in 2025. Permitting and construction of several alternatives will not be accomplished within this time frame; therefore, the project cost opinion considers the economic impact of delayed construction for specific alternatives. An interest rate of 4.4 percent per the United States Office of Budget and Management Circular A-94 (2025) was used to escalate costs in the stated time frame. The concept-level project costs include a 30 percent contingency and 15 percent for engineering. Engineering includes design services, construction services, administration, and legal.

Table 3-32 summarizes the infrastructure required for each alternative, the opinion of probable project conceptual level cost, and the associated time frame in which an alternative could reasonably be implemented. The alternatives are also ranked by the cost opinion order of magnitude, with a rank of “1” indicating the most cost-effective alternative and a rank of “13” indicating the least cost-effective alternative. Appendix E provides a summary of the alternative cost opinions.

Several alternatives reflect only the cost obligation for the Town of Fuquay-Varina. Alternatives 9A/9B, 9C, and 9D reflect only the cost obligation for the Town of Fuquay-Varina. Several other project partners are participating in the regional water supply solution with the City of Sanford. Alternative 1 (Surface Water, Purchase Finished Water from Raleigh Water) also reflects the cost obligation only to the Town of Fuquay-Varina. The proposed reservoir infrastructure would be shared between Raleigh Water and the Town of Fuquay-Varina; therefore, it was assumed that the Town would finance 50 percent of the reservoir, raw water intake, raw water conveyance, and water treatment facility expansion.

Alternative 9A (Surface Water, Purchase Finished Water from City of Sanford) is ranked the highest with a rank of “1.” Alternative 5 (Surface Water, Purchase Finished Water from Harnett County) is ranked the second highest. Alternative 9D (Surface Water, Purchase Finished Water from City of Sanford with Return of Water to Cape Fear River via Western Wake Regional WRF) ranks the third highest. The cost opinion for Alternative 9C (i.e., return water to the Cape Fear River) is twice the cost of Alternative 9A. The highest cost alternatives are Alternative 1 (Surface Water, Purchase Finished Water from Raleigh Water), Alternative 2 (Surface Water, Purchase Finished Water from Johnston County), Alternative 3 (Surface Water, Town of Fuquay-Varina Independent Water Supply in Neuse River Basin), and Alternative 10 (Interbasin Transfer Minimization, Groundwater) with total project cost greater than $0.75 billion.

Table 3-32: Summary of Infrastructure and Total Present Worth of Alternatives

No.	Alternative	Infrastructure	Opinion of Probable Project Cost [1, 2, 3]	Cost Rank	Time Frame for Construction
1	Surface Water, Purchase Finished Water from Raleigh Water	• New reservoir on Middle Creek (Town of Fuquay-Varina funds 50%) • New raw water intake and pump station (Town of Fuquay-Varina funds 50%) • New raw water transmission main (Town of Fuquay-Varina funds 50%) • Expansion of Dempsey E. Benton WTP (Town of Fuquay-Varina funds 50%) • New finished water transmission main • New booster pump station • New elevated water tank • Instream flow study (Town of Fuquay-Varina funds 50%)	$836,800,000 [4]	11	20 to 30 years (20 years used for cost opinion)
2	Surface Water, Purchase Finished Water from Johnston County	• New raw water intake and pump station • New raw water transmission main (from Neuse River to quarry and from quarry to new WTP) • New raw water quarry pump station • New booster pump station • New WTP (Town of Fuquay-Varina) • New finished water transmission main	$878,500,000	12	10 years
3	Surface Water, Town of Fuquay-Varina Independent Water Supply in Neuse River Basin	• New reservoir on Middle Creek • New raw water intake and pump station • New raw water transmission line • New WTP (Town of Fuquay-Varina) • New finished water transmission main • Instream flow study	$802,000,000	10	20 to 30 years (20 years used for cost opinion)
4	Surface Water, Purchase Finished Water from City of Dunn	• New raw water intake and pump station • New terminal reservoir and pump station • Expansion of A.B. Uzzle WTP with additional property • New finished water transmission main • New booster pump station	$449,200,000 [4]	4	5 to 8 years (6 years used for cost opinion)

Table 3-32: Summary of Infrastructure and Total Present Worth of Alternatives

No.	Alternative	Infrastructure	Opinion of Probable Project Cost [1, 2, 3]	Cost Rank	Time Frame for Construction
5	Surface Water, Purchase Finished Water from Harnett County	• New finished water transmission main • Expansion of raw water pump station and intake • Expansion of Harnett County Regional WTP • Instream flow study	$375,500,000	2	5 to 8 years (6 years used for cost opinion)
6	Surface Water, Raw Water from Jordan Lake (Cary/Apex)	• New raw water intake and pump station • New raw water transmission main • New booster pump station • New WTP (Town of Fuquay-Varina)	$497,100,000	6	10 years [5]
7	Surface Water, Raw Water from Jordan Lake (Western Intake Partnership)	• New raw water intake and pump station • New raw water transmission main • New booster pump station • New WTP (Town of Fuquay-Varina)	$565,000,000	8	10 years [5]
8A	Surface Water, Town of Fuquay-Varina Intake on the Cape Fear River with Return of Water to Cape Fear River Basin (Cape Fear River)	• New raw water intake and pump station • New raw water transmission main • New WTP (Town of Fuquay-Varina) • Effluent pump station at Terrible Creek WWTP • New disinfection facility • New effluent force main to Cape Fear River • Instream flow study • Water quality study	$660,100,000	9	10 years
8B	Surface Water, Town of Fuquay-Varina Intake on the Cape Fear River with Return of Water to Cape Fear River Basin (Kenneth Creek)	• New raw water intake and pump station • New raw water transmission main • New WTP (Town of Fuquay-Varina) • Effluent pump station at Terrible Creek WWTP • New disinfection facility • New effluent force main to Kenneth Creek • Instream flow study • Water quality study	$522,800,000	7	10 years

Table 3-32: Summary of Infrastructure and Total Present Worth of Alternatives

No.	Alternative	Infrastructure	Opinion of Probable Project Cost [1, 2, 3]	Cost Rank	Time Frame for Construction
9A/B	Surface Water, Purchase Finished Water from City of Sanford	• New raw water intake and pump station • Expansion of existing Sanford WTP • New finished water transmission main • New booster pump station and ground storage tank	$227,300,000 [4]	1	2 years
9C	Surface Water, Purchase Finished Water from City of Sanford with Return of Water to Cape Fear River	• New raw water intake and pump station • Expansion of existing Sanford WTP • New finished water transmission main • New booster pump station and ground storage tank • Effluent pump station at Terrible Creek WWTP • New disinfection facility • New effluent force main to Cape Fear River • Water quality study	$453,800,000 [4]	5	10 years
9D	Surface Water, Purchase Finished Water from City of Sanford with Return of Water via Western Wake WRF	• New raw water intake and pump station • Expansion of existing Sanford WTP • New finished water transmission main • New booster pump station and ground storage tank • Effluent pump station at Terrible Creek WWTP • New effluent force main to Western Wake WRF	$413,900,000	3	5 to 8 years (6 years used for cost opinion)
10	Interbasin Transfer Minimization, Groundwater	• 362 wells [6] • New WTP (Town of Fuquay-Varina) • Finished water transmission main network • Groundwater yield studies	$897,500,000	13	30 years (assumption that 100 wells installed by 2035; 200 wells installed by 2045; and 362 wells installed by 2055 for developing cost opinion)
11	Interbasin Transfer Minimization, Water Reuse	N/A	----	----	----

Table 3-32: Summary of Infrastructure and Total Present Worth of Alternatives

No.	Alternative	Infrastructure	Opinion of Probable Project Cost [1, 2, 3]	Cost Rank	Time Frame for Construction
12	Interbasin Transfer Minimization, Additional Conservation Measures	N/A	----	----	----

[1] Class 5 level of estimation per AACE Cost Estimate Classification System (2005) for Alternatives 1 through 8, 9C, 9D, and 10. Class 3 level of estimation per AACE Cost Estimate Classification System for Alternative 9A/B.

[2] An interest rate of 4.4% was used per OBM Circular A-94 (2025).

[3] Wetland and buffer mitigation costs were included with assumptions based on anticipated impacts once fieldwork is completed.

[4] Opinion reflects only the cost obligation for the Town of Fuquay-Varina and not the larger project.

[5] Assumption that the Town of Fuquay-Varina would receive an allocation of water from Jordan Lake in the next round of applications.

[6] Estimate of number of wells needed based on assumed yields consistent across proposed wellfield.

4. Affected Environment

Information relative to existing environmental conditions in the project area is provided in this section. The project area for each alternative includes pipe corridors and pump stations. Various other infrastructure is associated with the alternatives, as applicable, including proposed water treatment facilities, new reservoirs, upgrades to existing water treatment plants, raw water intakes and pumping facilities, raw water storage facilities, effluent force mains, and elevated storage. The potential exists for modifications during later phases of design. For all alternatives, the affected environment was assessed based on the pipe corridor width that would be necessary to accommodate an open-cut installation technique. Where feasible, quantitative evaluations of existing conditions were performed based on electronic and hardcopy data obtained from private, municipal, state, and federal entities. Elements that are common for all alternatives are discussed as a whole. Elements that differ between alternatives are discussed separately.

In Sections 4 and 5, the descriptive nomenclature of the project alternatives has been modified to reduce the table column width and to facilitate discussion of multiple alternatives. The descriptive nomenclature and project alternative numbering scheme used in Sections 4 and 5 are identified in Table 4-1. Alternative 11 is not a feasible alternative for the Town of Fuquay-Varina and does not meet the purpose and need. Alternative 12 consists of conservation measures. Therefore, Alternatives 11 and 12 are not included in the environmental impact analysis.

Table 4-1: Project Alternatives Nomenclature Used in Sections 4 and 5

Alternative Name	Alternative Nomenclature Used in Sections 4 and 5
Purchase Finished Water from Raleigh Water	1
Purchase Finished Water from Johnston County	2
Middle Creek Reservoir and Intake	3
Purchase Finished Water from City of Dunn	4
Purchase Finished Water from Harnett County	5
Jordan Lake Option A (Cary Intake)	6
Jordan Lake Option B (Triangle Water Partnership Intake)	7
Intake On and Return to Cape Fear River	8A
Intake on Cape Fear River and discharge to Kenneth Creek	8B
Purchase Finished Water from City of Sanford – North Route	9A
Purchase Finished Water from City of Sanford – South Route	9B
Purchase Finished Water from City of Sanford – North Route with Return of Water to Cape Fear River	9C
Purchase Finished Water from City of Sanford – North Route with Return of Water to Western Wake WRF	9D
Groundwater	10
Indirect and Direct Potable Reuse	11 [1]
Water Demand Management / Conservation	12 [1]
No Action	13

[1] *Alternative not assessed per Section 3 of this EIS.*

Anticipated areas of construction associated with pump stations, intake and discharge structures, raw water storage areas/reservoirs, areas associated with treatment facility sites, and easement widths associated with the pipe corridors were used to quantify existing conditions and the affected environment. For all alternatives except for Alternatives 1 and 8A, the assessed width of the corridor is 50 feet on each side of the proposed alignment. The assessed corridor for Alternative 1 widens to 200 feet south of the Dempsey E. Benton WTP where the finished water and raw water transmission mains run parallel for approximately 0.4 mile. The assessed corridor for Alternative 8A where the raw water transmission main and effluent force main run parallel for approximately 10.5 miles is 120 feet wide.

Table 4-2 provides the metrics used for the analysis (e.g., corridor length and acreage) specific to each alternative. Quantification of access roads, whether temporary or permanent, has not occurred for any of the alternatives. The well field associated with Alternative 10 consists of approximately 281,205 acres. Implementation of Alternative 10 will not require development of the entire 281,205-acre area; however, the location and size of the infrastructure associated with each individual well is not known at this time. Unless otherwise noted, quantifications provided for Alternative 10 include the resources located within the entire well field site. Figure 3-1 illustrates the components of each alternative.

Table 4-2: Project Length and Area per Alternative Used in Quantitative Analysis of Affected Environment

Alternative	Pipe Corridor Length, miles	Pipeline Corridor Area, acres	Booster Pump Station Area, acres	Raw Water Storage/ Reservoir, acres	WTP Area, acres	Raw Water Intake and Pump Station, acres	Other Infra-structure, acres [1]	Total Project Area, Acres
1	16.55	195	1	1,098	----	1	Elevated Water Tank, 6; WTP, 55	1,356
2	51.02	573	1	30	62	2	----	668
3	6.29	77	----	794	7	1	----	879
4	18.94	226	----	33	----	1	WTP, 40	300
5	13.28	162	----	----	----	1	WTP, 30	181
6	17.51	212	1	----	86	1	----	300
7	23.72	288	1	----	39	1	----	329
8A	30.78	275	----	----	45	1	WWTP, 46	367
8B	18.28	222	----	----	45	1	WWTP, 46	314
9A	16.25	197	1	----	32	----	----	198
9B	16.05	195	1	----	32	----	----	196
9C	35.2	457	1	----	32	----	WWTP, 46	536
9D	18.64	423	1	----	32	----	WWTP, 46	502
10 [2]	----	----	----	----	62	----	----	281,205

[1] *Other infrastructure includes upgrades to existing treatment facilities, discharge structures, and an elevated water tank and pump station associated with Alternative 1.*

[2] *Quantification of infrastructure components was not conducted as the wellfield is a concept level evaluation. However, all infrastructure is anticipated to be within the well field area.*

4.1 Topography and Geology

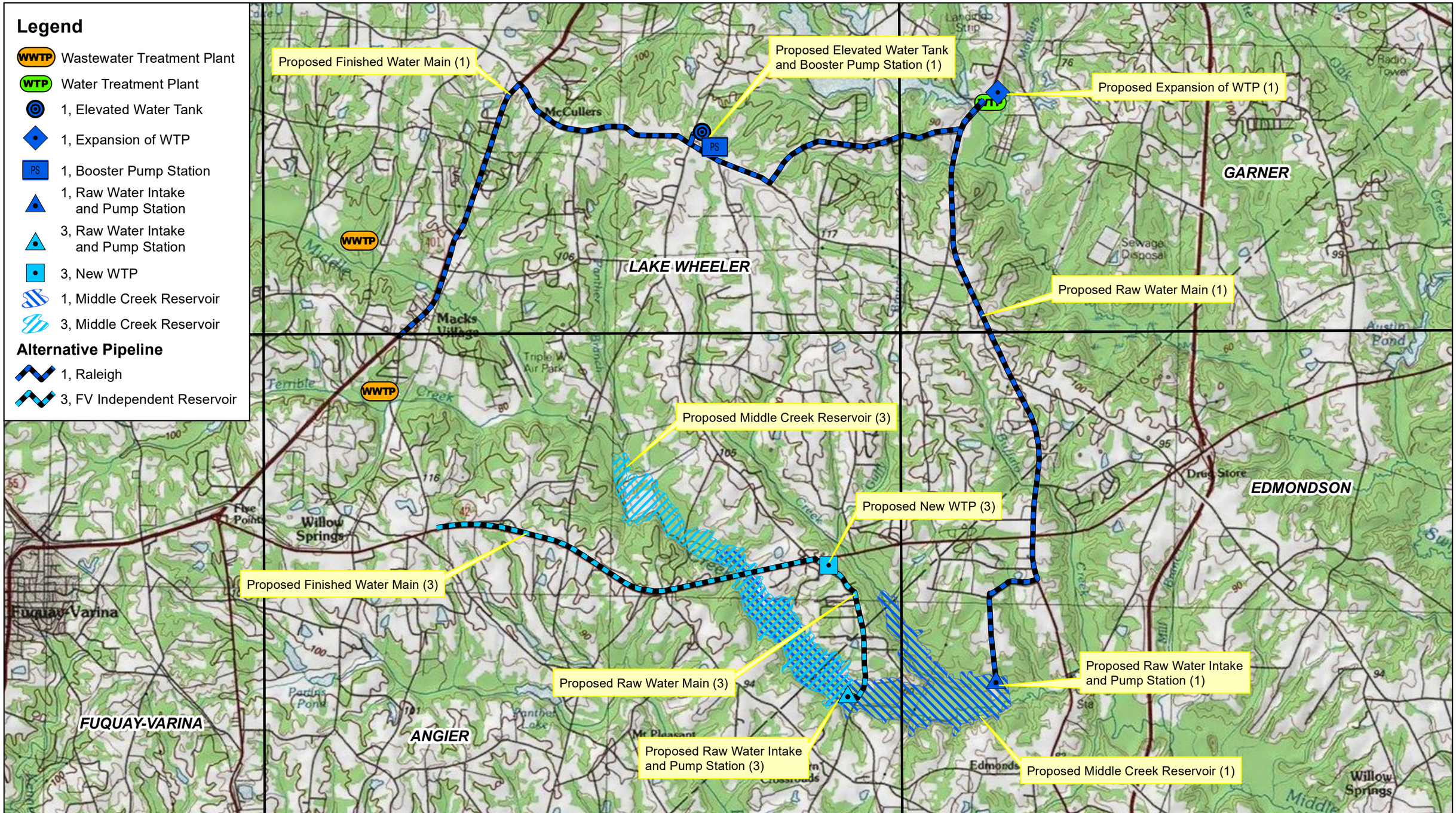
The project areas are situated in the Piedmont Upland section of the Piedmont physiographic province and the Sea Island section of the Coastal Plain physiographic province. Alternatives 1, 3, 6, 7, 9A, 9B, and 9D are in the Piedmont physiographic province and Alternatives 2, 4, 5, 8A, 8B, 9C, and 10 are in both the Piedmont and Coastal Plain physiographic provinces. The topography of the Piedmont physiographic province in the project areas consists of gently rolling hills and low ridges. The topography of the Inner Coastal Plain physiographic province consists of gently rolling hills and relatively flat areas.

The geology of the project areas varies due to the natural transition from the Piedmont to the Coastal Plain. Project areas within the Piedmont physiographic province are underlain by metamorphic rocks of the Carolina Slate Belt and sedimentary rocks of the Triassic Basins. Project areas within both the Piedmont and Coastal Plain physiographic provinces are underlain by intrusive rocks of the Raleigh Belt, sedimentary rocks of the Coastal Plain, and metamorphic rocks of the Eastern Slate Belt (DENR, 1999). An illustration of the physiographic province boundaries relative to the proposed alternatives can be found on Figure 3-1: Overview of Alternatives.

The project areas are located on the Merry Oaks, New Hill, Apex, Lake Wheeler, Garner, Moncure, Cokesbury, Fuquay-Varina, Angier, Edmondson, Powhatan, Selma, Kenly West, Mamers, Lillington, Coats, Benson, Princeton, Erwin, and Grantham, North Carolina USGS 7.5--minute Topographic Quadrangle Maps as illustrated in Figure 4-1. Elevations in the project areas range from approximately 70 feet MSL to 482 feet MSL. The minimum and maximum elevations in the project areas for each alternative are summarized in Table 4-3.

Table 4-3: Elevations per Alternative

Alternative	Minimum Elevation, feet MSL	Maximum Elevation, feet MSL
1	209	424
2	72	398
3	202	398
4	70	361
5	114	449
6	232	482
7	217	482
8A	112	430
8B	113	430
9A	160	477
9B	159	477
9C	112	477
9D	260	469



FUQUAY-VARINA north carolina

Hazen

Figure 4-1a: USGS Topographic Quadrangle Maps Alternatives 1 and 3

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

Legend

- WWTP — Wastewater Treatment Plant
- WTP — Water Treatment Plant
- PS — 2, Booster Pump Station
- 2, Raw Water Intake and Pump Station
- 2, New WTP
- 2, Raw Water Storage Facility

Alternative Pipeline

- 2, Johnston County

Proposed Finished Water Main

Proposed New WTP

Proposed Booster Pump Station

Proposed Raw Water Main

Proposed Raw Water Storage Facility, Raw Water Intake, and Pump Station

Proposed Raw Water Intake and Pump Station

LAKE WHEELER
GARNER
CLAYTON
FLOWERS
STANCILS CHAPEL
SELMA
KENLY WEST
POWHATAN
EDMONDSON
ANGIER
FUQUAY-VARINA
LILLINGTON
COATS
BENSON
FOUR OAKS
FOUR OAKS NE
PRINCETON
GRANTHAM
BUNNLEVEL
ERWIN
DUNN
PEACOCKS CROSSROADS
NEWTON GROVE NORTH

N W E S

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-1b: USGS Topographic Quadrangle Maps
Alternative 2
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Legend

- WWTP — Wastewater Treatment Plant
- WTP — Water Treatment Plant
- PS — 4, Booster Pump Station
- 4, Expansion of WTP and New Raw Water Intake, Pump Station, and Raw Water Storage Facility
- 5, Expansion of WTP, Withdrawal Increase, and New Raw Water Storage Facility
- 8A and 8B, Expansion of WWTP
- 8A and 8B, New Raw Water Intake and Pump Station
- 8A and 8B, New WTP
- 8A, Expansion of Wastewater Allocation

Alternative Pipeline

- 4, Dunn
- 5, Harnett County
- 8A and 8B, Cape Fear River Intake
- 8A, Cape Fear Effluent FM
- 8B, Cape Fear Effluent FM

Proposed WWTP expansion (8A and 8B)

Proposed Effluent Discharge into Kenneth Creek (8B)

Proposed New WTP (8A and 8B)

Proposed Finished Water Main (5)

Proposed Finished Water Main (5) and Proposed Raw Water Main (8A and 8B)

Proposed Finished Water Main (4)

Proposed WTP expansion, Raw Water Intake expansion, and Raw Water Storage Facility (5)

Proposed New Raw Water Intake and Pump Station (8A and 8B)

Proposed Expansion of WW Allocation and Effluent Discharge into Cape Fear River (8A)

Proposed WTP expansion, New Raw Water Intake, and Raw Water Storage Facility (4)

FUQUAY-VARINA
COKESBURY
ANGIER
EDMONDSON
POWHATAN
MAMERS
LILLINGTON
COATS
BENSON
FOUR OAKS
BROADWAY
OLIVIA
ANDERSON CREEK
ERWIN
DUNN
PEACOCKS CROSSROADS
BUNNLEVEL
RAVEN ROCK STATE PARK

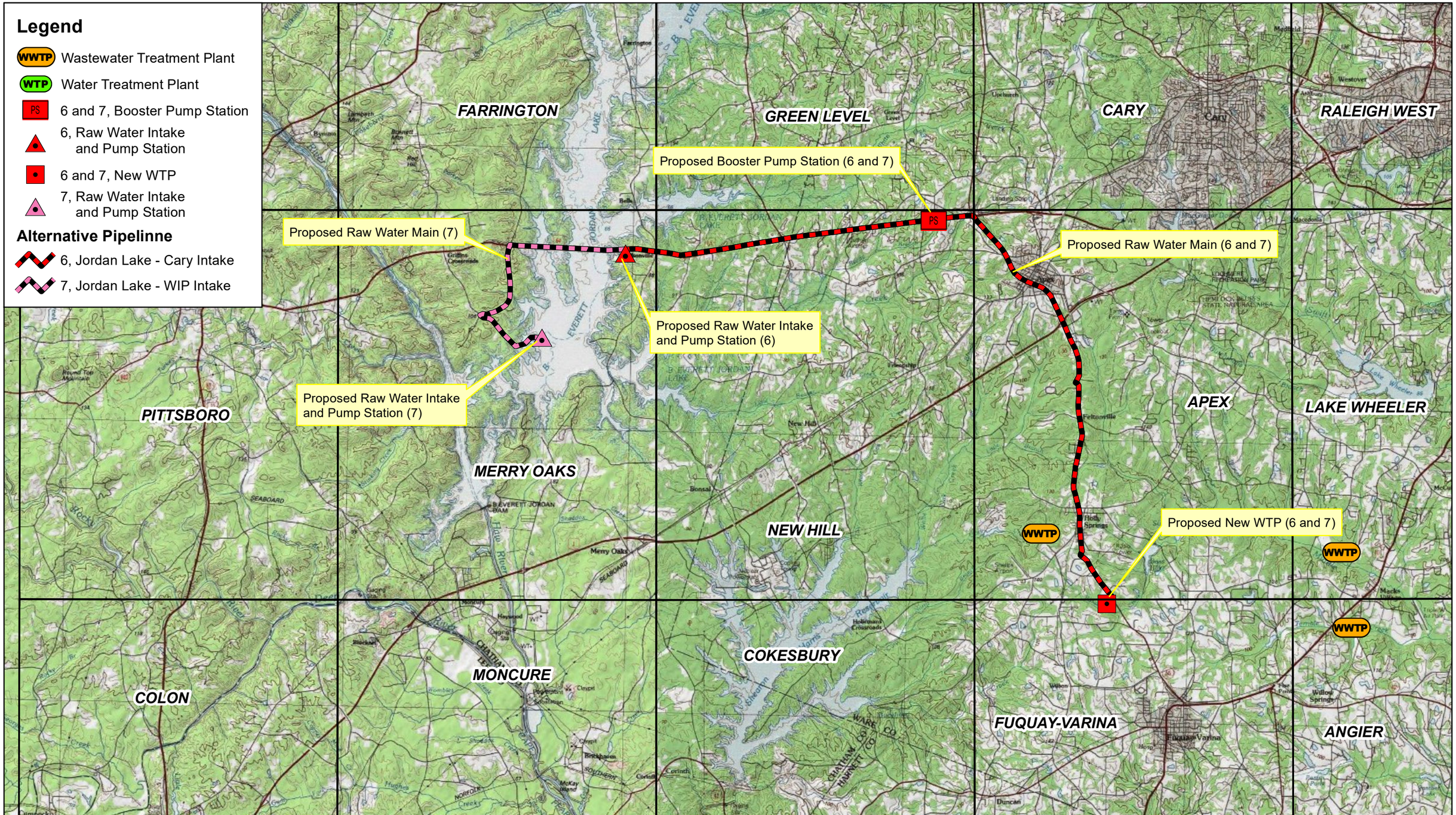
N W E S

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-1c: USGS Topographic Quadrangle Maps
Alternatives 4, 5, 8A, and 8B
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River



FUQUAY-VARINA
north carolina

Hazen

Figure 4-1d: USGS Topographic Quadrangle Maps
Alternatives 6 and 7
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Legend

- WWTP — Wastewater Treatment Plant
- WTP — Water Treatment Plant
- PS — 9A, 9B, 9C, and 9D Booster Pump Station
- 9C and 9D Expansion of WWTP and WW Allocation

Alternative Pipeline

- 9A and 9C, Sanford - North
- 9B, Sanford - South
- 9C, Cape Fear Effluent FM
- 9D, Sanford - North Effluent FM

Proposed Effluent Force Main (9D)

Proposed Booster Pump Station (9A, 9B, 9C, and 9D)

Proposed Finished Water Main (9A, 9B, 9C, and 9D)

Proposed Finished Water Main (9A, 9C, and 9D)

Proposed Finished Water Main (9B)

Proposed WWTP Improvements (9C and 9D)

Proposed Effluent Force Main (9C)

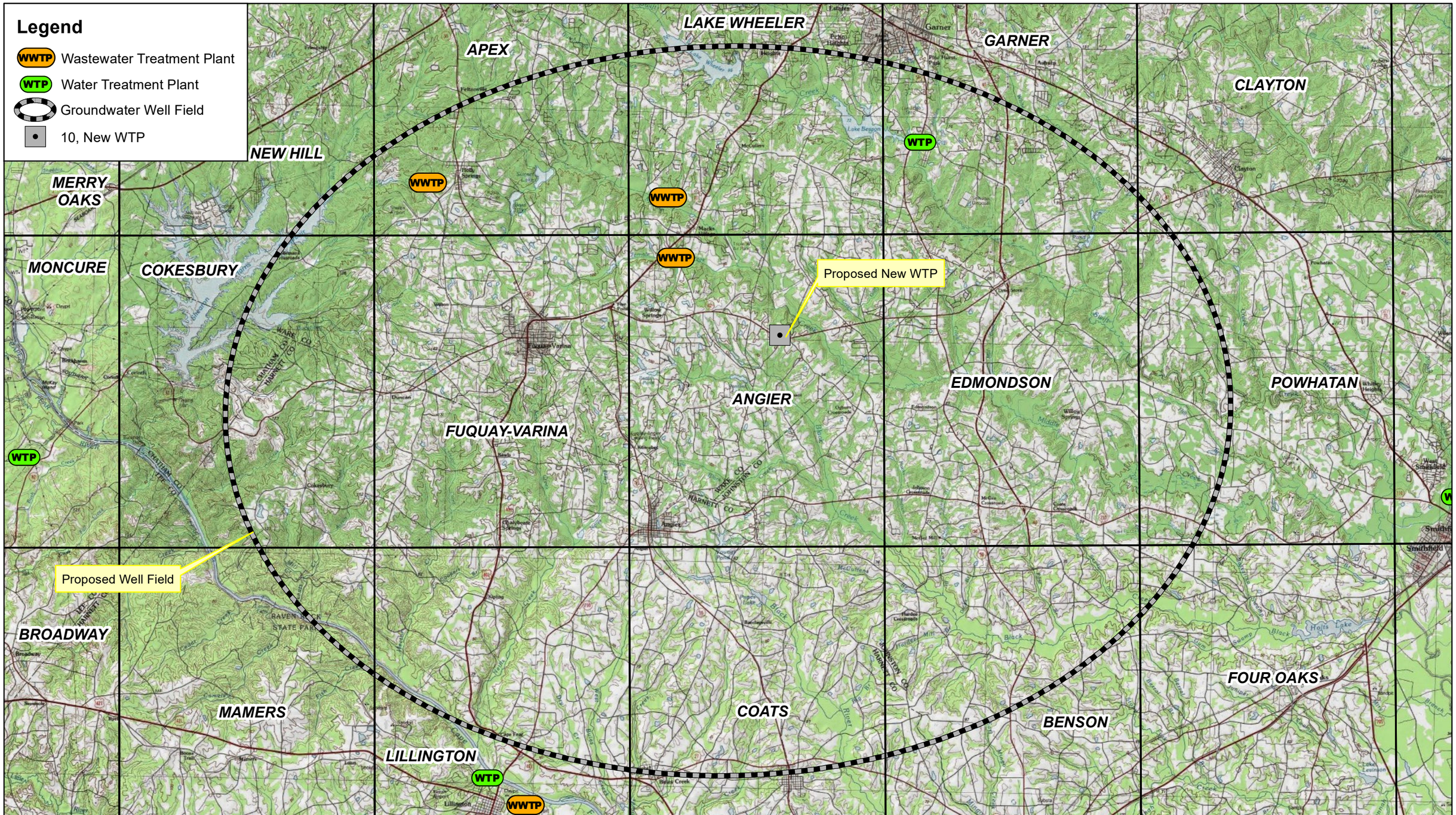
MERRY OAKS · NEW HILL · APEX · LAKE WHEELER · GARNER · FUQUAY-VARINA · COLON · MONCURE · COKESBURY · ANGIER · EDMONDSON · MAMERS · LILLINGTON · SANFORD · BENSON

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-1e: USGS Topographic Quadrangle Maps
Alternatives 9A, 9B, 9C, and 9D
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River



N W E S

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-1f: USGS Topographic Quadrangle Maps
Alternative 10
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

4.2 Soils

The published soil survey for each county and the Natural Resources Conservation Service (NRCS) Web Soil Survey contain general and detailed information relative to the soils underlying Chatham, Harnett, Johnston, Lee, and Wake Counties. Across the five counties, the general soil types are separated into 26 soil associations based on landscape position and underlying geology or parent material. The soil associations that underlie the study areas of the proposed alternatives described in Table 4-4 are based on the information provided in the Web Soil Survey.

Soil associations are divided into soil mapping units, which allow for detailed descriptions of the soils and the properties at a specific location. The detailed soil types, or soil-mapping units, are delineated, mapped, and described by NRCS and available through the Web Soil Survey (USDA, 2021). The number of soil types present in the project area is approximately 130. Due to the alternatives being located in geologically similar locations within the landscape, the soil types are common for the majority of alternatives.

Table 4-4: Soil Associations per Alternative

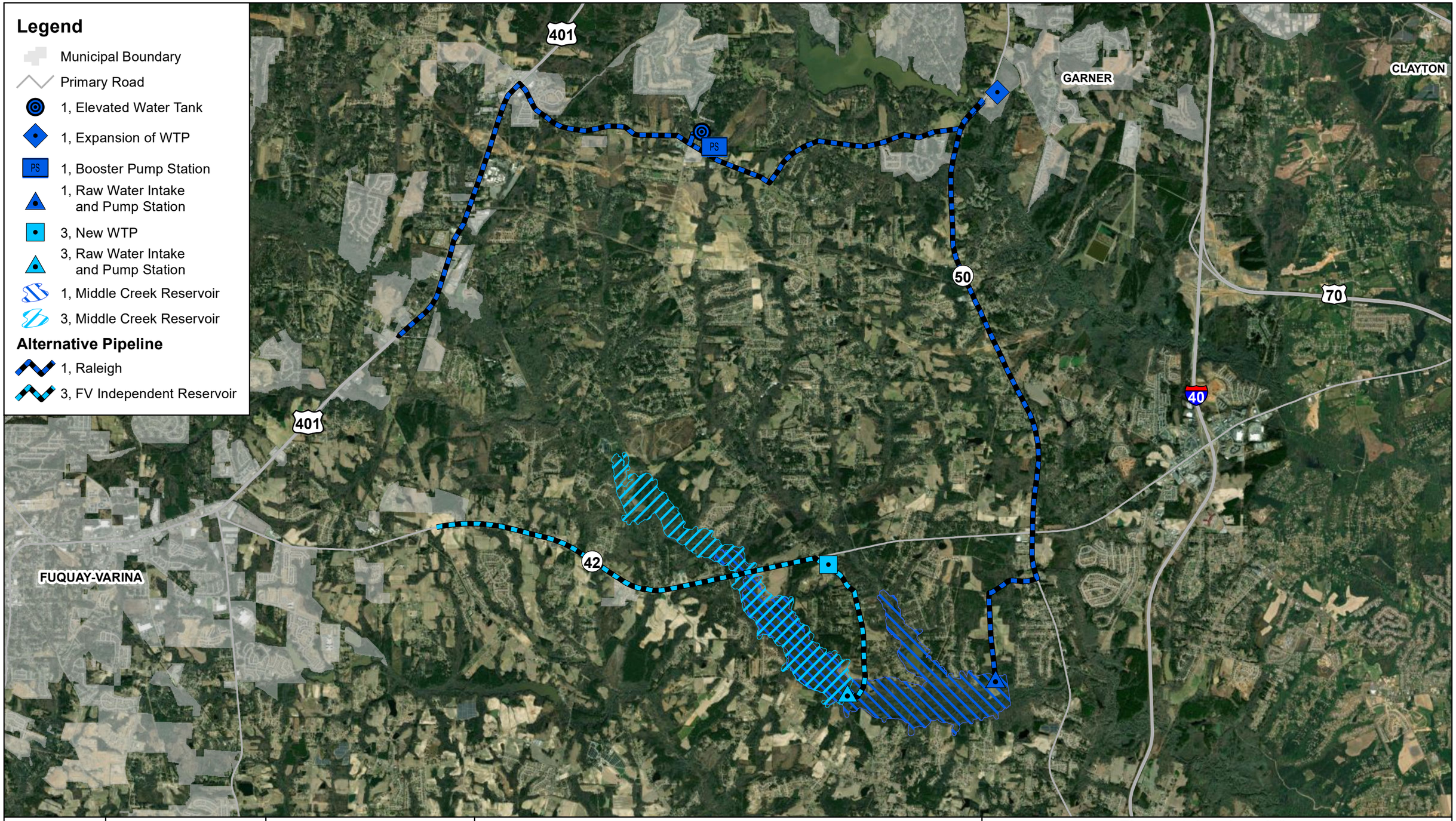
Soil Association	Alternative	Slope	Depth	Drainage	Subsoil / Parent Material (PM)	County
Altavista-State-Augusta	2	Dominantly nearly level	----	Well drained to poorly drained, subject to flooding	----	Johnston
Bibb-Wehadkee	5, 8A, 8B, 9C	Nearly level	----	Poorly drained	Loamy and sandy subsoil	Harnett
Cecil-Appling	1, 5, 7, 8A, 8B, 9A, 9B, 9C, 9D	Gently sloping to steep	Deep	Well drained	Firm clay loam to clay subsoil/ granite, gneiss, and schist PM	Wake
Cecil-Pacolet	9A, 9B, 9C, 9D	Gently sloping to steep	Very deep	Well drained	Predominately clayey subsoil	Chatham
Cecil-Pacolet-Durham	9A, 9B, 9C, 9D	Gently sloping to steep	----	Well drained	Clayey and loamy subsoil	Lee
Cecil-Pacolet-Nason	2, 3, 5, 8A, 8B, 9C	Dominantly gently sloping to moderately steep	----	Well drained, moderately well drained and poorly drained	----	Johnston, Harnett
Chewacla-Wehadkee-Congaree	9A, 9C, 9D	Nearly level	----	Well drained to poorly drained	Loamy subsoil	Lee
Cid-Nanford-Lignum	7	Gently sloping to steep	Moderately deep to deep	Somewhat poorly drained to well drained	Clayey subsoil	Chatham
Creedmoor-Green Level	6, 7, 9A, 9B, 9C, 9D	Gently sloping to moderately steep	Very deep	Somewhat poorly drained to moderately well drained	Firm, moderately plastic to very firm, very plastic clay subsoil	Chatham

Table 4-4: Soil Associations per Alternative

Soil Association	Alternative	Slope	Depth	Drainage	Subsoil / Parent Material (PM)	County
Creedmoor-White Store	6, 7, 9A, 9B, 9C, 9D	Gently sloping to hilly	Deep and moderately deep	Moderately well drained	Very firm clayey subsoil/ sandstone, shale, and mudstone PM	Wake, Lee
Dothan-Fuquay-Gilead	4, 5, 8A, 8B, 9C	Nearly level to strongly sloping	----	Well drained and moderately well drained	Loamy or clayey subsoil	Harnett
Fuquay-Dothan	9A, 9B, 9C, 9D	Nearly level to sloping	----	Well drained	Loamy subsoil	Lee
Georgeville-Badin-Nanford	7	Gently sloping to steep	Very deep, deep, moderately deep	Well drained	Clayey subsoil	Chatham
Gilead-Uchee-Bibb	3	Dominantly gently sloping to moderately steep	----	Well drained, moderately well drained, and poorly drained	----	Johnston
Herndon-Georgeville	6, 7	Gently sloping to moderately steep	Deep	Well drained	Friable silty clay loam to clay subsoil/phyllite (Carolina slates) PM	Wake
Mayodan-Granville-Creedmoor	6, 7, 9D	Gently sloping to moderately steep	Deep or moderately deep	Well-drained and moderately drained	Friable sandy clay loam to very firm clay subsoil/ sandstone, shale and mudstone PM	Wake
Norfolk-Goldsboro-Rains	2, 3	Dominantly nearly level and gently sloping	----	Well drained to poorly drained	----	Johnston
Norfolk-Wagram-Rains	4, 5, 8A, 8B, 9C	Nearly level to strongly sloping	----	Well drained and poorly drained	Loamy subsoil	Harnett
Peawick-Riverview-Mattaponi	9A, 9B, 9C, 9D	Nearly level to strongly sloping	Very deep	Moderately well drained or well drained	Clayey or loamy subsoil	Chatham
Rains-Goldsboro-Lynchburg	2	Dominantly nearly level and gently sloping	----	Well drained to poorly drained	----	Johnston
Roanoke-Wickham-Altavista	4	Nearly level to strongly sloping	----	Well drained to poorly drained	Loamy or clayey subsoil	Harnett
Tetotum-Wickham-State	9A, 9C, 9D	Nearly level to sloping	----	Well drained to moderately well drained	Loamy subsoil	Lee
Wagram-Blanton-Bonneau	2, 3	Dominantly nearly level and gently sloping	----	Well drained to poorly drained	----	Johnston

Table 4-4: Soil Associations per Alternative

Soil Association	Alternative	Slope	Depth	Drainage	Subsoil / Parent Material (PM)	County
Wagram-Norfolk	1, 2, 3, 4, 5, 8A, 8B, 9A, 9B, 9C, 9D	Nearly level to sloping	Very deep	Somewhat excessively drained and well drained	Friable sandy loam to sandy clay loam subsoil/Coastal Plain sediment PM	Wake
Wedowee	2	Dominantly gently sloping to moderately steep	Very deep	Well drained, moderately well drained and poorly drained	Clayey subsoil	Johnston
Wehadkee-Bibb-Chewacla	2, 3	Dominantly nearly level	----	Well drained to poorly drained, subject to flooding	----	Johnston



N
W E
S

SCALE
1 inch = 1 mile
0 0.5 1
Mile

FUQUAY-VARINA
north carolina

Hazen

Figure 4-2a: Land Cover
Alternatives 1 and 3
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

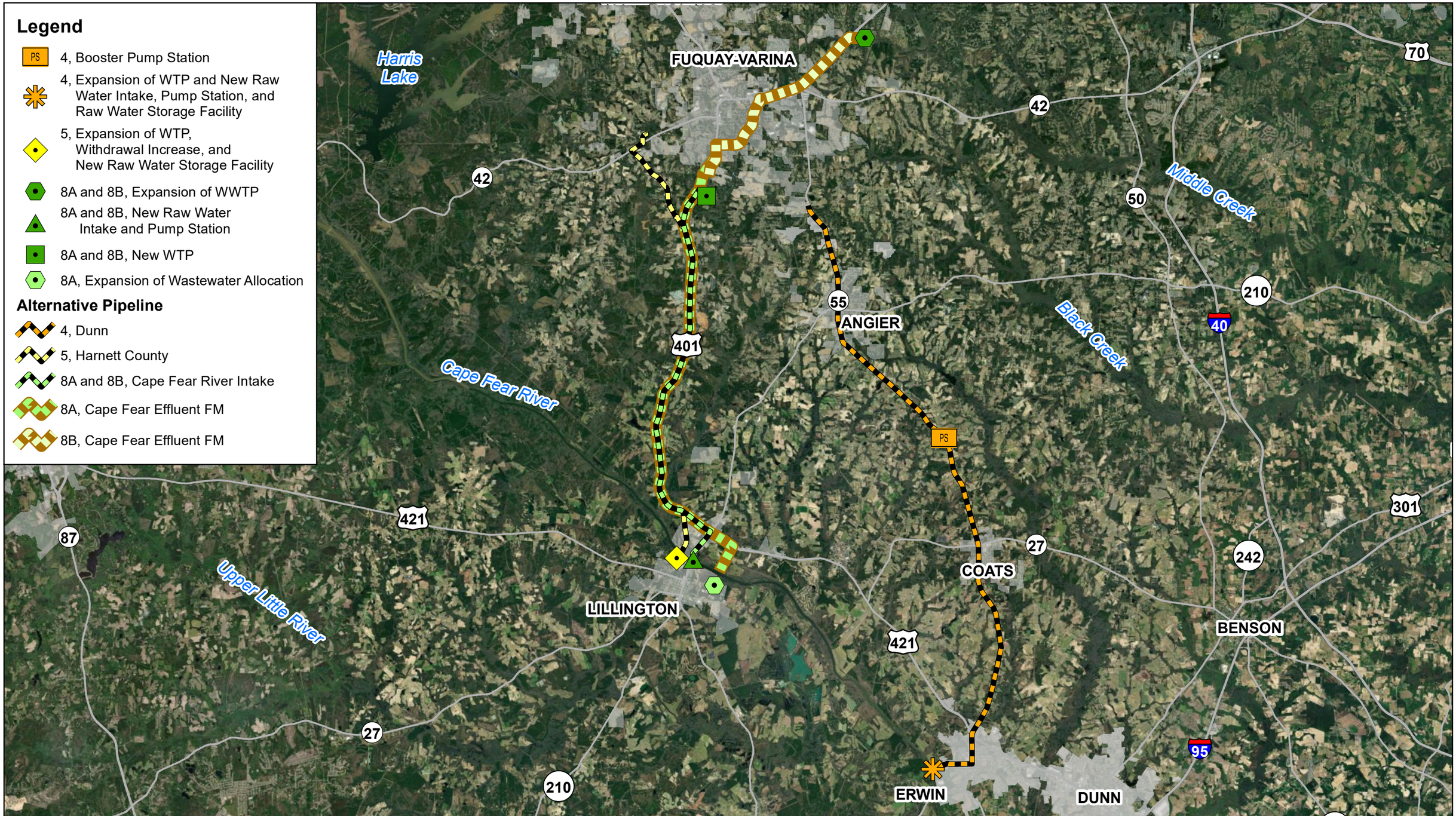
Figure 4-2b: Land Cover
Alternative 2
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Legend

- PS — 4, Booster Pump Station
- 4, Expansion of WTP and New Raw Water Intake, Pump Station, and Raw Water Storage Facility
- 5, Expansion of WTP, Withdrawal Increase, and New Raw Water Storage Facility
- 8A and 8B, Expansion of WWTP
- 8A and 8B, New Raw Water Intake and Pump Station
- 8A and 8B, New WTP
- 8A, Expansion of Wastewater Allocation

Alternative Pipeline

- 4, Dunn
- 5, Harnett County
- 8A and 8B, Cape Fear River Intake
- 8A, Cape Fear Effluent FM
- 8B, Cape Fear Effluent FM



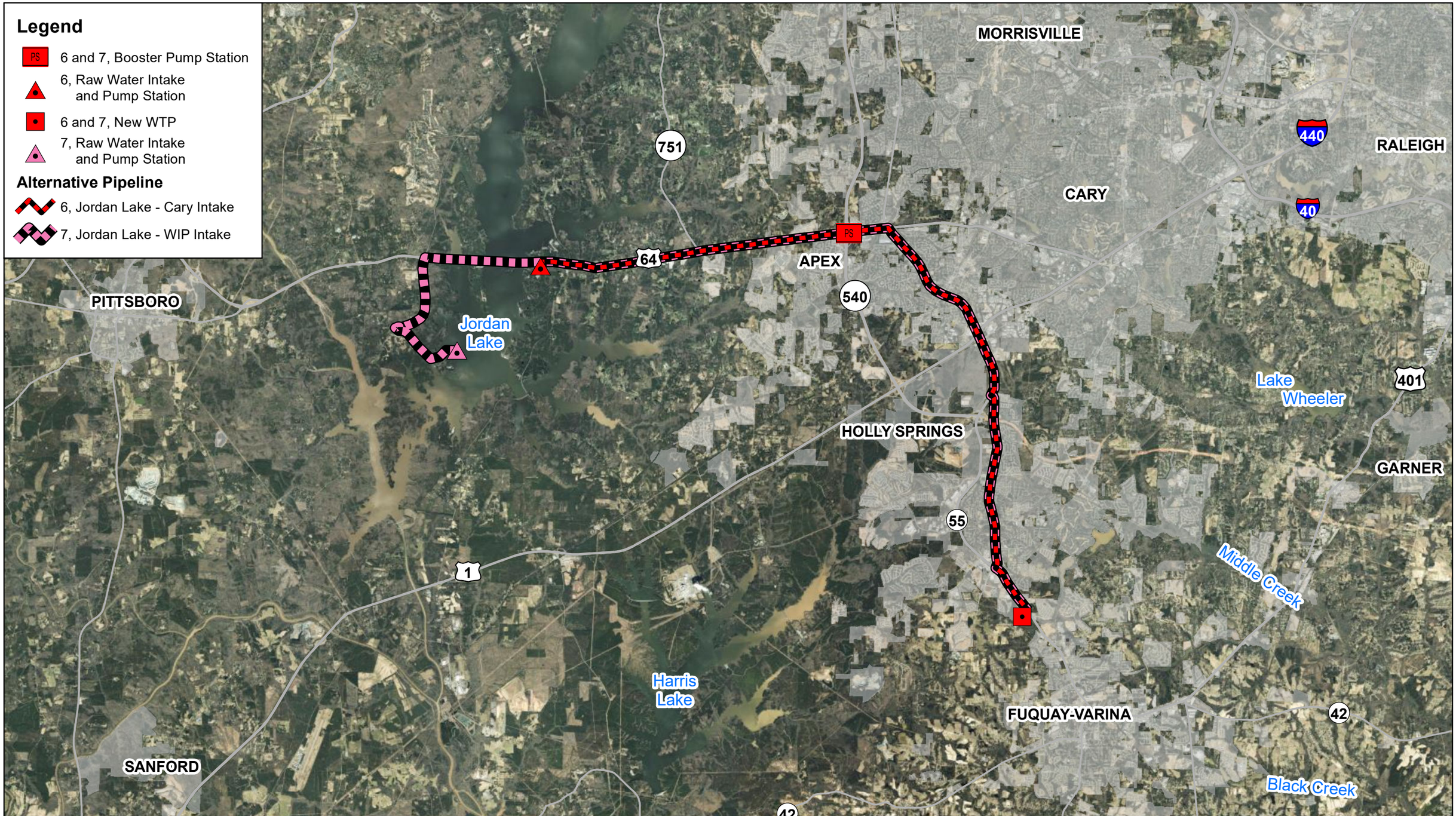
N W E S

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-2c: Land Cover
Alternatives 4, 5, 8A, and 8B
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River



FUQUAY-VARINA
north carolina

Hazen

Figure 4-2d: Land Cover
Alternatives 6 and 7
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Legend

- 9A, 9B, 9C, and 9D Expansion of WTP
- PS — 9A, 9B, 9C, and 9D Booster Pump Station
- 9C and 9D Expansion of WWTP and WW Allocation

Alternative Pipeline

- 9A and 9C, Sanford - North
- 9B, Sanford - South
- 9C, Cape Fear Effluent FM
- 9D, Sanford - North Effluent FM

APEX
GARNER
HOLLY SPRINGS
FUQUAY-VARINA
ANGIER
COATS
LILLINGTON
SANFORD
BROADWAY
BENSON
Harris Lake
Harris Lake
Middle Creek
Black Creek
Cape Fear River
Upper Little River
PS
1
55
401
42
15
50
210
40
78
421
87
27
242

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-2e: Land Cover
Alternatives 9A, 9B, 9C, and 9D
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Figure 4-2f: Land Cover
Alternative 10
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

4.3 Land Use

Land use defines a community's physical form and function and provides a framework for infrastructure-related decisions, including transportation, economic development, public utilities, community facilities, parks, and environmental protection. Land Use Plans or other planning documents have been prepared to guide growth and development in the municipalities and counties within the project areas.

4.3.1 Zoning

The zoning information presented herein is compiled from zoning classifications obtained from public access GIS data files for the Towns of Apex, Fuquay-Varina, Garner, Holly Springs, Clayton, and Smithfield, as well as Chatham, Harnett, Johnston, Lee, and Wake Counties, North Carolina. A discussion of the zoning classifications within the study area is provided in the following sections. Quantification of zoning districts for each alternative is not provided.

The proposed raw water transmission corridor alternatives cross fourteen municipal and five county zoning jurisdictions. The primary zoning classifications associated with the corridor alternatives include residential, commercial, industrial, and agricultural. Additional zoning classifications representing smaller portions of the corridor alternatives include office and apartments, manufacturing, institutional, special use and conditional, public and semi-public lands, wooded and undeveloped areas, and parks, recreation, and open space districts. The proposed water treatment facility sites are proposed to be located in areas that are zoned as low-density residential or rural.

4.3.2 Land Use Plans

Land Use Plans or other similar planning documents have been developed and approved by several municipalities and counties in which a portion of the project is located. Some of the planning documents provide a general goal or set of goals for each land use type or zoning district in the jurisdiction, while others provide greater detail, including policies and strategies for achieving the land use goals as well as maps depicting the areas of the jurisdiction's purview to be targeted for each development or preservation type. Common elements of the land use planning frameworks include the encouragement of well-planned growth while providing economic development, public facilities and services, intergovernmental coordination and cooperation, housing and neighborhoods, and transportation and protecting agriculture, open space, and environmental resources. The Counties of Chatham, Harnett, Johnston, Lee, and Wake along with the municipalities of Apex, Clayton, Fuquay-Varina, Garner, Holly Springs, Lillington, Princeton, Selma, and Wilsons Mill have adopted a land use planning framework.

4.3.3 Existing Land Use

The evaluation of existing land use is typically based on the information and mapping provided in the local government's Land Use Plan. However, for the proposed project area, limited data on the existing land uses within the proposed project footprints is available from the local municipalities and counties through published or publicly available mapping, or other documentation. While several jurisdictions provide an

existing land use map, they are at a scale that is difficult to accurately assess existing land uses in specific project corridors.

Where available and usable relative to the proposed project, published land use data was evaluated as the primary source of information, supplemented by aerial photography. Analysis of land use was performed using GIS to correlate the project areas with Google Earth aerial photography. Areas used for agricultural purposes were identified as well as areas developed for residential, industrial, and commercial uses. Undeveloped, wooded areas may include areas that are used for timberland, open space, riparian buffers, and those that are simply undeveloped.

4.3.3.1 Alternative 1

The pipe corridor associated with this alternative will follow NCDOT roadways and may be located in the right-of-way. Existing land uses associated with the proposed pipe corridors for this alternative are predominantly woodlands and agricultural with small areas of residential.

4.3.3.2 Alternative 2

Alternative 2 will require the use of existing roadway easements. The pipe corridors associated with this alternative will follow NCDOT roadways for the majority of their length and may be located in the ROW. In addition to the roadway, the areas within and abutting the pipe corridor associated with Alternative 2 are predominantly woodlands with some small areas of agricultural lands.

4.3.3.3 Alternative 3

Alternative 3 primarily follows an existing overhead utility easement. Areas associated with Alternative 3 located outside the roadway easement include woodlands and agriculture. Small pockets of residential and institutional development are also present within the pipe corridor for this alternative.

4.3.3.4 Alternative 4

The pipe corridor of Alternative 4 primarily follows the Highway 55 corridor. Within the pipe corridor, land uses include undeveloped woodland and agricultural areas and institutional, residential, and commercial development. As there are existing buried utility lines along some of the same length of Highway 55 as the proposed corridor, the area of new utility easement needed for Alternative 4 is unknown at this time. The areas abutting the roadways are dominated by woods and agricultural areas.

4.3.3.5 Alternative 5

The pipe corridor of Alternative 5 follows U.S. 401, N.C. 42, and State Route 1101 along the majority of the pipe distance. The southernmost segment of the pipe corridor parallels a railroad corridor through an undeveloped area. The pipe corridor crosses the railroad easement three times in the northern half of the corridor.

4.3.3.6 Alternative 6

The pipe corridor of Alternative 6 follows the existing roadways of Highway 64 and Highway 55. These roadways are abutted by wooded and residential areas. Acquisition of utility easement is expected to be necessary for the pipe corridor and associated infrastructure. Existing easements may be present in the footprint of Alternative 6; therefore, easement acquisition areas are not known at this time.

4.3.3.7 Alternative 7

Alternative 7 follows existing roadway corridors. The pipe corridor will follow an existing utility easement. Acquisition of additional easement may be required to accommodate the proposed pipe. The lands adjacent to the roadway and within the proposed pipe corridor include woodlands and areas that are in use for agricultural and residential purposes.

4.3.3.8 Alternative 8A

Alternative 8A pipe corridor follows existing roads from the Cape Fear River in Lillington to the Terrible Creek WWTP in the Town of Fuquay-Varina. The alternative follows roadway corridors that are abutted by woodlands, residential development, and small areas of agricultural lands. Acquisition of utility easement is expected to be required for the proposed alternative.

4.3.3.9 Alternative 8B

The Alternative 8B pipe corridor is mostly the same as the Alternative 8A corridor. The pipe corridor is primarily positioned in roadway easements with mainly wooded and agricultural areas surrounding the existing easements. Acquisition of utility easement is expected to be required for the pipe corridor and associated infrastructure.

4.3.3.10 Alternative 9A

Alternative 9A follows existing roads, ranging from secondary roads to major highways. The proposed pipe corridor is partially located within the existing NCDOT ROW. Wooded areas are common within the corridor. Acquisition of utility easement is expected to be required for the alternative.

4.3.3.11 Alternative 9B

Alternative 9B follows existing roads and goes through dominantly woodland areas. The proposed pipe corridor is partially located within the existing NCDOT ROW. Other land uses within the proposed pipe corridor are predominantly wooded areas. Acquisition of utility easement is expected to be required for the alternative.

4.3.3.12 Alternative 9C

The Alternative 9C water main follows existing roads, ranging from secondary roads to major highways and is partially located within existing NCDOT ROW. Wooded areas are common within the water main corridor. The effluent force main follows existing roads from the Terrible Creek WWTP in the Town of Fuquay-Varina to the Cape Fear River in Lillington. The effluent force main follows roadway corridors that are abutted by woodlands, residential development, and small areas of agricultural lands. Acquisition of utility easement is expected to be required for the alternative.

4.3.3.13 Alternative 9D

Alternative 9D includes all areas associated with Alternative 9A. The effluent force main corresponding with Alternative 9D follows the existing roads from Terrible Creek WWTP in the Town of Fuquay-Varina to Western Wake Regional WRF in Cary. The effluent force main follows roadway that are abutted by woodlands, residential development, and areas of commercial development. The pipe corridor will cross existing railroad tracks, south of Broad Street, on N. Ennis Street. Acquisition of utility easement is expected to be required for the pipe corridor and associated infrastructure.

4.3.3.14 Alternative 10

Alternative 10 includes the proposed groundwater well field. The well field area includes portions or all of several communities including the Towns of Fuquay-Varina, Holly Springs, Willow Springs, and Angier. Within developed areas of Alternative 10, there are residential structures, commercial buildings, and industrial and institutional facilities. Land in rural portions of the well field is dominated by agricultural and forested/undeveloped areas. Areas in which wells may be sited within the well field include undeveloped/wooded areas, areas in agriculture use, large acre parcels with minimal development, municipal/public lands with undeveloped areas.

4.3.4 Land Cover

Land cover describes the type of vegetation and the intensity of the development of an area. Primary classes of land cover include forested areas, agricultural lands, and developed cover. The primary classes are further divided into specific types, which may be defined by the vegetative composition of a forested or herbaceous area, the specific agricultural use, or the intensity of the development or improvement. For the purposes of this EIS, land cover was analyzed at the primary classification level. Land cover in the project areas, excluding the well field area, is summarized in Table 4-5 and illustrated in Figure 4-3.

Table 4-5: Land Cover in Project Area

Project Component	Alternative	Undeveloped, Wooded, %	Agricultural Use, %	Developed, %
Pipe corridor	1	1%	2%	97%
	2	2%	3%	95%
	3	2%	1%	97%
	4	2%	1%	97%
	5	2%	1%	97%
	6	1%	----	99%
	7	3%	----	97%
	8A	5%	2%	93%
	8B	5%	----	95%
	9A	15%	----	85%
	9B	55%	----	45%
	9C	10%	1%	89%
	9D	15%	----	85%
Pump station / booster pump station	1	47%	48%	5%
	2	30%	50%	20%
	3	100%	----	----
	4	70%	----	30%
	6	90%	----	10%
	7	90%	----	10%
	8A	97%	----	3%
	8B	97%	----	3%
	9A	85%	15%	----
	9B	85%	15%	----
	9C	90%	----	2%
	9D	85%	----	2%
Raw water storage/ reservoir	1	95%	1%	4%
	2	19%	80%	1%
	3	95%	2%	3%
	4	95%	1%	4%
Other infrastructure	1	47%	48%	5%
	5	5%	----	95%
	8A	65%	25%	10%
	8B	75%	----	25%
WTP / WWTP	1	65%	----	35%
	2	30%	45%	25%
	3	65%	2%	33%
	4	60%	----	40%
	5	5%	----	95%

Table 4-5: Land Cover in Project Area

Project Component	Alternative	Undeveloped, Wooded, %	Agricultural Use, %	Developed, %
	6	80%	5%	15%
	7	95%	----	5%
	8A	100%	----	----
	8B	100%	----	----
	9A	30%	----	70%
	9B	30%	----	70%
	9C	30%	----	70%
	9D	30%	----	70%

[1] *Land cover was not quantified for Alternative 10.*

Legend

- Trail
- Bike Route
- State-Owned Land
- Federal Land
- Gameland
- Significant Natural Heritage Area
- State Park
- Open Space
- 1, Elevated Water Tank
- 1, Expansion of WTP
- 1, Booster Pump Station
- 1, Raw Water Intake and Pump Station
- 3, Raw Water Intake and Pump Station
- 3, New WTP
- 1, Middle Creek Reservoir
- 3, Middle Creek Reservoir

Alternative Pipeline

- 1, Raleigh
- 3, FV Independent Reservoir

Lake Benson
GARNER
Middle Creek
Black Creek
ANGIER
401
50
70
40
42
PS

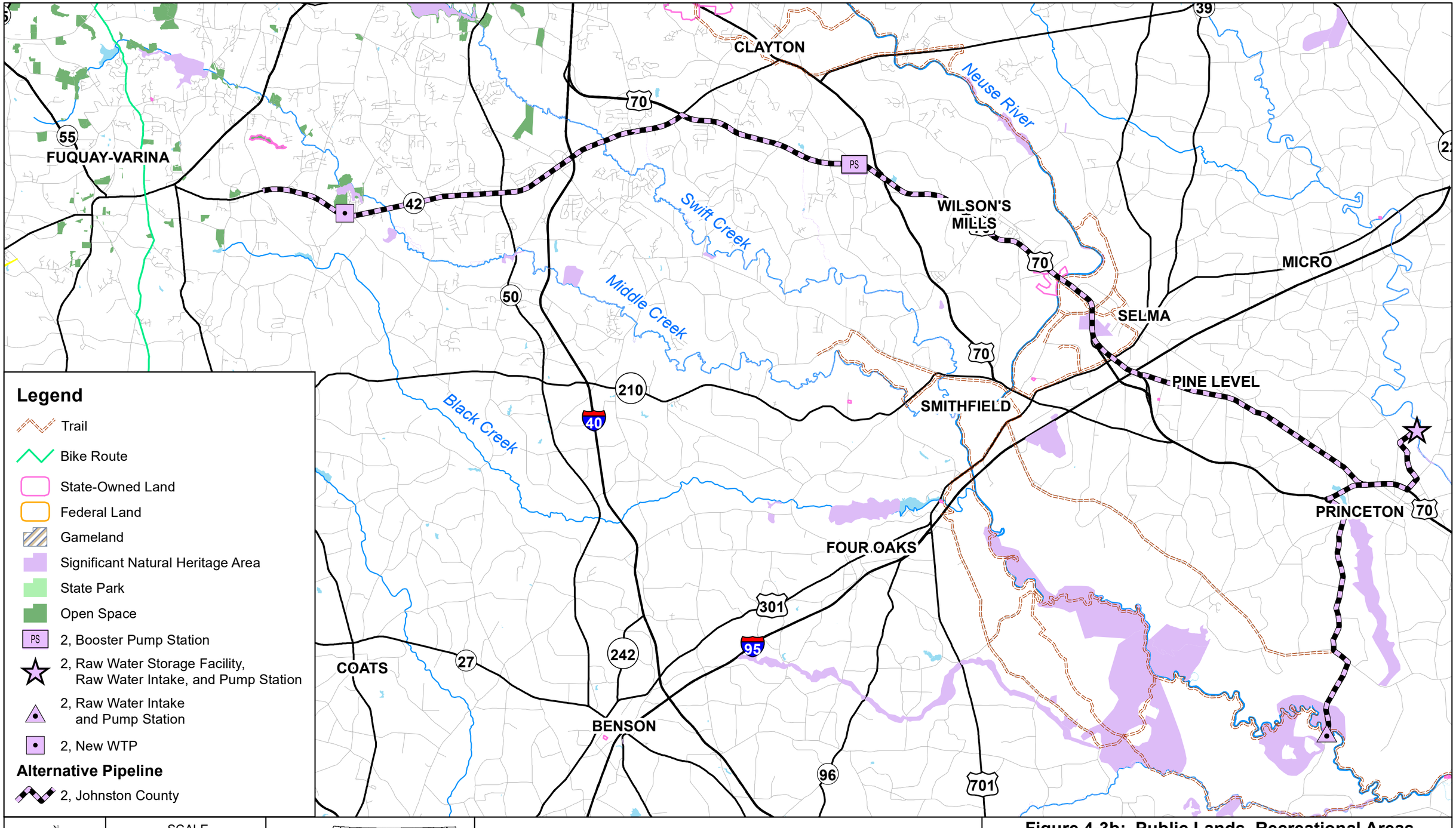
N W E S

SCALE
1 inch = 1 mile
0 0.5 1
Mile

FUQUAY-VARINA
north carolina

Hazen

Figure 4-3a: Public Lands, Recreational Areas, and State Natural Areas - Alternatives 1 and 3
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River



FUQUAY-VARINA north carolina

Hazen

Figure 4-3b: Public Lands, Recreational Areas, and State Natural Areas - Alternative 2

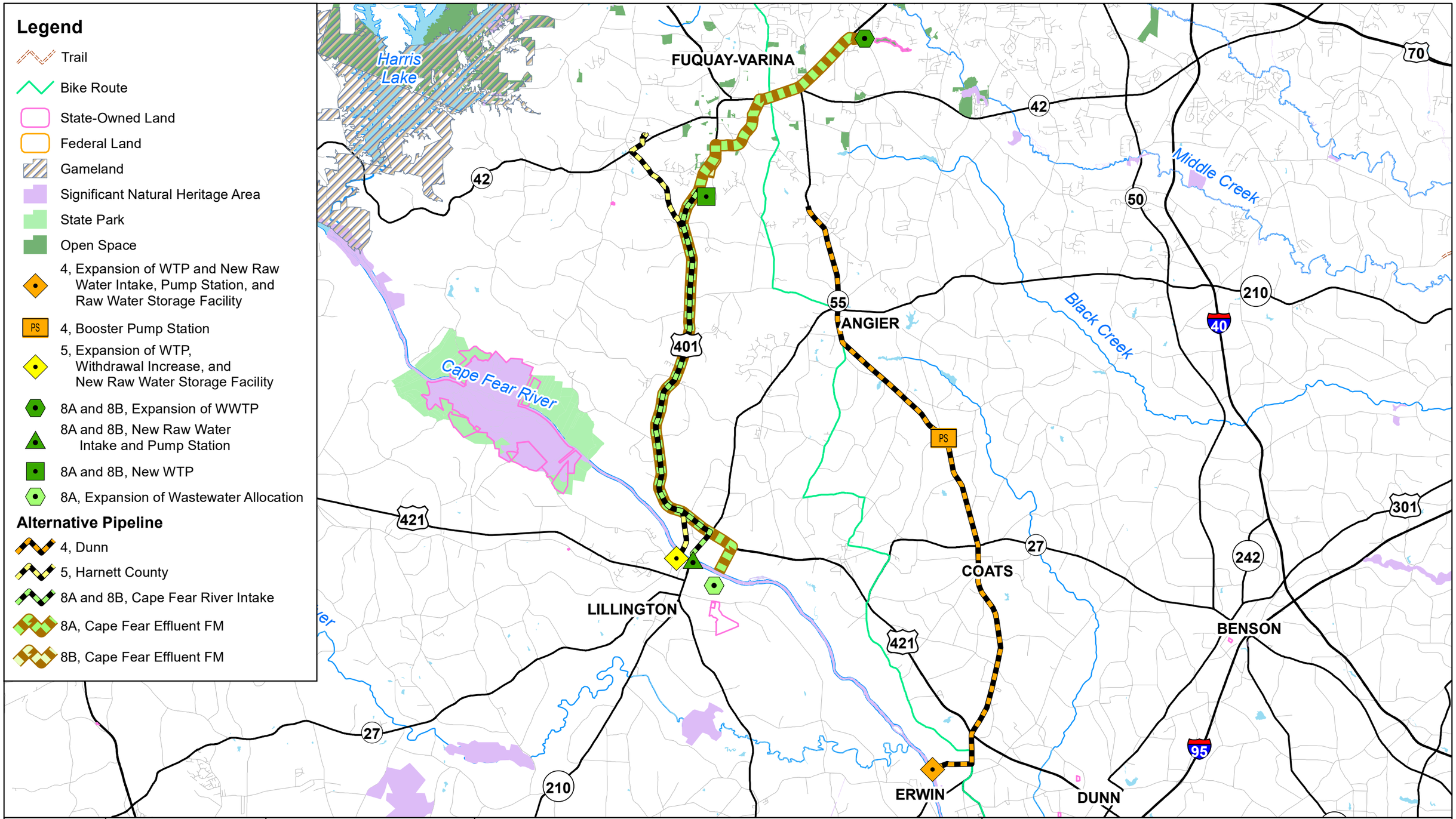
Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

Legend

- Trail
- Bike Route
- State-Owned Land
- Federal Land
- Gameland
- Significant Natural Heritage Area
- State Park
- Open Space
- 4, Expansion of WTP and New Raw Water Intake, Pump Station, and Raw Water Storage Facility
- PS 4, Booster Pump Station
- 5, Expansion of WTP, Withdrawal Increase, and New Raw Water Storage Facility
- 8A and 8B, Expansion of WWTP
- 8A and 8B, New Raw Water Intake and Pump Station
- 8A and 8B, New WTP
- 8A, Expansion of Wastewater Allocation

Alternative Pipeline

- 4, Dunn
- 5, Harnett County
- 8A and 8B, Cape Fear River Intake
- 8A, Cape Fear Effluent FM
- 8B, Cape Fear Effluent FM



N W E S

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-3c: Public Lands, Recreational Areas, and State Natural Areas - Alternatives 4, 5, 8A, and 8B
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Legend

- Trail
- Bike Route
- State-Owned Land
- Federal Land
- Gameland
- Significant Natural Heritage Area
- State Park
- Open Space
- PS — 6 and 7, Booster Pump Station
- 6, Raw Water Intake and Pump Station
- 6 and 7, New WTP
- 7, Raw Water Intake and Pump Station

Alternative Pipeline

- 6, Jordan Lake - Cary Intake
- 7, Jordan Lake - WIP Intake

MORRISVILLE
RALEIGH
CARY
APEX
HOLLY SPRINGS
FUQUAY-VARINA
GARNER
SANFORD
Jordan Lake
Harris Lake
Lake Wheeler
Middle Creek
Black-Creek
751
64
540
55
1
42
401
440
40
PS

N W E S

SCALE
1 inch = 2 miles
0 1 2 Miles

FUQUAY-VARINA
north carolina

Hazen

Figure 4-3d: Public Lands, Recreational Areas, and State Natural Areas - Alternatives 6 and 7
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Legend

- Trail
- Bike Route
- State-Owned Land
- Federal Land
- Gameland
- Significant Natural Heritage Area
- State Park
- Open Space
- PS — 9A, 9B, 9C, and 9D Booster Pump Station
- 9C and 9D Expansion of WWTP and WW Allocation

Alternative Pipeline

- 9A and 9C, Sanford - North
- 9B, Sanford - South
- 9C, Cape Fear Effluent FM
- 9D, Sanford - North Effluent FM

APEX
GARNER
HOLLY SPRINGS
FUQUAY-VARINA
ANGIER
COATS
LILLINGTON
BENSON
SANFORD
BROADWAY
Harris Lake
Cape Fear River
Middle Creek
Black Creek
Upper Little River
1
55
401
42
50
210
40
78
421
87
27
242

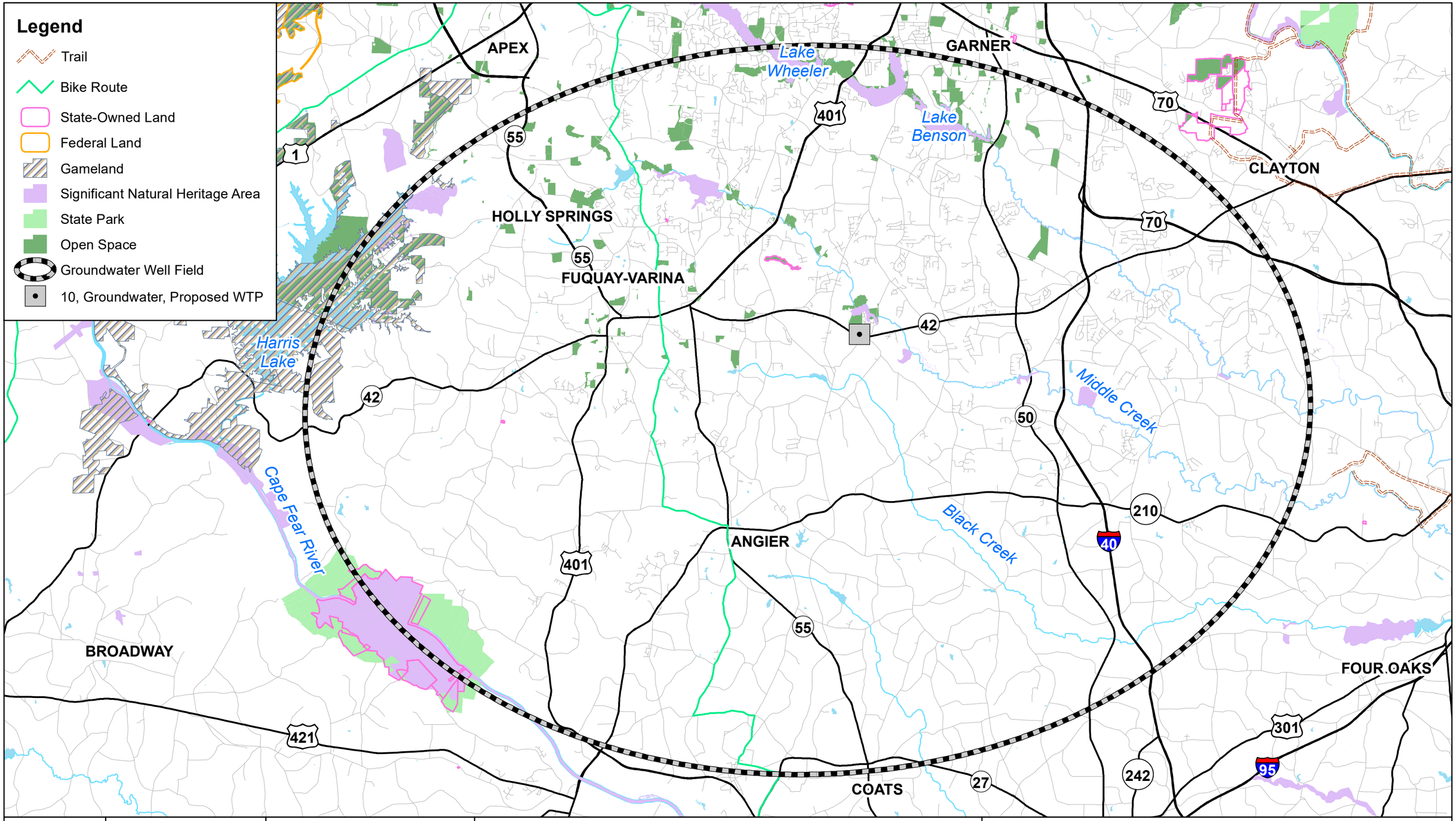
N
W
E
S

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA
north carolina

Hazen

Figure 4-3e: Public Lands, Recreational Areas, and State Natural Areas - Alternatives 9A, 9B, 9C and 9D
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River



N
W E
S

SCALE
1 inch = 2.5 miles
0 2.5
Miles

FUQUAY-VARINA
north carolina

Hazen

Figure 4-3f: Public Lands, Recreational Areas, and State Natural Areas - Alternative 10
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

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

Federal, state, county, and municipal-owned lands, American Indian tribal lands, parks, and scenic and recreational areas located throughout the project area are described herein. Areas designated by the Department of Natural and Cultural Resources Natural Heritage Program (NHP) as significant natural heritage areas (SNHAs) are also discussed in this section. SNHAs may be on public or private land and their designation as a natural area by NHP does not confer protection.

A summary of the public lands and scenic, recreational, and state natural areas within or in proximity to the project area is provided in Table 4-6 and illustrated in Figure 4-4. Quantification of public lands in the project area is provided in Table 4-7. The provided information was obtained from data downloaded from NC OneMap, municipalities, counties, or other readily available sources.

Table 4-6: Summary of Public Lands and Scenic, Recreational, and State Natural Areas by Alternative

Name	Description
Alternative 1:	
SNHAs	• Proposed reservoir is in Middle Creek (Wake/Johnston) Aquatic Habitat
	• Corridor crosses Middle Creek (Wake/Johnston) Aquatic Habitat
	• The Dempsey E. Benton WTP abuts the Swift Creek Aquatic Habitat
	• Proposed reservoir is in Middle Creek Ravine, downstream of N.C. 42
Other recreational areas	• Corridor passes by Lake Benson
	• Corridor passes by Wrenn Road Elementary School
	• Corridor passes by Vance Elementary School Park
Alternative 2:	
Walking routes	• Corridor crosses walking routes four times
	• 2.7 miles of corridor is located within designated walking trail
SNHAs	• Corridor crosses Middle Creek (Wake/Johnston) Aquatic Habitat
	• Corridor crosses Swift Creek (Wake/Johnston) Aquatic Habitat four times
	• Proposed raw water storage area abuts Little River Aquatic Habitat
	• Corridor crosses Richardson Bridge Bottomlands
	• Corridor passes by Selma Pine Flatwoods
State owned lands	• Corridor passes by the Johnston County Correctional Institution
	• Corridor passes by Richard's Bridge
Other recreational areas	• Corridor passes by Southeast County Park • Corridor traverses a Johnston County Environmental Sensitive Zone
Alternative 3:	
SNHAs	• Proposed reservoir is in Middle Creek Ravine – Below NC 42
	• Proposed reservoir is in Middle Creek Aquatic Habitat
	• Proposed reservoir is in Middle Creek Slopes – West of Barber Bridge Road

Table 4-6: Summary of Public Lands and Scenic, Recreational, and State Natural Areas by Alternative

Name	Description
Other recreational areas	• Corridor passes by Southeast County Park
	• Proposed reservoir is in Southeast County Park
Alternative 4:	
Bike / walking routes	• 1.4 miles of corridor is located within designated bike route area
	• Dunn-Erwin Rail Trail terminates adjacent to corridor
SNHAs	• AB Uzzle WTP abuts Upper Cape Fear River Aquatic Habitat
American Indian Tribal Lands	• The FWM corridor traverses two areas of land associated with the Coharie tribe and the A.B. Uzzle WTP is located on land associated with the Coharie tribe
State owned lands	• Proposed raw water storage site abuts Upper Cape Fear River Aquatic Habitat
Game lands	• 0.6 mile of corridor in game lands associated with Jordan Lake
Other recreational areas	• Corridor traverses Angier Depot
	• Corridor passes by W. N. Porter Park
Alternative 5:	
SNHAs	• Corridor crosses Upper Cape Fear River Aquatic Habitat
American Indian Tribal Lands	• Harnett County Regional WTP is located on land associated with the Coharie tribe, a state recognized tribe
Other recreational areas	• Corridor passes by Cape Fear Shiner Park
Alternative 6:	
Bike/Walking Routes	• Corridor crosses one walking route
	• Corridor crosses one bike route twice
State Owned Lands	• Corridor crosses one park associated with Jordan Lake
Game Lands	• Pump station and 0.6 mile of corridor in game lands associated with Jordan Lake
Other Recreational Areas	• Raw water intake is in Jordan Lake
	• Corridor passes by Jaycee Park
	• Corridor passes by Apex Middle School
	• Corridor passes by Ting Park
Alternative 7:	
Bike/Walking Routes	• Corridor crosses walking routes three times
	• Corridor crosses one bike route
	• 0.7 mile of corridor is located within designated bike route area
SNHAs	• Corridor passes by Parkers Creek Ridges
State Parks	• The corridor crosses three parks associated with Jordan Lake
Game Lands	• Pump station and 5.4 miles of corridor in game lands associated with Jordan Lake
Other Recreational Areas	• Corridor passes by Jaycee Park
	• Corridor passes by Apex Middle School
	• Corridor passes by Ting Park

Table 4-6: Summary of Public Lands and Scenic, Recreational, and State Natural Areas by Alternative

Name	Description
	• Corridor crosses Jordan Lake at two locations
	• Raw water intake is in Jordan Lake
Alternative 8A:	
Bike/Walking Routes	• Corridor crosses one bike route
	• Corridor crosses one greenway trail
American Indian Tribal Lands	• The North Harnett Regional WWTP is located on land associated with the Coharie tribe, a state recognized tribe
SNHAs	• Corridor crosses Upper Cape Fear River Aquatic Habitat
	• Raw water intake is in Upper Cape Fear River Aquatic Habitat
	• Effluent discharge is in Upper Cape Fear River Aquatic Habitat
Other Recreational Areas	• Corridor passes by Ransdell Soccer Field
	• Corridor passes by Carroll Howard Johnson Park
	• Corridor passes by South Park
Alternative 8B:	
Bike Routes	• Corridor crosses one bike route
SNHAs	• Raw water intake is in Upper Cape Fear River Aquatic Habitat
Other Recreational Areas	• Corridor passes by Ransdell Soccer Field
	• Corridor passes by Carroll Howard Johnson Park
	• Corridor passes by South Park
Alternative 9A:	
SNHAs	• 0.3 mile of the corridor crosses the Cape Fear Game Lands Floodplain
Game Lands	• 3.5 miles of corridor crosses game land associated with Shearon Harris Nuclear Power Plant
Alternative 9B:	
SNHAs	• 0.5 mile of corridor crosses the Cape Fear River/Buckhorn Levees
Game Lands	• 4.6 miles of corridor crosses game land associated with Shearon Harris Nuclear Power Plant
Other Recreational Areas	• Corridor passes by Avent Ferry Boat Ramp
Alternative 9C:	
Bike/Walking Routes	• Corridor crosses one bike route • Corridor crosses one greenway trail
American Indian Tribal Lands	• The North Harnett Regional WWTP is located on land associated with the Coharie tribe, a state recognized tribe
SNHAs	• Corridor crosses Upper Cape Fear River Aquatic Habitat • Effluent discharge is in Upper Cape Fear River Aquatic Habitat • 0.3 mile of the corridor crosses the Cape Fear Game Lands Floodplain

Table 4-6: Summary of Public Lands and Scenic, Recreational, and State Natural Areas by Alternative

Name	Description
Other Recreational Areas	• Corridor passes by Ransdell Soccer Field • Corridor passes by Carroll Howard Johnson Park • Corridor passes by South Park
Game Lands	• 3.5 miles of corridor crosses game land associated with Shearon Harris Nuclear Power Plant
Alternative 9D:	
Bike/Walking Routes	• Corridor crosses one bike route
SNHAs	• 0.3 mile of the corridor crosses the Cape Fear Game Lands Floodplain
Game Lands	• Corridor crosses game land associated with Shearon Harris Nuclear Power Plant
Other Recreational Areas	• Corridor passes Fuquay-Varina High School • Corridor crosses Ting Park • Corridor passes by areas of open space associated with NCDOT
Alternative 10:	
Bike/Walking Routes	• 24.4 miles of NC 5/Cape Fear Run bike route in well field area
	• Several greenway trails are in the well field area
SNHAs	• A portion of Lake Wheeler, Raven Rock State Park, Upper Cape Fear River Aquatic Habitat, Swift Creek Aquatic Habitat, and Middle Creek Aquatic Habitat is in the well field area
	• The Blue Pond Salamander Site, Hollemans Crossroads Slopes, Jim Branch/Buckhorn Creek Forests, Lake Benson and Marsh, Middle Creek Amphibolite Slope, Middle Creek Bluffs and Floodplain, Middle Creek Floodplain Knolls, Middle Creek Ravine – Below NC 42, Middle Creek Slopes – West of Barber Bridge Road, Nestronia Site Near Holly Springs, Swift Creek Bottomland Forest above Benson, Swift Creek Magnolia Slopes, and Utley Creek Slopes are in the well field area
Native American Tribal Lands	• One area and a portion of a second area of land associated with the Coharie tribe is in the well field area
Game Lands	• Game land associated with Shearon Harris Nuclear Power Plant is in the well field area
State Parks	• A portion of Raven Rock Park is in the well field area
Other Recreational Areas	• Open space associated with the Town of Garner, Town of Holly Springs, Wake County, City of Raleigh, Town of Fuquay-Varina, Wake County Board of Education, North Carolina Department of Transportation, Triangle Greenways Council, Triangle Land Conservancy, and various smaller entities are in the well field area
	• Jack Marley Park, Angier Depot, Neills Creek Park, Town of Holly Springs Veterans Park, Jones Park, Bass Lake Retreat Center, Alston Ridge Park, Action Park, Falcon Park, Lawrence Street Park, Fleming Loop Recreational Park, South Park, and Carroll Howard Johnson Park are in the well field area • Corridor traverses a Johnston County Environmental Sensitive Zone

Table 4-7: Quantification Summary of Public Lands by Alternative, Acres

Alternative	Parks	Open Space	Significant Natural Heritage Areas [1]	Other Public Lands
1	----	----	43.2	----
2	----	----	12.2	0.5
3	105	----	133.5	---
4	----	0.6	1.2	1.6
5	----	----	1.0	-----
6	1.4	2.1	----	0.1
7	4.8	2.1	----	0.9
8A	----	----	1.1	0.05
8B	----	----	0.2	0.05
9A	----	----	4.5	----
9B	----	----	5.7	----
9C	----	----	5.6	0.05
9D	----	4.8	4.5	----
10	5,005	6,446	4,759	3,688

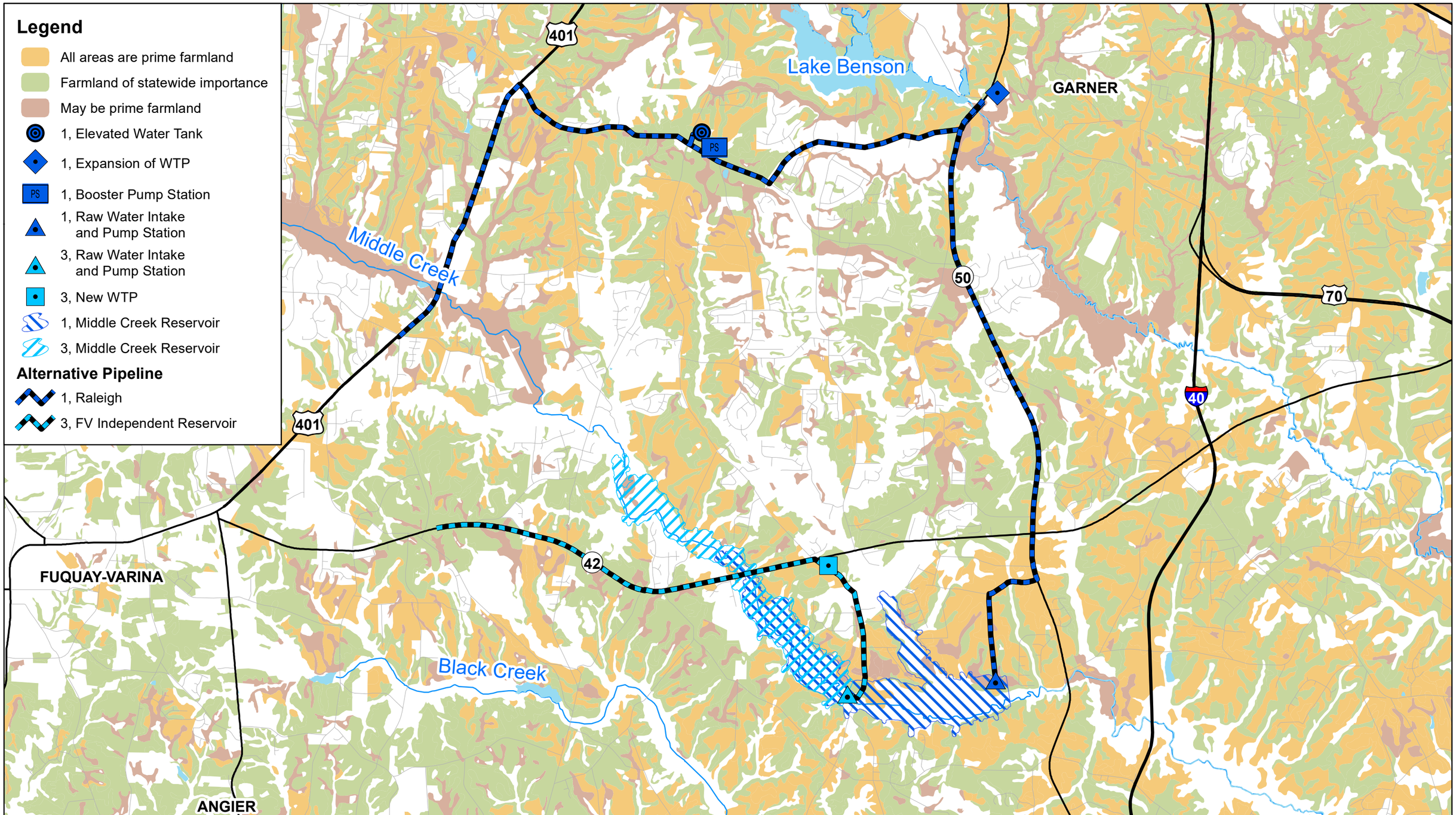
[1] *SNHA designation does not confer protection.*

Legend

- All areas are prime farmland
- Farmland of statewide importance
- May be prime farmland
- 1, Elevated Water Tank
- 1, Expansion of WTP
- 1, Booster Pump Station
- 1, Raw Water Intake and Pump Station
- 3, Raw Water Intake and Pump Station
- 3, New WTP
- 1, Middle Creek Reservoir
- 3, Middle Creek Reservoir

Alternative Pipeline

- 1, Raleigh
- 3, FV Independent Reservoir



N W E S

SCALE
1 inch = 1 mile
0 0.5 1
Mile

FUQUAY-VARINA north carolina

Hazen

Figure 4-4a: Prime Farmland Soils
Alternatives 1 and 3
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

CLAYTON
FUQUAY-VARINA
WILSON'S MILLS
MICRO
SELMA
PINE LEVEL
SMITHFIELD
ANGIER
FOUR OAKS
PRINCETON
COATS
BENSON
Neuse River
Swift Creek
Middle Creek
Black Creek
PS
55
42
70
50
210
40
401
27
242
301
95
96
701
39

Legend

- All areas are prime farmland
- Farmland of statewide importance
- May be prime farmland
- PS — 2, Booster Pump Station
- 2, Raw Water Storage Facility, Raw Water Intake, and Pump Station
- 2, Raw Water Intake and Pump Station
- 2, New WTP

Alternative Pipeline

- 2, Johnston County

N W E S

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

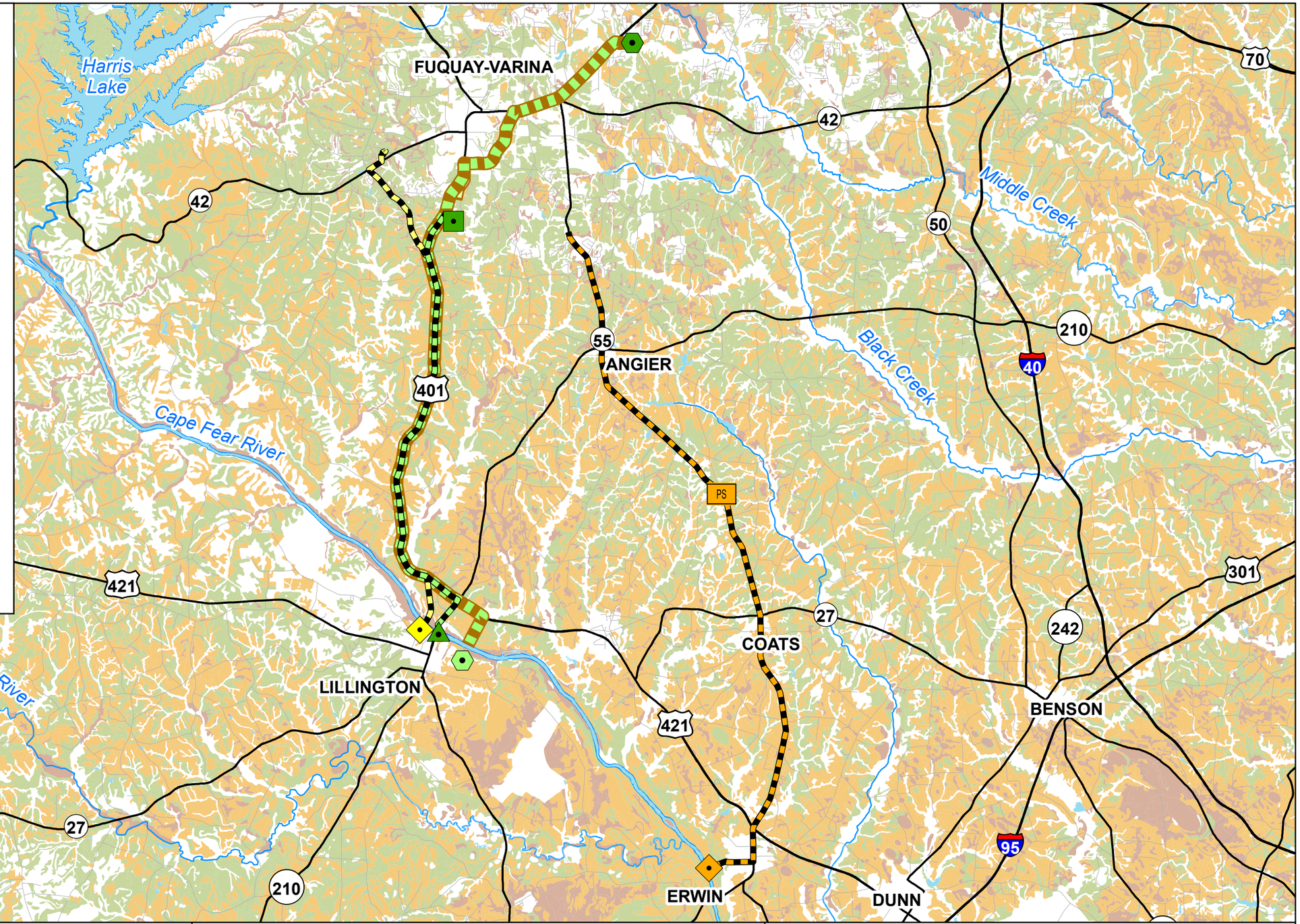
Figure 4-4b: Prime Farmland Soils
Alternative 2
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Legend

- All areas are prime farmland
- Farmland of statewide importance
- May be prime farmland
- 4, Expansion of WTP and New Raw Water Intake, Pump Station, and Raw Water Storage Facility
- PS — 4, Booster Pump Station
- 5, Expansion of WTP, Withdrawal Increase, and New Raw Water Storage Facility
- 8A and 8B, Expansion of WWTP
- 8A and 8B, New Raw Water Intake and Pump Station
- 8A and 8B, New WTP
- 8A, Expansion of Wastewater Allocation

Alternative Pipeline

- 4, Dunn
- 5, Harnett County
- 8A and 8B, Cape Fear River Intake
- 8A, Cape Fear Effluent FM
- 8B, Cape Fear Effluent FM



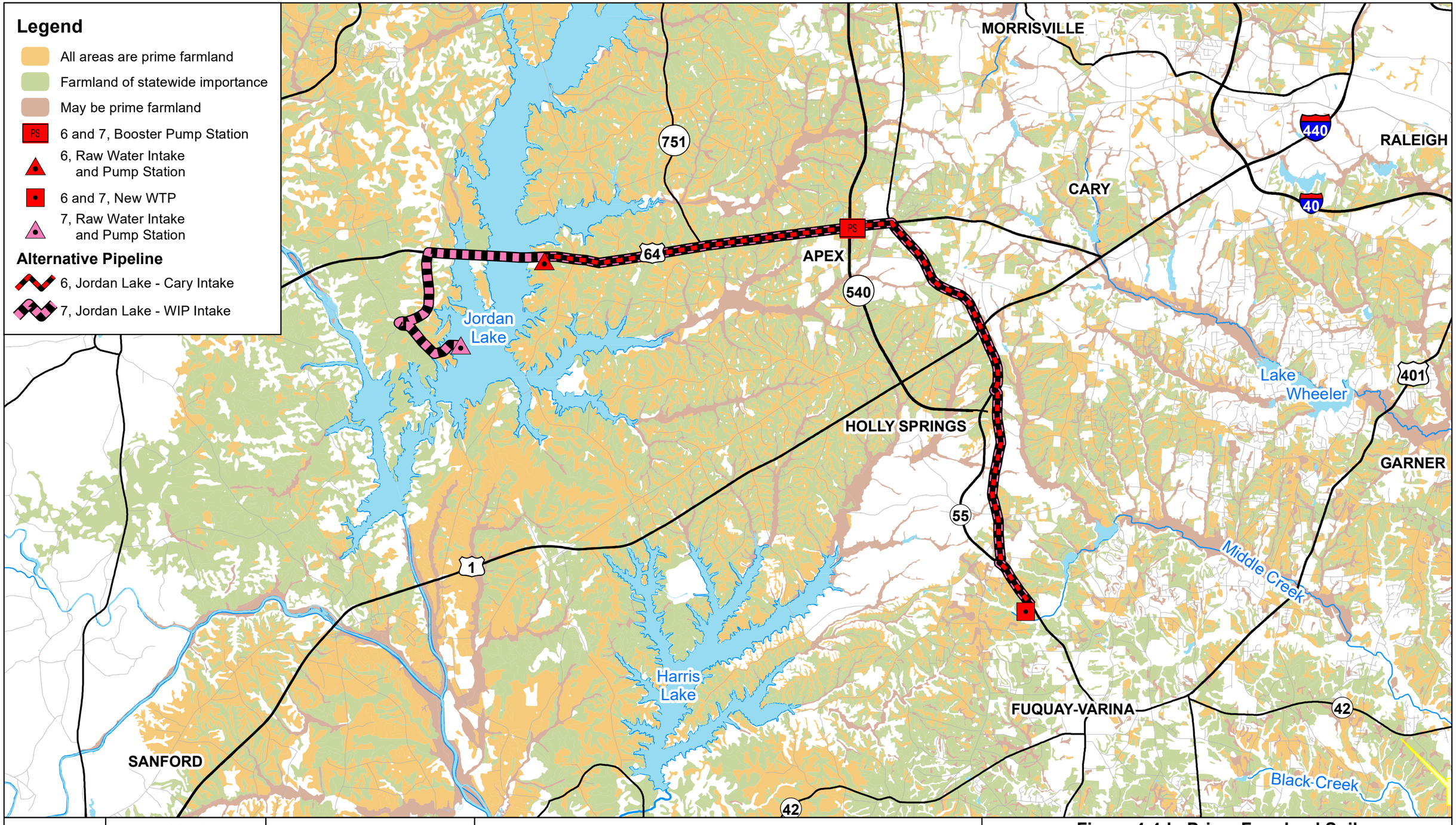
N W E S

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-4c: Prime Farmland Soils
Alternatives 4, 5, 8A, and 8B
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River



N
W E
S

SCALE
1 inch = 2 miles
0 1 2
Miles

FUQUAY-VARINA
north carolina

Hazen

Figure 4-4d: Prime Farmland Soils
Alternatives 6 and 7
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Legend

- All areas are prime farmland
- Farmland of statewide importance
- May be prime farmland
- PS — 9A, 9B, 9C, and 9D Booster Pump Station
- 9C and 9D Expansion of WWTP and WW Allocation

Alternative Pipeline

- 9A and 9C, Sanford - North
- 9B, Sanford - South
- 9C, Cape Fear Effluent FM
- 9D, Sanford - North Effluent FM

APEX
GARNER
HOLLY SPRINGS
FUQUAY-VARINA
ANGIER
BROADWAY
SANFORD
LILLINGTON
COATS
BENSON
Harris Lake
Cape Fear River
Middle Creek
Black Creek
Upper Little River
1
15
55
401
42
50
210
40
78
421
87
27
242
PS

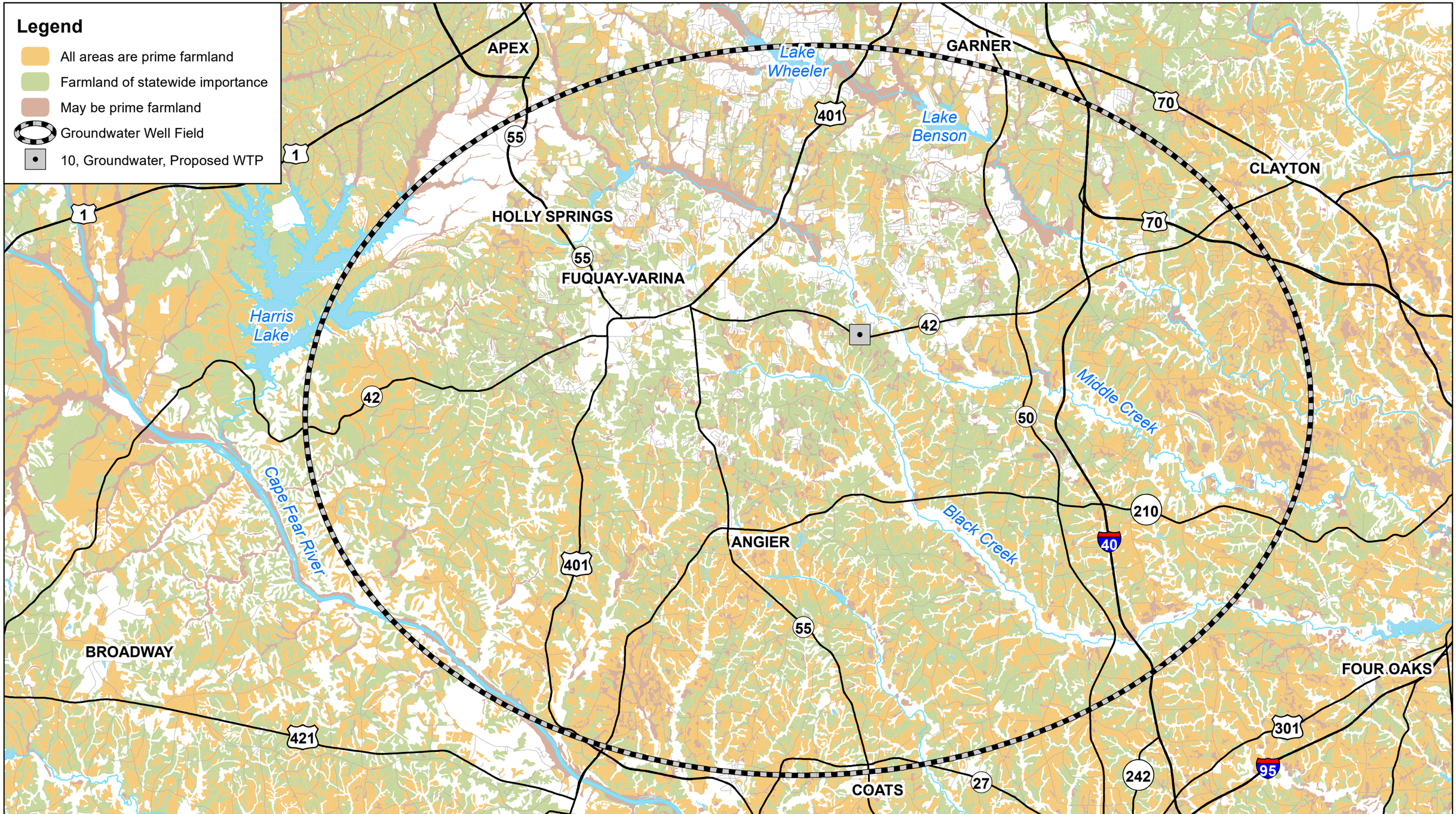
N W E S

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-4e: Prime Farmland Soils
Alternatives 9A, 9B, 9c, and 9D
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River



N
W E
S

SCALE
1 inch = 2.5 miles
0 2.5
Miles

FUQUAY-VARINA
north carolina

Hazen

Figure 4-4f: Prime Farmland Soils
Alternative 10
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

4.5 Prime or Unique Agricultural Lands

The Federal Farmland Protection Policy Act requires state agencies to minimize the loss of prime agricultural land. Areas denoted as prime agricultural land by the United States Department of Agriculture (USDA) NRCS are present in the project areas. Per the NRCS Web Soil Survey, a quantification of the acreage of prime agricultural lands within the alternative footprints is presented in Table 4-8 and illustrated on Figure 4-4 (USDA, 2021). Soils listed by NRCS as prime farmland if drained, prime farmland if drained and either protected from flooding or not frequently flooded during the growing season, or prime farmland if protected from flooding or not frequently flooded during the growing season are denoted under the “may be farmland” label in the legend of Figure 4-4. It should be noted that developed land no longer qualifies as prime or unique farmland, regardless of soil type.

Table 4-8: Summary of Prime Agricultural Land Soils, Acres

Soil Classification	Alternative													
	1	2	3	4	5	6	7	8A	8B	9A	9B	9C	9D	10 [1]
All areas are prime farmland	132	233	65	163	91	96	119	134	107	57	43	191	64	84,814
Farmland of statewide importance	169	111	91	76	57	92	112	93	80	71	77	164	68	95,873
Farmland if drained	51	88	29	3	5	3	3	10	9	----	----	10	6	10,325
Farmland if drained and either protected from flooding or not frequently flooded during the growing season	31	3	----	----	13	6	6	3	----	8	7	11	11	8,127
Farmland if protected from flooding or not frequently flooded during the growing season	----	----	----	----	----	----	----	----	----	1	3	1	----	----
Not prime farmland	967	167	687	57	7	98	129	127	110	61	64	188	118	82,051

[1] *Alternative 10 includes all prime agricultural land mapped in well field area. Prime agricultural land indicated for Alternative 10 is not specific to the areas that will be impacted if the alternative is selected and implemented.*

4.6 Areas of Archaeological or Historical Value

Authorized under the National Historic Preservation Act of 1966, the National Register of Historic Places (NRHP) houses the formal repository of information pertaining to historic structures and districts worth preservation. A database search of the National Register indicated currently listed structures and historic districts present within the alternative alignments (NPS, 2014). Table 4-9 includes a list of National Register listed, determined eligible, and potentially eligible historic resources/properties identified near the proposed project alignments according to the information available from the North Carolina State Historic Preservation Office GIS Service (HPOWEB) (SHPO, 2022). Properties designated as "Surveyed Only" and those noted as "Gone" or "Replaced" (e.g., a bridge designation) in the database are not included. The effects of the proposed project on archaeological sites will be reviewed by the North Carolina State Historic Preservation Office (SHPO) after the location, extent, and depth of disturbance has been determined.

Review of the National Park Service and SHPO GIS data relative to National Register structures and districts determined that a few resources are located within the project area or are traversed by an alternative corridor. To date, no information has been received from the North Carolina Office of State Archaeology regarding potential resources within the alternative corridors. Future coordination with the Office of State Archaeology will occur with the selection of a preferred alternative.

Table 4-9: Historic Resources by Alternative

Alternative	Name of Resource	County	National Register Listing Status	Site ID
1	Gerald Cochran House	Wake	DOE	WA7107
	George Williams Farm [1]	Wake	DOE	WA1212
	William Wesley Pate House	Johnston	SL	JT0901
	Williams Crossroads and Hollands Historic District [1]	Wake	SL	WA4163
	McCuller's Pines [1]	Wake	SL	WA7794
2	E.J. Holt House and Mill	Johnston	SL	JT1240
2, 3	John William Adams House	Wake	SL	WA1158
4	Erwin Commercial Historic District [1]	Harnett	NR	HT1169
	Erwin Mill Village Historic District [1]	Harnett	SL	HT0525
	Erwin Mills	Harnett	SL	HT0021
	Coats School	Harnett	SLDOE	HT0028
	Angier Commercial Historic District	Harnett	SL	HT0120
5, 8A, 8B, 9C	Johnson House and Store [1]	Harnett	DOE	HT0796
	Kipling United Methodist Church and Parsonage	Harnett	DOE	HT0791
	A.A. Johnson House	Harnett	DOE	HT0818
	David Henry Senter House	Harnett	DOE	HT0174

Table 4-9: Historic Resources by Alternative

Alternative	Name of Resource	County	National Register Listing Status	Site ID
6, 7	Apex Historic District	Wake	NR	WA4423
	Holly Springs Masonic Lodge	Wake	NR	WA0642
	Leslie-Alford-Mims House	Wake	NR	WA0629
	Holly Springs Historic District [1]	Wake	SL	WA0649
	J.B. Mills House [1]	Chatham	DOE	CH0210
	Beckwith-Goodwin Farm [1]	Chatham	SLDOE	CH0214
6, 7, 9D	Grigsby Avenue – South Main Street Historic District [1]	Wake	SL	WA7459
	Adams House [1]	Wake	DOE	WA0611
	Richard L. and Annie Adams Farm [1]	Wake	SLDOE	WA0612
8A, 9C	New Deal Warehouse	Wake	SL	WA7557
8A, 8B, 9C, 9D	House (Daniel Farm)	Wake	SL	WA1118
9A, 9C	Memphis Methodist Church and Cemetery	Lee	SL	LE0242
9A, 9B, 9C, 9D	Burt Farm [1]	Wake	SL	WA0538
9D	Varina Commercial Historic District [1]	Wake	NR	WA1195
	Jeff Stephens Farm (Gone) (Alsey Jeff Stephens Farm)	Wake	SL	WA0613
	Grigby Avenue – South Main Street Historic District [1]	Wake	SL	WA7459
	Holly Springs Historic District[1]	Wake	SL	WA0649
	New Hill First Missionary Baptist Church	Wake	SL	WA1110

[1] Resource is located within the project area or traversed by an alternative corridor.

Key to Listing Status
DOE – Determined Eligible
NR – National Register Listing
SL – Study List
SLDOE – Study List and Determined Eligible

4.7 Air Quality

The EPA uses the Air Quality Index (AQI) to report ambient air quality conditions with ratings of good, moderate, unhealthy for sensitive groups, and unhealthy. AQI incorporates five criteria pollutants into one index: ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. The North Carolina Division of Air Quality (DAQ) enforces state and federal laws and regulations dealing with air pollution in North Carolina and monitors compliance with the National Ambient Air Quality Standards (NAAQS).

Two air quality monitoring stations are present in Wake County, and one monitoring station is located in Johnston County. Lee, Chatham, and Harnett Counties do not have air quality monitoring stations. The AQI

data from monitoring stations in Wake and Johnston Counties for 2016 through 2021 found the air quality at the monitoring stations to be good or moderate for more than 99 percent of the time in which data was obtained. The AQI data recorded between 2016 and 2021 indicated that unhealthy air quality for sensitive groups was reached four days in Wake County and one day in Johnston County during the six-year monitoring period. Table 4-10 summarizes the AQI obtained by the EPA between 2016 and 2021 in Wake and Johnston Counties (EPA, 2022).

Table 4-10: Wake and Johnston County Air Quality Index

Year [1]	Number of Recorded Days (Percent of Recorded Days)			
	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy
Wake County				
2016	238 (65)	125 (34)	3 (<1)	0 (0)
2017	252 (69)	113 (31)	0 (0)	0 (0)
2018	246 (68)	115 (32)	0 (0)	0 (0)
2019	245 (67)	120 (33)	0 (0)	0 (0)
2020	284 (78)	80 (21)	1 (<1)	0 (0)
2021	268 (73)	97 (27)	0 (0)	0 (0)
Johnston County				
2016	238 (78)	65 (21)	1 (<1)	0 (0)
2017	289 (79)	75 (21)	0 (0)	0 (0)
2018	292 (83)	62 (17)	0 (0)	0 (0)
2019	294 (81)	69 (19)	0 (0)	0 (0)
2020	318 (94)	21 (6)	0 (0)	0 (0)
2021	298 (82)	67 (18)	0 (0)	0 (0)

[1] *The 2022 data was not included as this data was not finalized at the time of publication.*

According to the annual AQI plots by air pollutants, the main air pollutant responsible for unhealthy for sensitive groups days in Wake and Johnston Counties is ozone. Ozone is created by chemical reactions between oxides of nitrogen and volatile organic compounds in the presence of sunlight. Emissions from industrial facilities, electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are major sources of oxides of nitrogen and volatile organic compounds. EPA implements the NAAQS, as required by the Clean Air Act, by designating areas of the country as “attainment” or “nonattainment” areas for each of the criteria pollutants. Currently, the areas in which the alternatives are located are considered as ozone attainment or unclassified areas.

4.8 Noise

Noise is subject to the federal Noise Control Act of 1972 (PL-92-574) and Quiet Communities Act of 1978 (PL-95-6009). The Act requires standards of compliance and recommends approaches to abate stationary noise sources such as airports, highways, and industrial facilities. Elevated noise levels have been documented as negatively affecting human health and welfare as well as wildlife behavior. Thus, federal,

state, and local governments have established noise standards and guidelines to protect citizens from potential hearing damage and various other adverse physiological and social effects associated with noise.

Noise levels are measured in terms of the A-weighted decibel [dB(A)] and are measured through a sound level meter having characteristics defined by the American National Standards Institute. The majority of the study area is located in a low-density residential area and complies with noise standards. Current noise levels within the study area are considered part of the ambient noise levels for the area. The existing sources of noise pollution of the study area include traffic along the roadways and other ambient day-to-day noise representative of the residential, forested, recreational, and agricultural land uses within the rural areas of the project area. Within the more developed areas of the project area, increased noise occurs due to additional facilities, industries, and roadways.

4.9 Floodways and 100-Year Floodplains

The Federal Emergency Management Agency (FEMA) designates areas as 100-year floodplains and floodways. FEMA defines floodways as, "*the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than designated height.*" FEMA defines a floodplain as, "*any land area FEMA has determined has at least a one percent chance in any given year of being inundated by floodwaters from any source*." The designated areas are classified collectively as Special Flood Hazard Areas (SFHAs). As construction, disturbance, and development restrictions vary between the 100-year floodplain and the floodway, each designation is discussed separately herein. Table 4-11 and Figure 4-5 present information relative to the designations for each alternative corridor.

All alternatives, except Alternative 10, include construction of a new raw water intake located on a river or a reservoir. A new raw water intake is proposed on a proposed Middle Creek Reservoir included in Alternatives 1 and 3. A raw water intake on the Neuse River and offline reservoir is part of Alternative 2. Expansion of existing raw water intakes on the Cape Fear River is part of Alternatives 4 and 5, and a new raw water intake on the Cape Fear River is part of Alternatives 8A, 8B, 9A, 9B, 9C, and 9D. Raw water intakes on Jordan Lake are included for Alternatives 6 and 7. The raw water intake structures associated with these alternatives have not been sited precisely; however, the intake structures are expected to be located within the 100-year floodplain associated with Middle Creek or the Neuse River in the Neuse River Basin and the Cape Fear River and Jordan Lake in the Cape Fear River Basin. Alternative 10 does not include a new raw water intake but does traverse streams along which 100-year floodplains have been mapped by FEMA.

The booster pump stations associated with Alternatives 1, 2, 4, 5, 6, 9A, 9B, 9C and 9D are not proposed to be in a mapped SFHA. The Alternative 3, 7, 8A, and 8B raw water pump stations are sited in a 100-year floodplain. No raw water pump station is proposed to be located within a floodway. The locations of the pump stations required for Alternative 10 have not been determined.

The areas associated with the proposed water treatment facilities for all the alternatives do not contain mapped floodway or SFHA. Portions of each of the corridor alternatives, except 9A, 9B, and 9D, traverse floodways and all corridor alternatives traverse the SFHA as designated by FEMA. It should be noted that

Alternatives 9A, 9B, 9C, and 9D traverse the Cape Fear River in Lee County and floodways have not been designated in Lee County.

FEMA has assigned Base Flood Elevations (BFEs) for most of the SFHAs traversed by the project areas. The BFEs along the Cape Fear range from 108 feet MSL at the Alternative 4 raw water intake; between 125 and 198 feet MSL at the raw water intakes associated with Alternatives 5, 8A, and 8B. The BFE of the Neuse River at the Alternative 2 raw water intake is 85 feet MSL. The BFEs of Alternatives 1 and 3 raw water intakes in Middle Creek Reservoir is 204 and 210 feet MSL.

Table 4-11: Floodways and 100-Year Floodplains per Alternative, Acres

Alternative	Pipe Corridor	Pump Station/ Booster Pump Station	Raw Water Storage Facility [1]	Raw Water Intake	Total per Alternative
Floodway					
1	1.2	----	359.3	----	360.5
2	13.2	----	0.6	1.0	14.8
3	0.9	----	360.2	----	361.1
4	1.0	----	----	1.0	2.0
5	1.1	----	----	1.0	2.1
6	0.4	----	----	----	0.4
7	0.4	----	----	----	0.4
8A	2.7	----	----	1.5	4.2
8B	0.6	----	----	1.5	2.1
9A [2]	----	----	----	----	----
9B [2]	----	----	----	----	----
9C [2]	2.7	----	----	----	2.7
9D [2]	7.4	----	----	----	7.4
10 [3]	----	----	----	----	----
100-Year Floodplain					
1	3.5	----	459.5	1.0 [4]	464.0
2	23.7	----	21.0	----	44.7
3	2.6	0.9	245.3	1.0 [4]	249.8
4	1.2	----	0.5	----	1.7
5	7.8	----	----	----	7.8
6	1.2	----	----	1.0	2.2
7	15.0	1.0	----	1.0	17.0
8A	15.7	0.9	----	----	16.6
8B	10.4	0.9	----	----	11.3
9A	15.6	----	----	----	15.6
9B	11.5	----	----	----	11.5
9C	31.3	0.9	----	----	32.2
9D	35.5	----	----	----	35.5
10 [3]	----	----	----	----	----

[1] SFHAs in the reservoir footprints will be inundated; however, new SFHAs will be established abutting the new normal pool extents. No analysis or modeling has been performed to determine the new SFHA footprint.

[2] Detailed floodway studies have not been conducted in Lee County.

[3] Quantification of floodways and floodplains in the Alternative 10 project area has not been performed.

[4] The raw water intake will be in the proposed Middle Creek Reservoir.

Legend

- Floodway
- 100-Year Floodplain
- 1, Elevated Water Tank
- 1, Expansion of WTP
- 1, Booster Pump Station
- 1, Raw Water Intake and Pump Station
- 3, Raw Water Intake and Pump Station
- 3, New WTP
- 1, Middle Creek Reservoir
- 3, Middle Creek Reservoir

Alternative Pipeline

- 1, Raleigh
- 3, FV Independent Reservoir

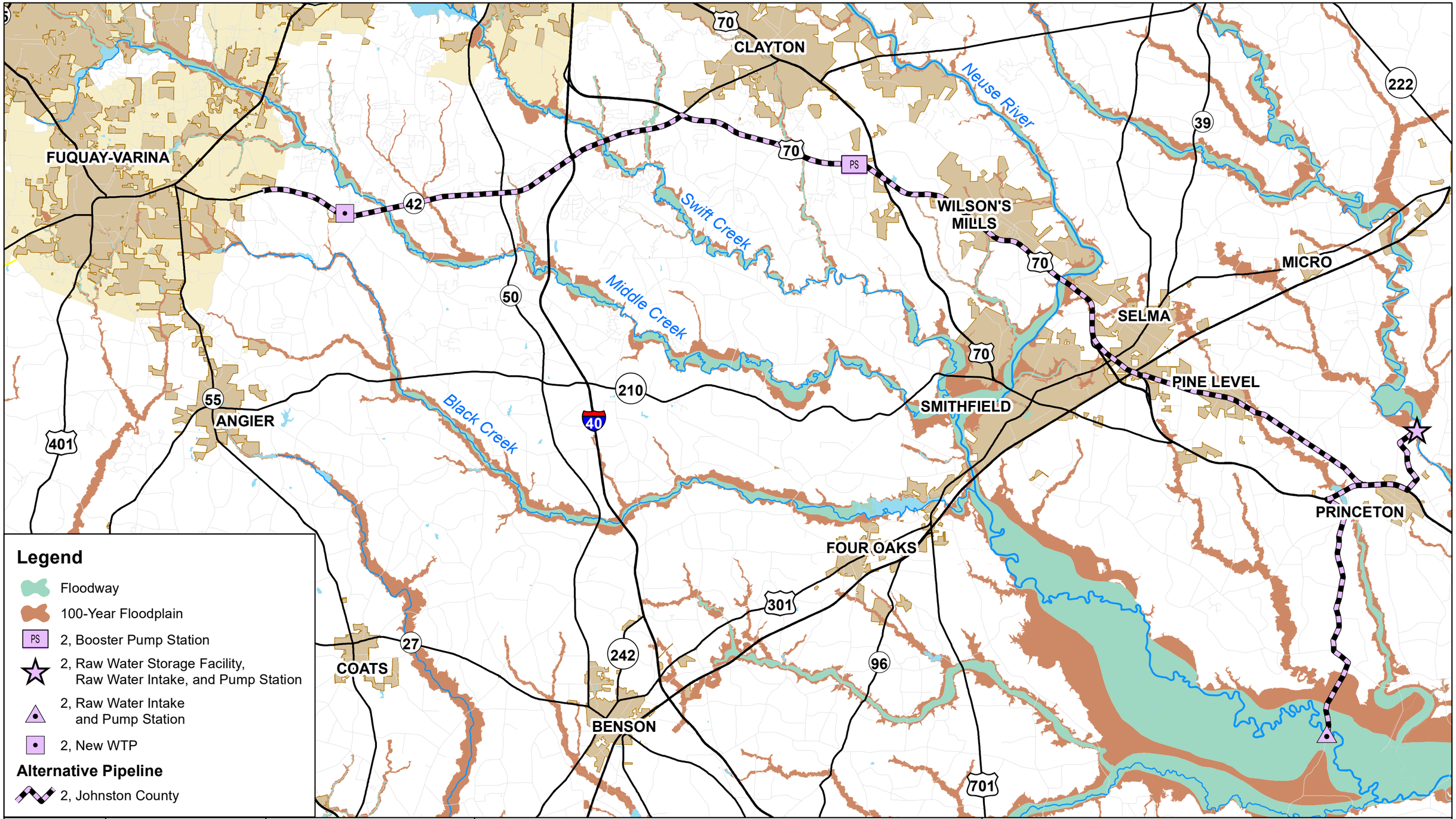
Lake Benson
GARNER
Middle Creek
FUQUAY-VARINA
Black Creek
ANGIER
401
50
70
40
42
PS

SCALE
1 inch = 1 mile
0 0.5 1 Mile

FUQUAY-VARINA north carolina

Hazen

Figure 4-5a: Floodplain and Floodway Alternatives 1 and 3
Interbasin Transfer for Water Supply from Cape Fear River to Neuse River



FUQUAY-VARINA
north carolina

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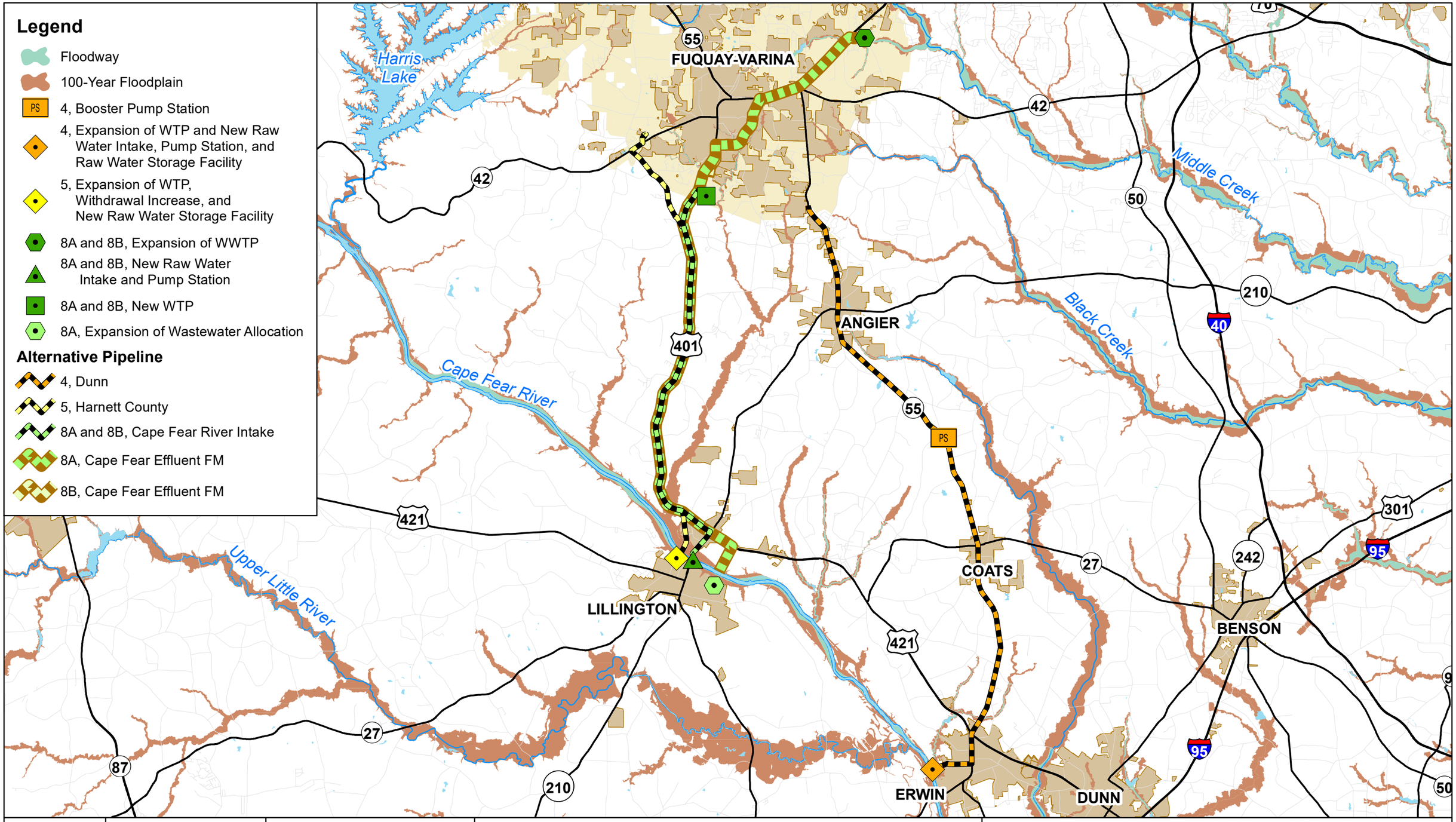
Figure 4-5b: Floodplain and Floodway
Alternative 2
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Legend

- Floodway
- 100-Year Floodplain
- PS — 4, Booster Pump Station
- 4, Expansion of WTP and New Raw Water Intake, Pump Station, and Raw Water Storage Facility
- 5, Expansion of WTP, Withdrawal Increase, and New Raw Water Storage Facility
- 8A and 8B, Expansion of WWTP
- 8A and 8B, New Raw Water Intake and Pump Station
- 8A and 8B, New WTP
- 8A, Expansion of Wastewater Allocation

Alternative Pipeline

- 4, Dunn
- 5, Harnett County
- 8A and 8B, Cape Fear River Intake
- 8A, Cape Fear Effluent FM
- 8B, Cape Fear Effluent FM



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SCALE
1 inch = 2.5 miles
0 2.5
Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-5c: Floodplain and Floodway Alternatives 4, 5, 8A, and 8B
Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

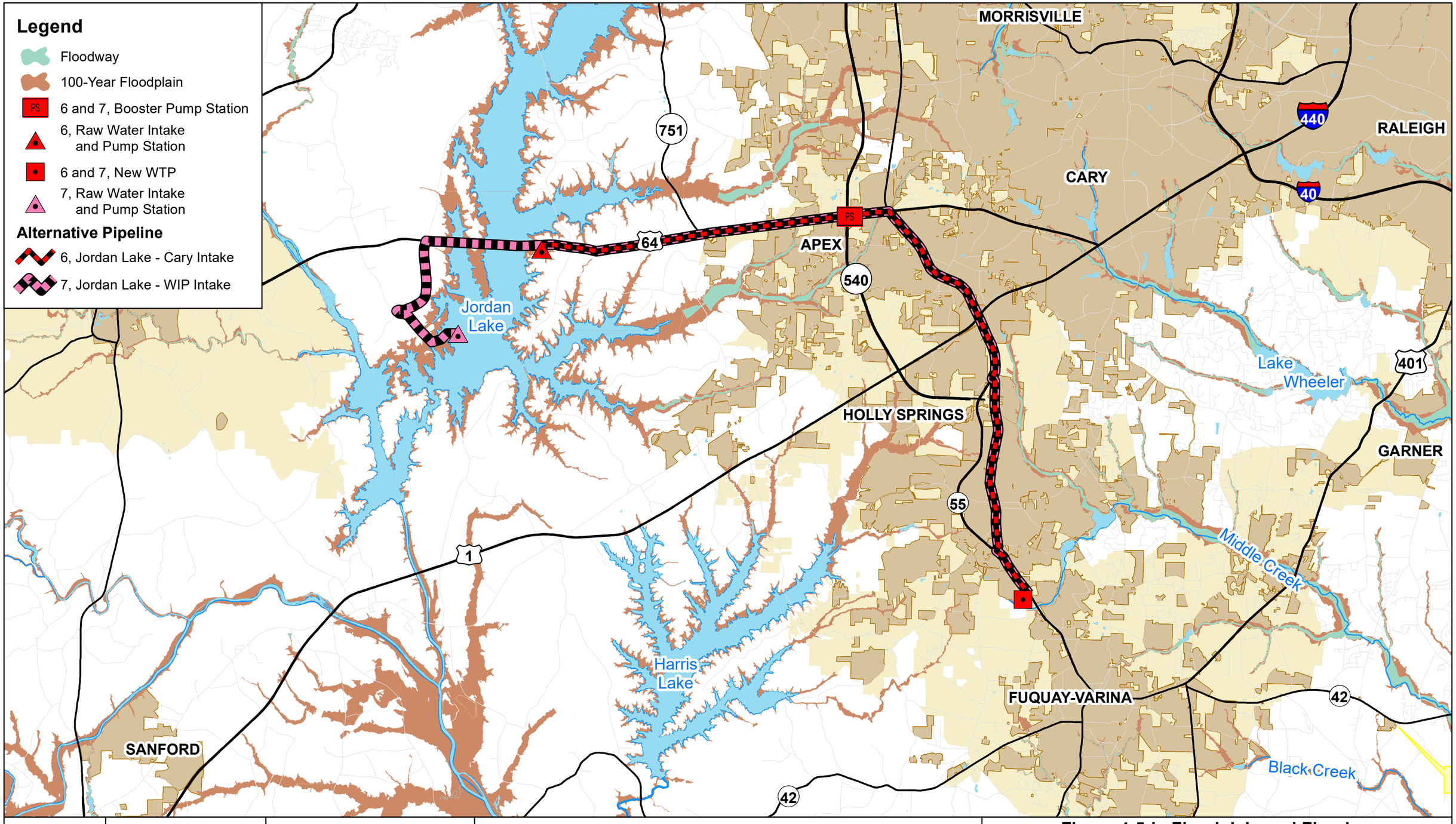
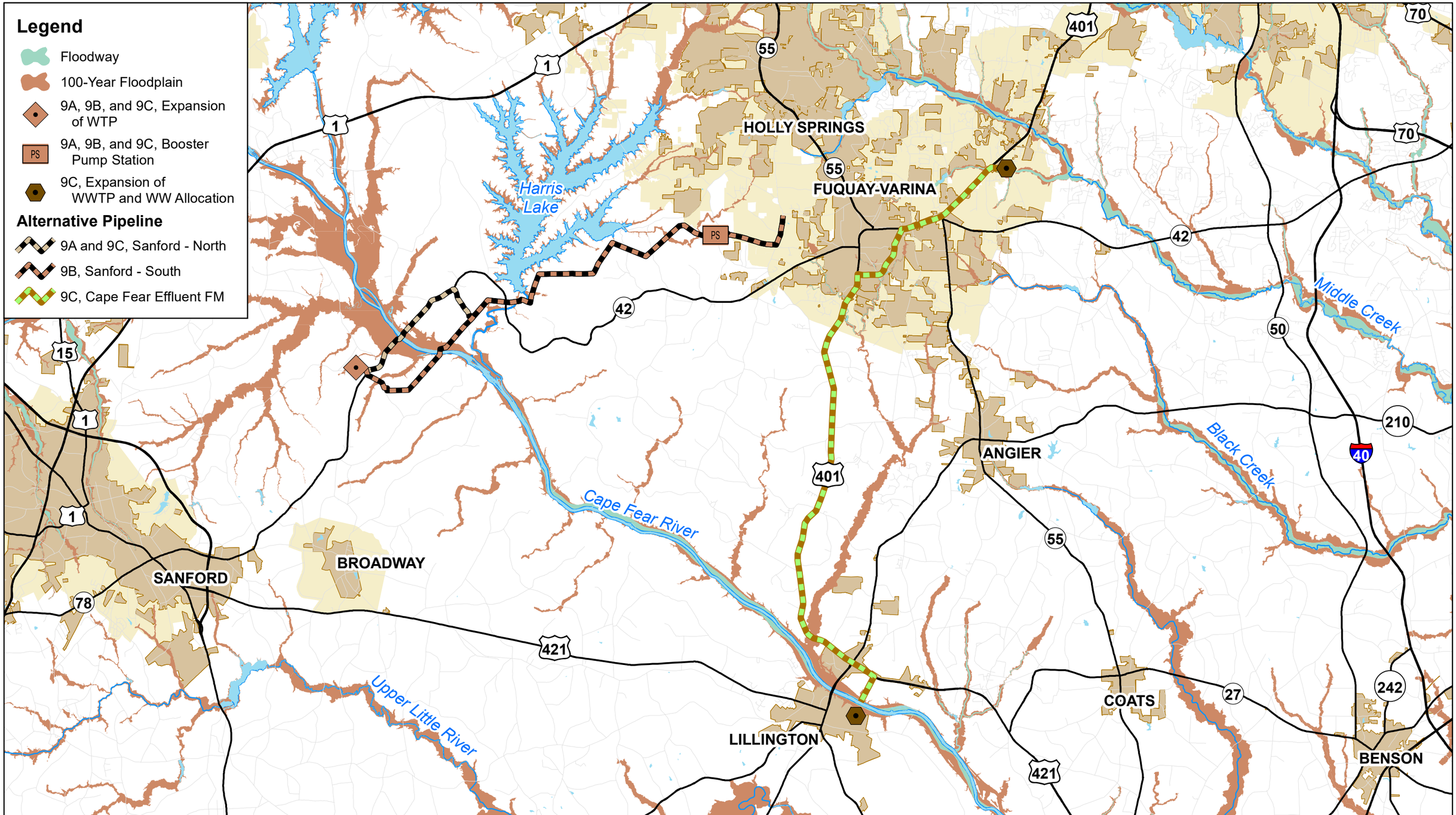


Figure 4-5d: Floodplain and Floodway Alternatives 6 and 7

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River



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Miles

FUQUAY-VARINA
north carolina

Hazen

Figure 4-5e: Floodplain and Floodway Alternatives 9A, 9B, and 9C
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Legend

- Floodway
- 100-Year Floodplain
- Groundwater Well Field
- 10, Groundwater, Proposed WTP

APEX
GARNER
CLAYTON
HOLLY SPRINGS
FUQUAY-VARINA
ANGIER
BROADWAY
COATS
FOUR OAKS
Lake Wheeler
Lake Benson
Harris Lake
Cape Fear River
Middle Creek
Black Creek
1
55
401
70
42
50
210
40
421
27
301
242
96

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-5f: Floodplain and Floodway
Alternative 10
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

4.10 Wetlands

Wetlands, as defined by federal regulations (40 Code of Federal Regulations 230.3(t)) and state regulations via 15A NCAC 04B, are areas that are “inundated or saturated by an accumulation of surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.” The USACE requires the presence of three parameters (e.g., hydrophytic vegetation, hydric soils, and evidence of hydrology) in support of a jurisdictional wetland determination (USACE, 1987). The boundary between wetlands and deep-water habitat is defined as the maximum depth where rooted emergent vegetation may be found. Rooted emergent vegetation is generally present at depths less than six feet below mean low water during the growing season.

The USFWS has mapped wetlands across the U.S. to create the National Wetland Inventory (NWI). NWI mapping depicts the type of wetland that is expected to occur in an area and has not been verified by field investigations for this EIS. Delineation of wetlands within the proposed project areas has not been performed. Wetlands in the project areas were evaluated based on NWI mapping and are illustrated on Figure 4-6. In pipe corridors, wetland acreage varies from 3.6 acres for Alternative 4 to 716.7 acres for Alternative 1. Table 4-12 provides a summary of NWI wetlands by alternative except for Alternative 10. There are 3,906 acres of mapped NWI wetlands in the Alternative 10 potential well field area; however, quantification by wetland type was not performed. The location of infrastructure within the well field has not been determined, and the wetland acreage mapped for Alternative 10 is expected to be much higher than the acreage that would be impacted if the alternative is selected and implemented.

In general, the dominant wetland type present within the transmission corridors is palustrine forested, broad-leaved deciduous (PFO1) wetlands. Palustrine, scrub-shrub, broad-leaved deciduous (PSS1) wetlands comprise the second most common wetlands within the alternative areas. Lacustrine and riverine wetlands are mapped by NWI within the project areas but to much less extent than the palustrine wetlands. NWI mapping also includes rivers (R2UBH, R4SBC, and R5UBH), ponds (PUB), and lakes (L1UB).

In general, the dominant wetland type present within the transmission corridors is PFO1 wetlands. Palustrine, scrub-shrub, broad-leaved deciduous (PSS1) wetlands comprise the second most common wetlands within the alternative areas. Lacustrine and riverine wetlands are mapped by NWI in the project areas but to much less extent than the palustrine wetlands. NWI mapping also includes rivers (R2UBH, R4SBC, and R5UBH), ponds (PUB), and lakes (L1UB).

Table 4-12: NWI Wetlands in Proposed Project Areas

Alternative	NWI Wetland Type, acres [1]								
	PEM1	PFO1	PSS1	PUBH	L1UB	R2UBH	R4SB	R5UBH	Total
1	----	628.2	80.25	0.5	----	0.1	6.0	1.6	716.7
2	----	6.3	2.3	13.6	1.4	0.9	1.5	0.6	26.6
3	2.5	366.4	30.0	1.9	----	0.6	4.5	1.5	407.4
4	0.4	0.8	----	0.5	----	1.0	0.8	0.1	3.6
5	0.1	2.2	----	0.2	----	----	1.4	1.1	5.0
6	----	0.9	----	0.9	0.6	----	1.7	0.3	4.4
7	10.9	1.0	----	0.9	----	----	1.9	0.4	15.1
8A	----	16.9	0.1	0.3	----	1.0	0.9	0.4	19.6
8B	----	12.8	0.1	0.2	----	----	0.9	0.3	14.3
9A	----	1.8	--	0.1	1.8	0.2	0.5	0.4	4.8
9B	----	2.9	0.7	0.1	----	0.1	0.8	0.4	5.0
9C	----	18.7	0.1	0.4	1.8	1.2	1.4	0.8	24.4
9D	----	13.1	0.08	0.1	1.8	0.2	1.4	0.5	17.18

[1] *Definitions:*
PEM1 – Palustrine, emergent, persistent
PFO1 – Palustrine, forested, broad-leaved deciduous
PSS1 – Palustrine, scrub-shrub, broad-leaved deciduous
PUBH – Palustrine, unconsolidated bottom, permanently flooded
L1UBH – Lacustrine, limnetic, unconsolidated bottom, permanently flooded
R2UBH – Riverine, lower perennial, unconsolidated bottom
R4SBC – Riverine, intermittent, streambed, seasonally flooded
R5UBH – Riverine, unknown perennial, unconsolidated bottom, permanently flooded

In general, the dominant wetland type present within the transmission corridors is PFO1 wetlands. PSS1 wetlands comprise the second most common wetlands within the alternative areas. Lacustrine and riverine wetlands are mapped by NWI within the project areas but to much less extent than the palustrine wetlands. NWI mapping also includes rivers (R2UBH, R4SBC, and R5UBH), ponds (PUB), and lakes (L1UB).

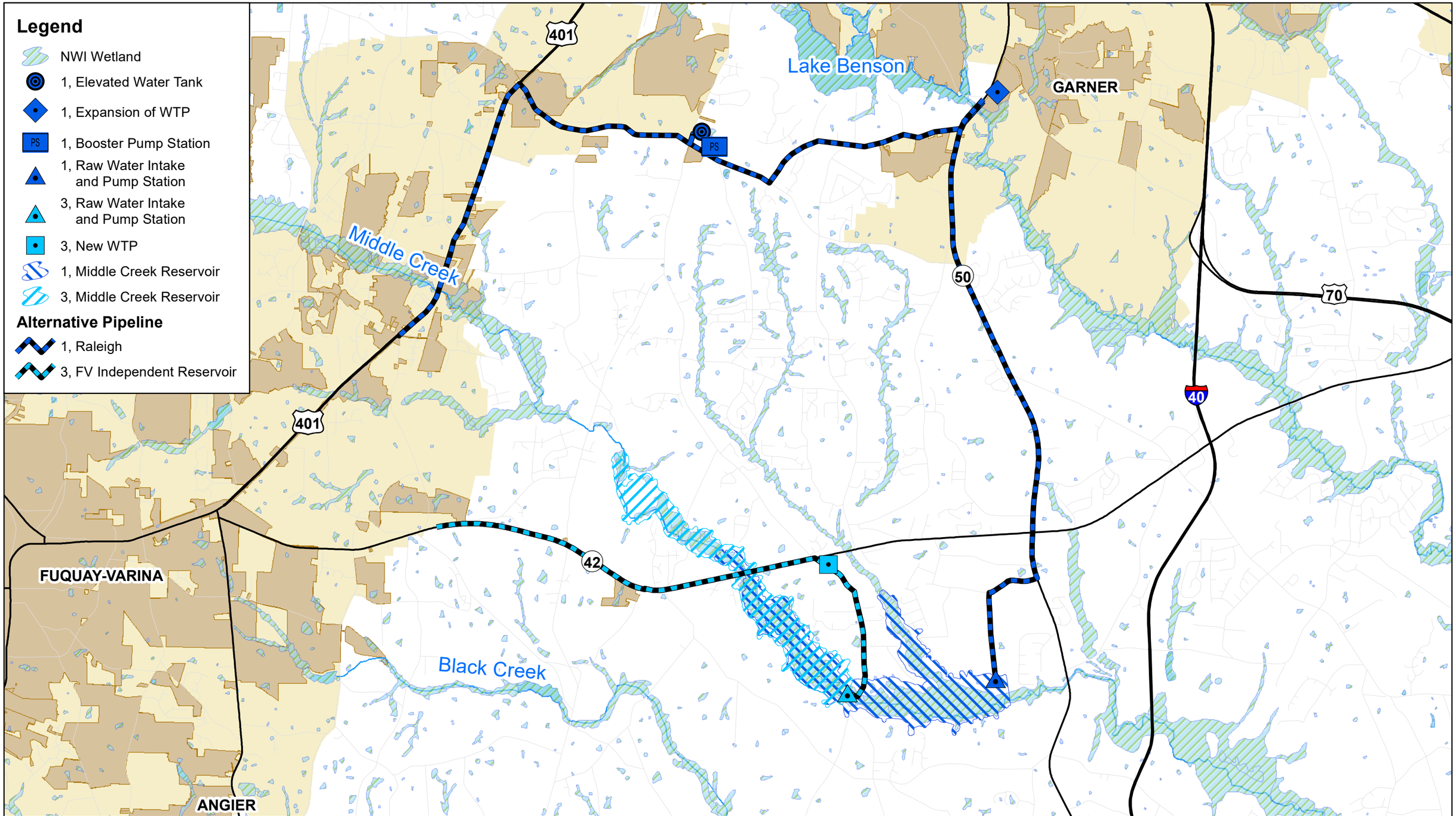
The palustrine, forested and palustrine, scrub-shrub wetlands in the project corridors are typically associated with small to medium streams and are characterized by the presence and prevalence of woody vegetation. Palustrine, emergent wetlands are dominated by herbaceous plant species and may contain scattered shrubs or trees. The palustrine, emergent wetlands in the project corridors are primarily located adjacent to or in the floodplain area of small to medium streams.

Legend

- NWI Wetland
- 1, Elevated Water Tank
- 1, Expansion of WTP
- 1, Booster Pump Station
- 1, Raw Water Intake and Pump Station
- 3, Raw Water Intake and Pump Station
- 3, New WTP
- 1, Middle Creek Reservoir
- 3, Middle Creek Reservoir

Alternative Pipeline

- 1, Raleigh
- 3, FV Independent Reservoir



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1 inch = 1 mile
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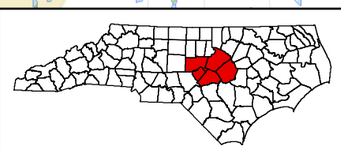


FUQUAY-VARINA
north carolina

Hazen

Figure 4-6a: NWI Mapping
Alternatives 1 and 3
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

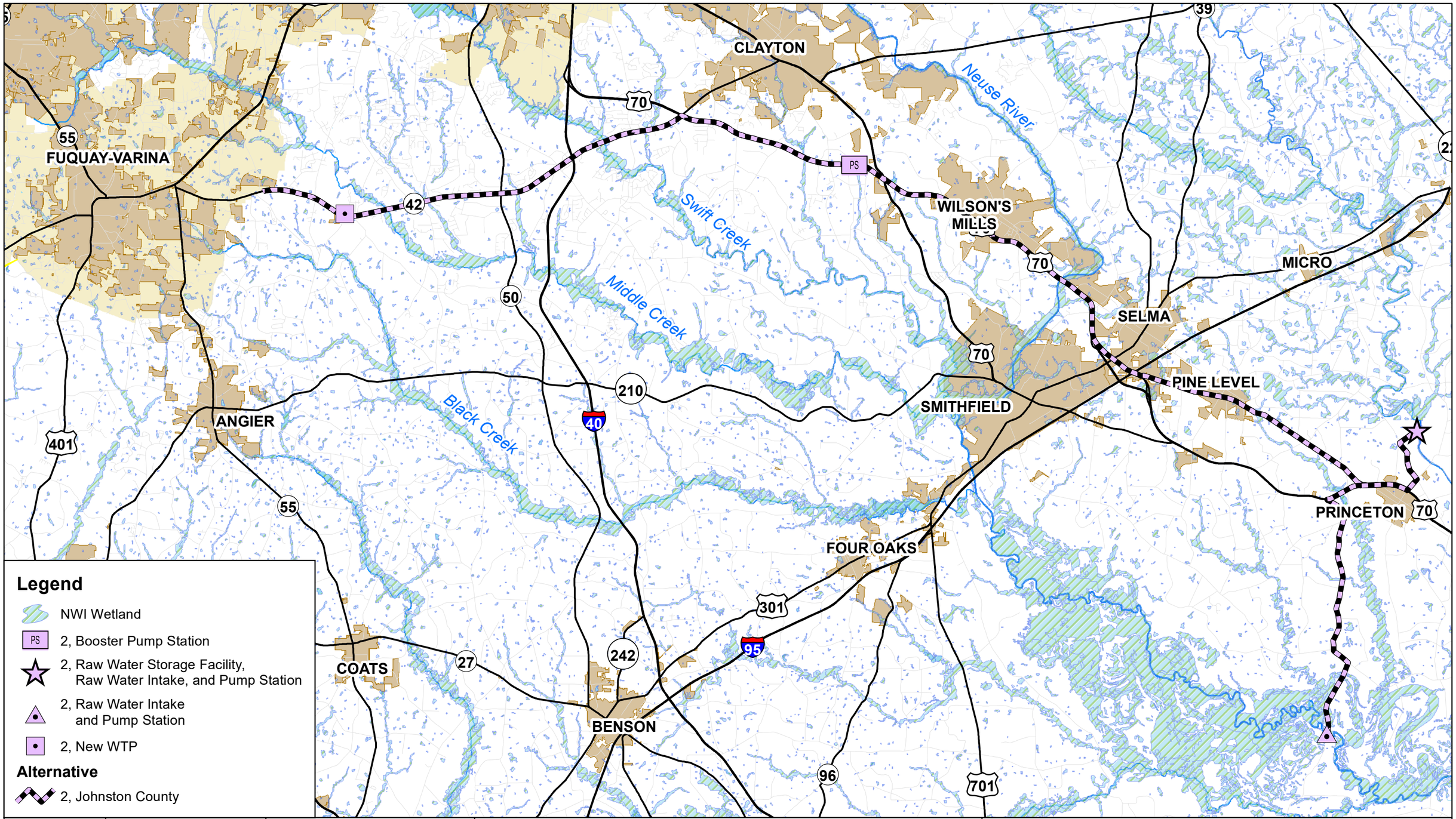


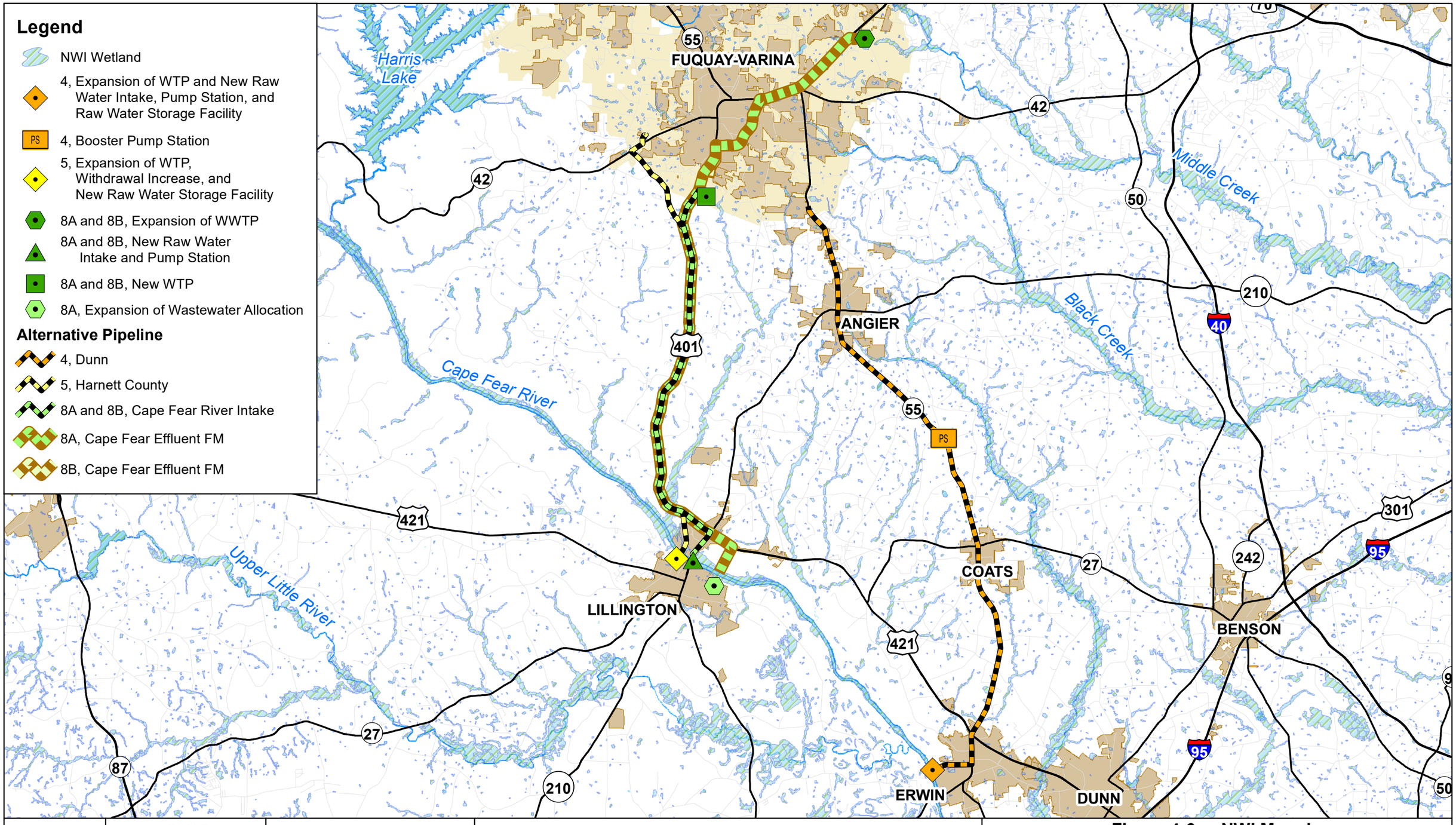
Figure 4-6b: NWI Mapping
Alternative 2
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Legend

- NWI Wetland
- 4, Expansion of WTP and New Raw Water Intake, Pump Station, and Raw Water Storage Facility
- PS — 4, Booster Pump Station
- 5, Expansion of WTP, Withdrawal Increase, and New Raw Water Storage Facility
- 8A and 8B, Expansion of WWTP
- 8A and 8B, New Raw Water Intake and Pump Station
- 8A and 8B, New WTP
- 8A, Expansion of Wastewater Allocation

Alternative Pipeline

- 4, Dunn
- 5, Harnett County
- 8A and 8B, Cape Fear River Intake
- 8A, Cape Fear Effluent FM
- 8B, Cape Fear Effluent FM



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SCALE
1 inch = 2.5 miles
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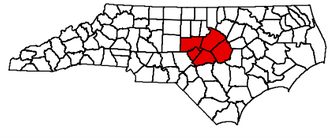


FUQUAY-VARINA north carolina

Hazen

Figure 4-6c: NWI Mapping
Alternatives 4, 5, 8A, and 8B
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

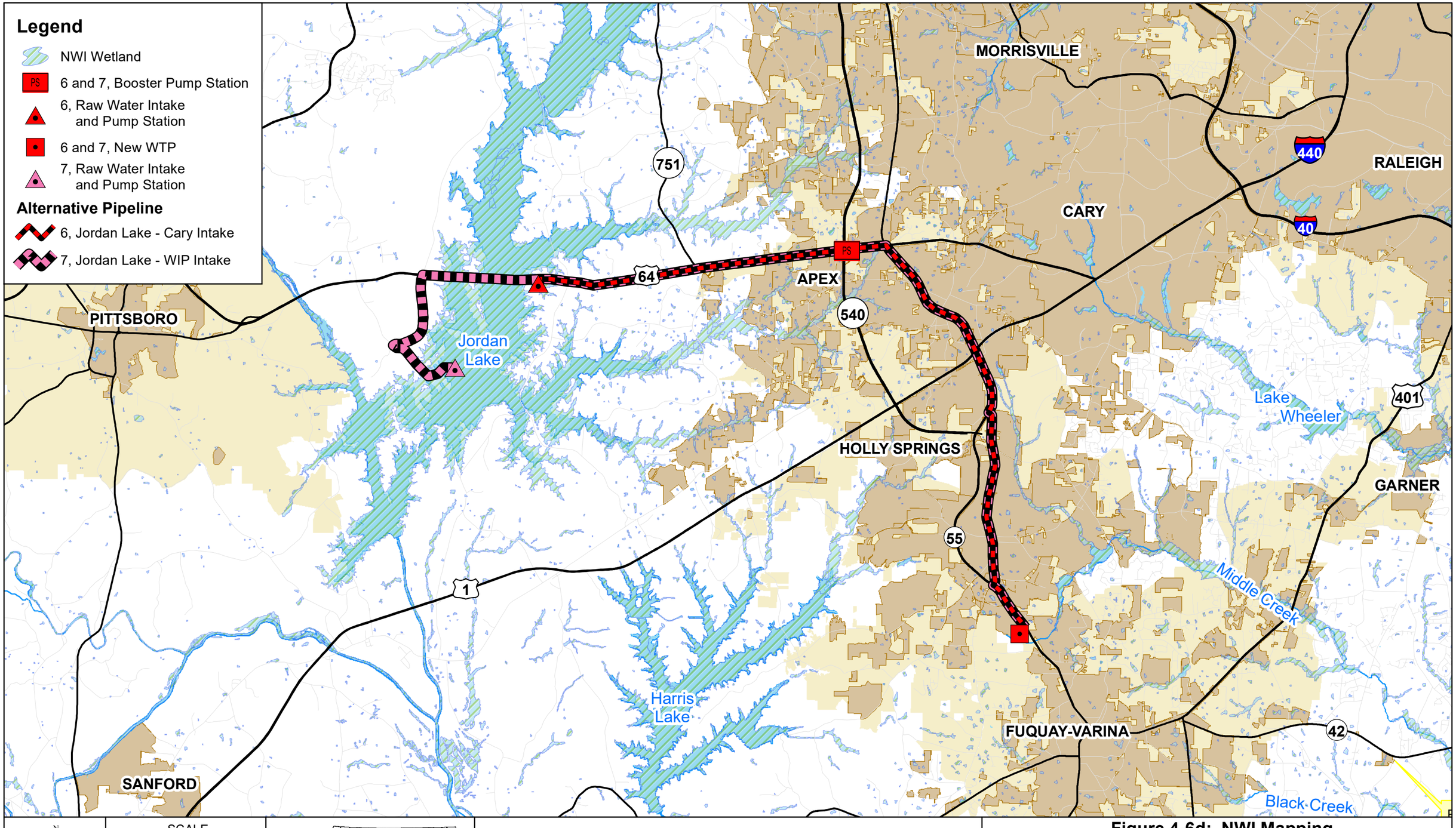
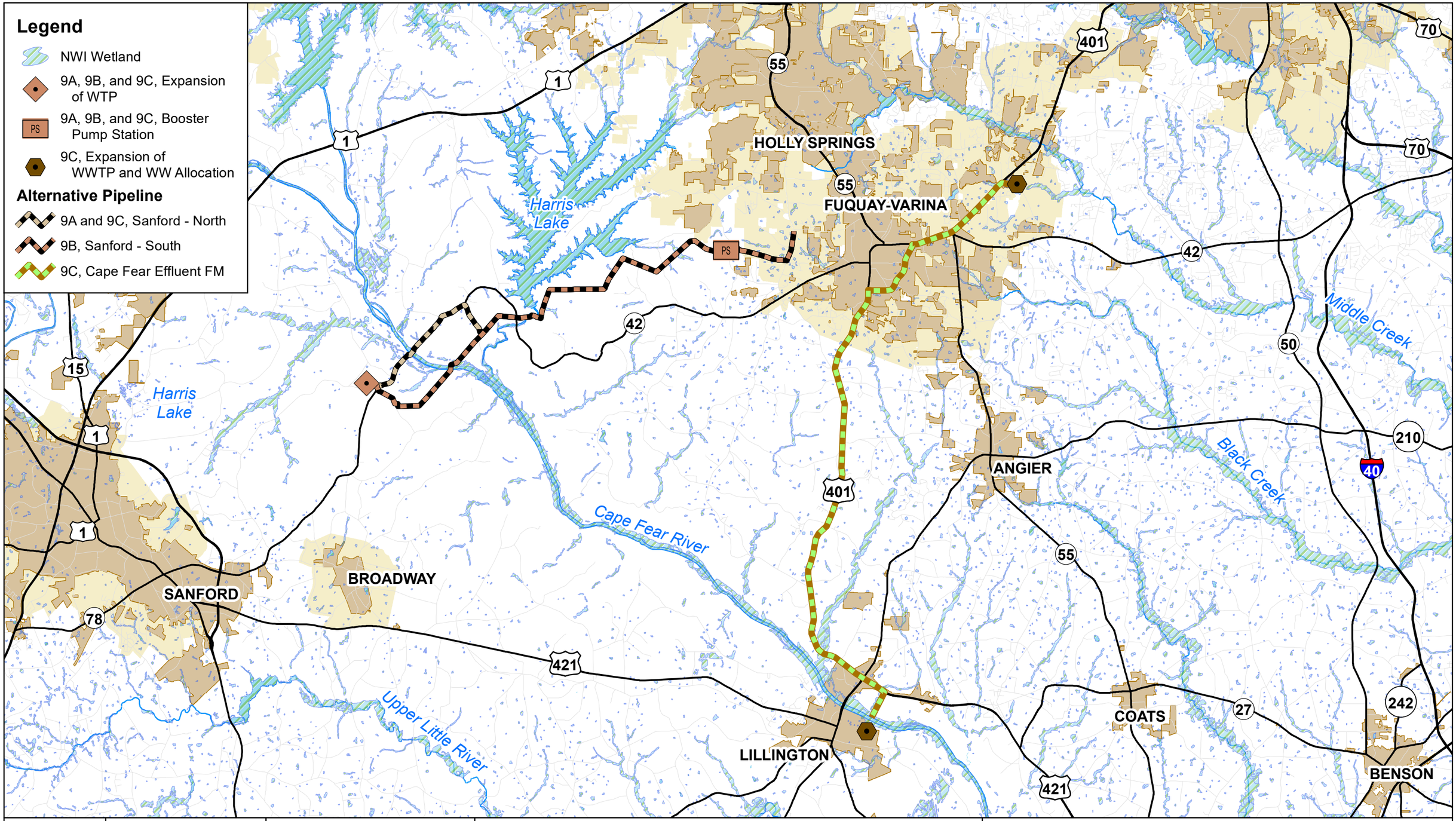


Figure 4-6d: NWI Mapping
Alternatives 6 and 7
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River



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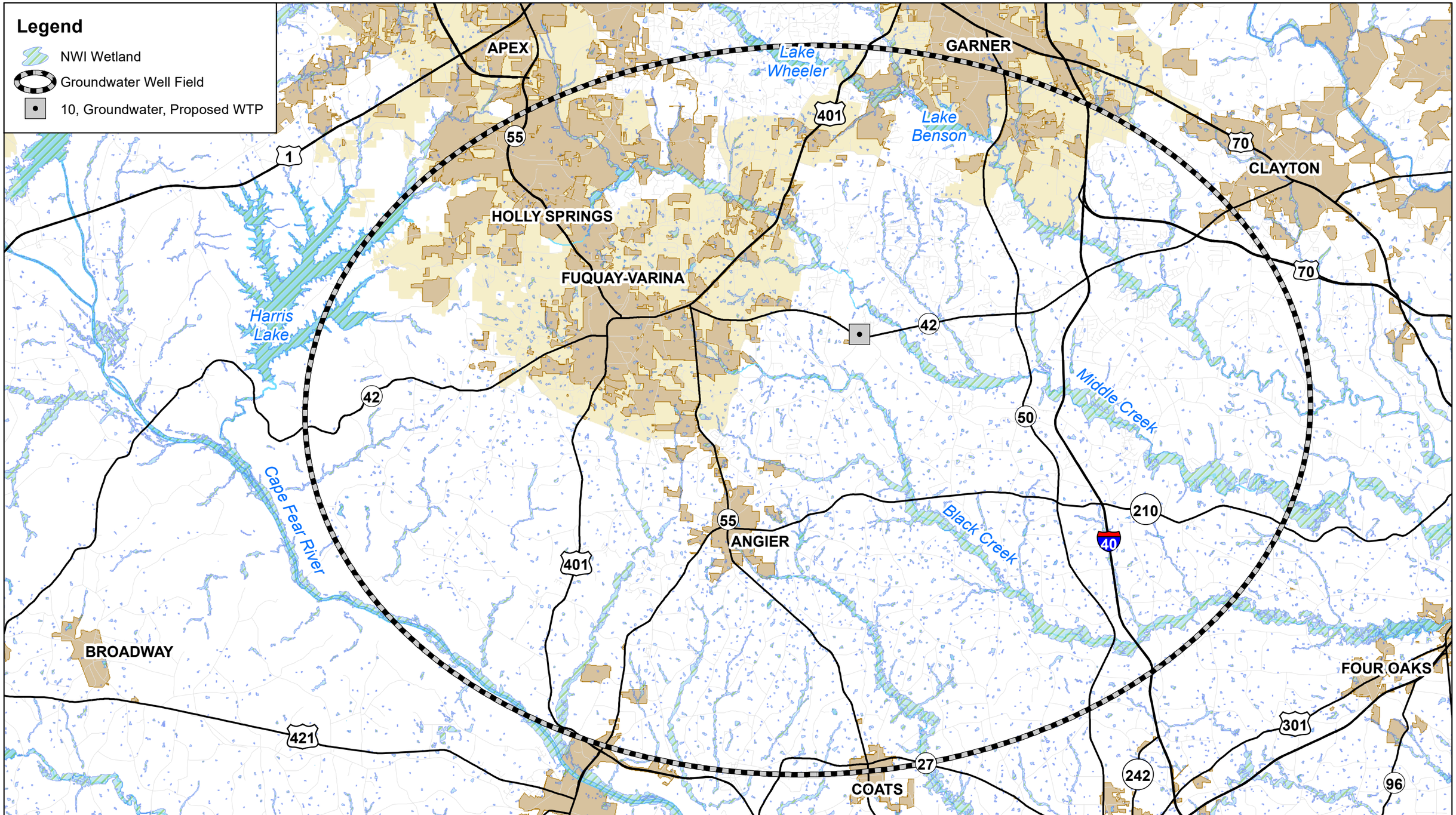
SCALE
1 inch = 2.5 miles
0 2.5
Miles

FUQUAY-VARINA
north carolina

Hazen

Figure 4-6e: NWI Mapping
Alternatives 9A, 9B, and 9C
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River



N
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SCALE
1 inch = 2.5 miles
0 2.5
Miles

FUQUAY-VARINA
north carolina

Hazen

Figure 4-6f: NWI Mapping
Alternative 10
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

4.11 Shellfish or Fish and Their Habitats

Aquatic habitats in the project areas include streams, which provide free-flowing, warm-water habitats, and ponds, which also provide warm-water habitat. Several named, perennial streams are located in the project area, including Buckhorn Creek, Buies Creek, Upper South River, Middle Creek, Swift Creek, Black Creek, Walnut Creek, Little River, Moccasin Creek, Basal Creek, and Mill Creek. Numerous unnamed perennial, intermittent, and ephemeral streams that are tributaries to the aforementioned major streams are also present in the project areas and provide habitat for various species of fish and shellfish.

WRC has listed the priority aquatic species in the North Carolina portions of the Cape Fear and Neuse River basins and performs periodic fish community sampling within some of the wadeable streams in the Cape Fear and Neuse River basins (WRC, 2005). Approximately 95 fish species and priority aquatic species were reported by WRC in 2017 in sampled streams traversed by the project areas. Of the priority species listed by WRC, two species listed as a Federal Species of Concern (FSC), Carolina darter (*Etheostoma collis*) and sandhills chub (*Semotilus lumbee*), were collected within the Cape Fear and Neuse River basins. Other priority aquatic fish species found by WRC include the following:

- Roanoke bass (*Ambloplites cavifrons)*
- Snail bullhead *(Ameiurus brunneus)*
- Banded pygmy sunfish *(Elassoma zonatum)*
- Blackbanded sunfish (*Enneacanthus chaetodon)*
- Lake chubsucker *(Erimyzon sucetta)*
- Johnny darter (*Etheostoma nigrum)*
- Glassy darter (*Etheostoma vitreum)*
- Lined topminnow (*Fundulus lineolatus)*
- Dollar sunfish (*Lepomis marginatus)*
- Pinewoods shiner (*Lythrurus matutinus)*
- Notchlip redhorse (*Moxostoma collapsum)*
- Shorthead redhorse (*Moxostoma macrolepidotum)*
- V-lip redhorse (*Moxostoma pappillosum)*
- Comely shiner *(Notropis amoenus)*
- Ironcolor shiner (*Notropis chalybaeus)*
- Mimic shiner (*Notropis volucellus)*
- Sea lamprey (*Petromyzon marinus)*

Nine federally protected mussel species are listed as priority aquatic species in both the Cape Fear and Neuse River basins. Three mussel species are not federally protected but are listed as priority aquatic species by WRC. Six federally protected mussel species are listed as priority aquatic species in the Cape Fear River basin. Five federally protected mussel species are listed as priority aquatic species in the Neuse River basin. There are seven crayfish species and four snail species listed as priority aquatic species for

both river basins. Additional information regarding the state and federally protected species and documented occurrences is provided in Section 4.13.

4.12 Forest Resources

Natural forested communities are scattered throughout the undeveloped and developed portions of the project area. The forested areas include conifer forests, bottomland forests, and mixed hardwood forests. The project area consists of developed land with small, wooded areas (e.g., mature soft and hardwoods) primarily located along riparian corridors, agricultural land, and wooded, undeveloped land. The North Carolina Division of Forest Resources (DFR) has mapped Important Forest Lands throughout the state. Important Forest Lands are defined by DFR as "those which are important for sustaining the forest products sector of our economy and providing ecosystem services that are compatible with forest management, such as protecting drinking water supplies." Within components of each alternative, portions of the areas denoted as Important Forest Lands have been converted to non-forested uses such as farm fields and residential development. Additionally, some of the areas designated as Important Forest Land encroach into maintained roadway rights-of-way, in which a large portion of the pipe corridors are located. Forest land is not a regulated resource. Forest resources within the project areas were calculated from visual assessment and electronic measurement of forested areas shown on recent aerial photographs and Important Forestland GIS data.

4.12.1 Alternative 1

The pipe corridor associated with Alternative 1 is mainly located along maintained roadway easements. Several small portions of the pipe corridor traverse undeveloped areas that consist of agricultural and forested land. Approximately 198 acres of the Alternative 1 pipe corridor is located in areas denoted as Important Forest Land. The elevated water tank and pump station cover approximately 6 acres denoted as Important Forest Lands. The expansion of the WTP is expected to encroach upon 55 acres of Important Forest Lands. The proposed Middle Creek Reservoir encompasses 1,098 acres of Important Forest Lands. The booster pump station site associated with this alternative is not located in areas denoted as Important Forest Lands. Alternative 1 is expected to encroach upon 1,357 total acres of Important Forest Lands.

4.12.2 Alternative 2

The Alternative 2 pipe corridor is mainly located along maintained roadway ROW and crosses numerous agricultural fields and wooded areas. Approximately 116 acres of the Alternative 2 pipe corridor is located in areas denoted as Important Forest Lands. The raw water storage site with 100-foot buffer includes approximately 12 acres of Important Forest Lands. The booster pump station and WTP sites each cover one acre of Important Forest Lands. The two raw water intake and pump station sites associated with this alternative are not located in areas denoted as Important Forest Lands. Alternative 2 is expected to encroach upon 130 total acres of Important Forest Lands.

4.12.3 Alternative 3

The pipe corridor associated with Alternative 3 is located entirely in maintained roadway rights-of-way. The pipe corridor traverses approximately six acres of area denoted as Important Forest Lands. The proposed WTP is expected to cover two acres of Important Forest Lands. Approximately 678 acres of the Alternative 3 proposed Middle Creek Reservoir is located in areas denoted as Important Forest Lands. The raw water intake and pump station site associated with this alternative is not located in areas denoted as Important Forest Lands. Alternative 3 is expected to encroach upon 686 total acres of Important Forest Lands.

4.12.4 Alternative 4

Portions of the Alternative 4 pipe corridor are located along roadways, with the remainder of the corridor traversing agricultural and wooded land. Approximately 15 acres of the Alternative 4 pipe corridor traverses areas denoted as Important Forest Lands. The raw water storage site is expected to cover 13 acres of Important Forest Lands. The expansion of the existing WTP will encompass approximately 14 acres of Important Forest Lands. The raw water intake and pump station site associated with this alternative is not located in areas designated as Important Forest Land. Alternative 4 is expected to encroach upon 42 total acres of Important Forest Lands.

4.12.5 Alternative 5

The pipe corridor associated with Alternative 5 is located entirely along maintained roadway rights-of-way. Approximately 14 acres of the Alternative 5 pipe corridor traverse an area denoted as Important Forest Lands. The expansion of the existing WTP is expected to cover five acres of areas designated as Important Forest Lands. The raw water intake expansion and the raw water intake and pump station site associated with this alternative are not located in areas designated as Important Forest Land. Alternative 5 is expected to encroach upon 19 total acres of Important Forest Lands.

4.12.6 Alternative 6

The Alternative 6 pipe corridor is mainly located along maintained roadway ROW. Two portions of the pipe corridor are not located along roadway easement and traverse mainly agricultural land and some undeveloped, wooded land. Approximately 14 acres of the Alternative 6 pipe corridor traverses Important Forest Land. The proposed booster pump station site is expected to cover less than one acre of Important Forest Lands. Approximately 62 acres of the proposed WTP is in areas denoted as Important Forest Land. The raw water intake and pump station site associated with this alternative is not located in areas designated as Important Forest Land. Alternative 6 is expected to encroach upon 76 total acres of Important Forest Lands.

4.12.7 Alternative 7

The pipe corridor associated with Alternative 7 is located entirely along maintained roadway rights-of-way. The pipe corridor traverses approximately 23 acres of area denoted as Important Forest Lands, most of which is presently forested. Less than one acre of the booster pump station site covers Important Forest

Lands. The proposed WTP is expected to encompass 62 acres of Important Forest Lands. The raw water intake and pump station site associated with this alternative is not located in Important Forest Land areas. Alternative 7 is expected to encroach upon 85 total acres of Important Forest Lands.

4.12.8 Alternative 8A

The pipe corridor associated with Alternative 8A is located entirely along maintained roadway ROW. The portion of the pipe corridor traverses approximately 36 acres of area denoted as Important Forest Lands. Approximately 37 acres of the proposed WTP is denoted as Important Forest Lands. The pump station is within one acre of Important Forest Lands. The existing WWTP to be expanded contains 34 acres of Important Forest Lands. Alternative 8A is expected to encroach upon 108 total acres of Important Forest Lands.

4.12.9 Alternative 8B

The pipe corridor associated with Alternative 8B is located entirely along maintained roadway ROW. The pipe corridor traverses approximately 22 acres of Important Forest Lands. The Important Forest Lands acreage associated with the proposed WTP, pump station, and expansion of the WWTP for Alternative 8B are the same as Alternative 8A. Alternative 8B is expected to encroach upon 94 total acres of Important Forest Lands.

4.12.10 Alternative 9A

The Alternative 9A pipe corridor is located entirely along maintained roadway easements. Approximately 108 acres of land located along the pipe corridor are denoted as Important Forest Lands. The booster pump station site associated with this alternative is not located in Important Forest Land areas. Alternative 9A is expected to traverse 108 total acres of Important Forest Lands.

4.12.11 Alternative 9B

The pipe corridor associated with Alternative 9B is mainly located along maintained roadway easements. Approximately 138 acres of the pipe corridor traverse areas designated as Important Forest Lands. The booster pump station site associated with this alternative is not located in Important Forest Land areas. Alternative 9B is expected to traverse 138 total acres of Important Forest Lands.

4.12.12 Alternative 9C

The Alternative 9A finished water line corridor is located entirely along maintained roadway easements. Approximately 108 acres of land located along the pipe corridor are denoted as Important Forest Lands. The booster pump station site associated with this alternative is not located in Important Forest Land areas. The pipe corridor associated with effluent force main is located entirely along maintained roadway rights-of-way and traverses approximately 36 acres of area denoted as Important Forest Lands. The existing WWTP contains 34 acres of Important Forest Lands. Alternative 9C is expected to encroach upon 216 total acres of Important Forest Lands.

4.12.13 Alternative 9D

The pipe corridor associated with Alternative 9D is primarily located along actively maintained roadway easements. Approximately 57 acres of pipe corridor will traverse areas designated as Important Forest Lands. The existing WWTP to be expanded contains 34 acres of Important Forest Lands. The proposed booster station associated with Alternative 9D is not located in Important Forest Land areas.

4.12.14 Alternative 10

The well field is dominated by agricultural land with developed and undeveloped areas present. Approximately 125,106 acres of Important Forest Lands are mapped in the well field area. Mapped Important Forest Lands within the Alternative 10 footprint is not known since the well field has not been designed.

4.13 Wildlife and Natural Vegetation

4.13.1 Wildlife Habitat and Resources

The availability and distribution of wildlife habitat can be determined by assessing the land cover of an area. For the purposes of this EIS, primary land cover classes are combined into major community types. The major community types in the project area are typical of urbanized areas in the piedmont and include disturbed lands and forested areas. General descriptions of the flora and fauna that are commonly observed in the major community types are provided in the following sections.

4.13.1.1 Disturbed Lands

Disturbed lands are present in portions of the project area. Urban disturbed land includes residential areas with maintained grass lawns and sporadically planted hardwood trees and shrubs, industrial buildings with wide-open cultivated grass lawns, and various rights-of-way or otherwise disturbed lands. Agricultural lands are included in the disturbed land category as well. Trees and shrubs in urban areas include many non-native species. Common woody species include silver maple (*Acer saccharinum*), Bradford pear (*Pyrus calleryana*), sawtooth oak (*Quercus acutissima*), willow oak (*Q. phellos*), pecan (*Carya illinoinensis*), hybrid azaleas (*Rhododendron* spp.), Chinese privet (*Ligustrum sinense*), Russian olive (*Eleagnus angustifolia*), and crepe myrtle (*Lagerstroemia indica*). Agricultural lands include plowed fields of planted crops and pasturelands for livestock.

Cats, dogs, and introduced species are abundant in these areas, reducing habitat suitability for native species. Reptile and amphibian species are limited to a few small, secretive species, such as the rough earth snake (*Virginia striatula*), northern brown snake (*Storeria dekayi*), and ground skink (*Scincella lateralis*). Predominant birds include the introduced house sparrow (*Passer domesticus*), European starling (*Sturnus vulgaris*), and feral pigeon (*Columba livia*) in addition to the native cardinal (*Cardinalis cardinalis*), American robin (*Turdus migratorius*), white-throated sparrow (*Zonotrichia albicollis*), blue jay (*Cyanocitta cristata*), Carolina wren (*Thryothorus ludovicianus*), mourning dove (*Zenaida macroura*), and northern mockingbird (*Mimus polyglottos*). Typical mammals of these areas are gray squirrel (*Sciurus carolinensis*),

house mouse (*Mus musculus*), Norway rat (*Rattus norvegicus*), raccoon (*Procyon lotor*), Virginia opossum (*Didelphus virginiana*), and big brown bat (*Eptesicus fuscus*).

4.13.1.2 Forested Areas

Forested areas in the project area include both mixed hardwood and pine forest. Wildlife in hardwood and mixed hardwood forests may be more diverse in woods that are less disturbed and that have greater stratification. The spotted (*Ambystoma maculatum*), white-spotted slimy (*Plethodon cylindraceus*), and marbled (*Ambystoma opacum*) salamanders may be found in the project area. The five-lined skink (*Eumeces fasciatus*) and eastern worm snake (*Carphophis amoenus amoenus*) are found in hardwood forests. The multi-strata structure of mixed hardwood and bottomland hardwood forests typically support high densities and diversities of neotropical migratory birds such as wood thrush (*Hylocichla mustelina*), ovenbird (*Seiurus aurocapillus*), Swainson's warbler (*Limnothlypis swainsonii*), worm-eating warbler (*Helmitheros vermivora*), prothonotary warbler (*Protonotaria citrea*), hooded warbler (*Wilsonia citrina*), and white-breasted nuthatch (*Sitta carolinensis*). Mammals such as the white-tail deer (*Odocoileus virginianus*), raccoon, eastern cottontail (*Sylvilagus floridanus*), gray squirrel, and white-footed mouse (*Peromyscus leucopus*) are likely to be found in the forests of the project area.

Pine forests in the Piedmont tend to support a relatively sparse animal community because of their lower plant species diversity compared with hardwood forest. Characteristic amphibians and reptiles are Fowler's toad (*Bufo woodhousei*), eastern box turtle (*Terrapene carolina*), rough green snake (*Opheodrys aestiva*), fence lizard (*Sceloporus undulatus*), six-lined racerunner (*Cnemidophorus sexlineatus*), five-lined skink, black rat snake (*Elaphe obsoleta*), kingsnakes (*Lampropeltis* spp.), and black racer (*Coluber constrictor*). Birds of pine forests include sharp-shinned hawk (*Accipiter striatus*), downy woodpecker (*Picoides pubescens*), yellow-bellied sapsucker (*Sphyrapicus varius*), pine warbler (*Dendroica pinus*), yellow-rumped warbler (*D. coronata*), white-breasted nuthatch, and several finch and sparrow species (*Fringillidae* spp.). Pine forest mammals include Virginia opossum, raccoon, gray squirrel, woodland vole (*Microtus pinetorum*), white-footed mouse, and red fox (*Vulpes vulpes*).

4.13.2 Rare and Protected Species or Habitats

Some populations of fauna and flora have been, or are, in the process of decline due to either natural forces or their inability to coexist with humans. Federal law, under the provisions of Section 7 of the Endangered Species Act (ESA) of 1973, as amended, requires that any action likely to adversely affect a federally protected species be subject to review by USFWS. Other species may receive additional protection under separate federal laws.

The project area is located in portions of Wake, Lee, Harnett, Johnston and Chatham Counties. The USFWS lists of federally protected species for each county were obtained via the USFWS Information for Planning and Consultation (IPaC) tool in August 2023. Eleven federally endangered (E) species, four federally threatened (T) species, one federal candidate (C) species, one federally proposed endangered (PE) species, and one federal similarity of appearance (SAT) species have been identified within the five counties. The bald eagle has been de-listed from the USFWS list but remains protected by the Bald and Golden Eagle Protection Act of 1940 (BGPA), as amended, and the Migratory Bird Treaty Act of 1918

(MBTA), as amended. In addition to the federally protected species, NHP has identified thirty-five endangered species, thirty-seven threatened species, and twenty-eight species of special concern in the five North Carolina counties (May 2023). Some of the state-listed species are historical occurrences. As state-listed species are not afforded legal protection in North Carolina, species that are listed by NHP only are not discussed aside from inclusion in Table 4-13. Each federally listed species and their state and federal status are described in the following subsections.

Critical habitat is designed by USFWS to ensure that areas essential to conservation of federally listed species is protected. Critical habitat was assessed for portions of Wake, Lee, Harnett, Johnston and Chatham Counties using the IPaC tool provided by USFWS. Four of the five counties provide critical habitat for specific aquatic species. Chatham and Lee Counties both provide critical habitat for the Cape Fear shiner. Wake County provides critical habitat for the Atlantic pigtoe, Neuse River waterdog, and the yellow lance. Johnston County provides critical habitat for the Atlantic pigtoe, Carolina madtom, Neuse River waterdog, and yellow lance. No critical habitat was identified for federally listed species in Harnett County.

A review of available NHP data from natural heritage shape files revealed there are forty federally protected species occurrences in the project areas (May 2023). Additional occurrences of thirty-nine federally protected species have been documented within a two-mile radius of the proposed project corridors. It should be noted that field surveys were not performed within the project areas to determine the presence or absence of habitat or species.

Table 4-13: Protected Species Listed for Chatham, Harnett, Johnston, Lee, and Wake Counties, North Carolina

Scientific Name	Common Name	State Status	Federal Status	County
Vertebrates				
Aimophila (Peucaea) aestivalis	Bachman's sparrow	SC	----	W, H, C
Alligator mississippiensis	American alligator	T	SAT	W, J, C, H
Ambloplites cavifrons	Roanoke bass	SR	----	L, J, C
Ambystoma mabeei	Mabee's salamander	T	----	H
Ambystoma talpoideum	Mole salamander	SC	----	W
Ambystoma tigrinum	Eastern tiger salamander	T	----	W
Ammodramus henslowii	Henslow's sparrow	E	----	W
Anaxyrus quercicus	Oak toad	SR	----	L, H, J
Colubar flagellum flagellum	Eastern coachwhip	SC	----	H
Crotalus horridus	Timber rattlesnake	SC	----	W
Condylura cristata pop. 1	Star-nosed mole, coastal plain population	SC	----	W
Corynorhinus rafinesquii macrotis	Eastern big-eared bat	SC	----	J
Enneacanthus chaetodon	Blackbanded sunfish	SR	----	H, J
Enneacanthus obesus	Banded sunfish	SR	----	W, H, J
Etheostoma collis	Carolina darter	SC	----	C
Eurycea quadridigitata	Dwarf salamander	SC	----	W, H, J
Farancia erytrogramma	Rainbow snake	SR	----	H, J
Haliaeetus leucocephalus	Bald eagle	T	BGPA	W, L, H, J, C
Hemidactylium scutatum	Four-toed salamander	SC	----	W, C
Heterodon simus	Southern hognose snake	T	----	W
Hyla andersonii	Pine barrens treefrog	T	----	L, H, J
Lampetra aepyptera	Least brook lamprey	T	----	W, J
Lanius ludovicianus	Loggerhead shrike	SC	----	W, L, H, J, C
Loxia curvirostra	Red crossbill	SC	----	W
Masticophis flagellum	Coachwhip	SR	----	H
Micrurus fulvius fulvius	Eastern coralsnake	E	----	H
Moxostoma robustum	Robust redhorse	E	----	C
Moxostoma sp.3	Carolina redhorse	T	----	L, H, C
Mycteria americana	Wood stork	----	T *	J

Table 4-13: Protected Species Listed for Chatham, Harnett, Johnston, Lee, and Wake Counties, North Carolina

Scientific Name	Common Name	State Status	Federal Status	County
Myotis austroriparius	Southeastern bat	SC	----	W, L, J
Myotis lucifugus	Little brown bat	E	----	W
Necturus lewisi	Neuse River waterdog	T	T	W, J, H
Notropis chalybaeus	Ironcolor shiner	T	----	W, H, J
Notropis mekistocholas	Cape Fear shiner	E	E	W, L, H, C
Notropis volucellus	Mimic shiner	T	----	W, J
Noturus furiosus	Carolina madtom	E	E	W, J, H
Noturus sp.2	Broadtail madtom	SC	----	H
Ophisaurus attenuates longicaudus	Eastern slender glass lizard	SR	----	W, H, J, C
Perimyotis subflavus	Tricolored bat	E	PE	W, L, H, J, C
Phalacrocorax auritus	Double-crested cormorant	SR	----	C
Picoides (Dryobates) borealis	Red-cockaded woodpecker	E	E	W, L, H, J, C
Pituophis melanoleucus melanoleucus	Northern pinesnake	T	----	H
Pseudacris nigrita	Southern chorus frog	SC	----	W, H, J
Pseudacris ornata	Ornate chorus frog	E	----	H
Semotilus lumbee	Sandhills chub	SC	----	L, H
Setophaga cerulea	Cerulean warbler	SC	----	J
Sistrurus miliarius miliarius	Carolina pigmy rattlesnake	SC	----	H
Vireo gilvus	Warbling vireo	SR	----	W
Zapus hudsonius	Meadow jumping mouse	SR	----	W
Invertebrates				
Acronicta albarufa	Barrens dagger moth	SR	----	W
Agrotis carolina	A dart moth	SR	----	H
Alasmidonta heterodon	Dwarf wedgemussel	E	E	W, J
Alasmidonta undulata	Triangle floater	T	----	W, L, H, J, C
Alasmidonta varicose	Brook floater	E	----	L, C
Apamea inebriate	Drunk apamea	SR	----	H
Argyrostrotis quadrifilaris	Four-lined chocolate moth	SR	----	H
Asioplax dolani	A mayfly	SR	----	J
Bombus affinis	Rusty-patched bumble bee	SR	----	W

Table 4-13: Protected Species Listed for Chatham, Harnett, Johnston, Lee, and Wake Counties, North Carolina

Scientific Name	Common Name	State Status	Federal Status	County
Bombus variabilis	Variable cuckoo bumble bee	SR	----	W, H
Callophrys hesseli	Hessel's hairstreak	SR	----	H
Callophrys irus	Frosted elfin	SR	----	H
Cambarus davidi	Carolina ladle crayfish	SR	----	W, H, C
Catocala marmorata	Marbled underwing	SR	----	W
Caupolicana electa	A plasterer bee	SR	----	H
Chlorochroa dismalia	Dismal Swamp green stink bug	SR	----	H
Choroterpes basalis	A mayfly	SR	----	C
Coryphaeschna ingens	Regal darner	SR	----	W
Danaus plexippus	Monarch butterfly	----	C	W, J, C, L, H
Dibusa angata	Angulated microcaddisfly	SR	----	W
Digrammia ordinata	Amorpha angle	SR	----	H
Diplectrona metaqui	A diplectronan caddisfly	SR	----	H
Elliptio fisheriana	Northern lance	SR	----	W, H, J
Ellipto folliculata	Pod lance	SC	----	H
Elliptio lanceolata	Yellow lance	T	T	W, J
Elliptio marsupiobesa	Cape Fear spike	SC	----	J
Elliptio roanokensis	Roanoke slabshell	SC	----	W, L, H, J, C
Erynnis martialis	Mottled duskywing	SR	----	W
Euphyes bimacula	Two-spotted skipper	SR	----	H, J
Exyra ridingsii	A pitcher-plant moth	SR	----	H
Fusconaia masoni	Atlantic pigtoe	T	T	W, H, J, C
Gomphurus septima	Septima's clubtail	SR	----	W, L, H, C
Gomphurus ventricosus	Skillet clubtail	SR	----	W
Grammia doris	Doris tiger moth	SR	----	W
Grammia placentia	Placentia tiger moth	SR	----	H
Heraclides cresphontes	Eastern giant swallowtail	SR	----	W
Hesperia metea	Cobweb skipper	SR	----	W, H, C
Lagoa pyxidifera	Yellow flannel moth	SR	----	H
Lampsilis cariosa	Yellow lampmussel	E	----	L, H, J, C
Lampsilis radiata	Eastern lampmussel	T	----	W, L, J, C

Table 4-13: Protected Species Listed for Chatham, Harnett, Johnston, Lee, and Wake Counties, North Carolina

Scientific Name	Common Name	State Status	Federal Status	County
Lampsilis splendida	Rayed pink fatmucket	SR	----	C
Lampsilis sp.2	Chameleon lampmussel	SR	----	L, C
Lasmigona subviridis	Green floater	E	----	W, J
Leucania calidior	Cane wainscot	SR	----	H
Ligumia nasuta	Eastern pondmussel	T	----	C
Lioplax subcarinata	Ridged lioplax	SC	----	J
Lytrosis permagnaria	A geometrid moth	SR	----	C
Megachile brimleyi	A leafcutter bee	SR	----	H
Megachile deflexa	A leafcutter bee	SR	----	H
Megachile ingenua	A leafcutter bee	SR	----	W
Megachile integra	A leafcutter bee	SR	----	W, H
Megachile oenotherae	A leafcutter bee	SR	----	W
Melanoplus nubilus	Nubile short-wing grasshopper	SR	----	H
Neonympha helicta	Helicta satyr	SR	----	H, C
Neonympha mitchellii francisci	Saint Francis' satyr butterfly	----	E	H
Nomada tyrrellensis	A cuckoo bee	SR	----	W
Orconectes (Faxonius) carolinensis	North Carolina spiny crayfish	SC	----	W, J
Parvospina steinstansana	Tar River spinymussel	E	E	W, J, C
Perlesta bjostadi	Anomalus stone	SR	----	H
Perlesta georgiae	Barbeque stone	SR	----	H
Phanogomphus quadricolor	Rapids clubtail	SR	----	C
Pontia protodice	Checkered white	SR	----	W, H, C
Procambarus medialis	Pamlico crayfish	T	----	J
Satyrium edwardsii	Edward's hairstreak	SR	----	H
Schizura sp. 1	A new prominent moth	SR	----	W
Somatochlora georgiana	Coppery emerald	SR	----	L, H, J, C
Somatogyrus virginicus	Panhandle pebblesnail	SR	----	C
Sphingicampa bisecta	Bisected honey locust moth	SR	----	C
Stenelmis hollandi	A riffle beetle	SR	----	H
Strophitus undulatus	Creeper	T	----	W, L, H, J, C
Toxolasma pullus	Savannah Lilliput	E	----	W, L, C

Table 4-13: Protected Species Listed for Chatham, Harnett, Johnston, Lee, and Wake Counties, North Carolina

Scientific Name	Common Name	State Status	Federal Status	County
Villosa constricta	Notched rainbow	T	----	W, L, H, J, C
Villosa delumbis	Eastern creekshell	SR	----	L, H, C
Villosa vaughaniana	Carolina creekshell	E	----	L, C
Vascular Plants				
Acmella repens	Creeping spotflower	SR-D	----	W
Acmispon helleri	Carolina birdfoot-trefoil	T	----	W
Agastache nepetoides	Yellow giant-hyssop	SR-P	----	W
Amorpha georgiana	Georgia indigo-bush	E	----	L, H
Asclepias purpurascens	Purple milkweed	SR-T	----	J
Astragalus michauxii	Sandhills milk-vetch	SC-V	----	H
Baptisia alba	Thick-pod white wild indigo	T	----	J
Buchnera americana	American bluehearts	E	----	W, H
Cardamine douglassii	Douglass's bittercress	SR-P	----	W, H
Carex austrodefelxa	Canebrake sedge	SR-L	----	H, L
Carex barrattii	Barratt's sedge	SC-H	----	H
Carex bushii	Bush's sedge	SR-P	----	J
Carex crus-corvi	Crowfoot sedge	SR-P	----	J, C
Carex emmonsii	Emmons's sedge	SR-O	----	H, J
Carex exilis	Coastal sedge	E	----	H
Carex impressinervia	Ravine sedge	SC-V	----	H
Carex jamesii	James's sedge	SC-V	----	L, H
Carex meadii	Mead's sedge	E	----	W
Carex projecta	Necklace sedge	SR-P	----	L
Carex reniformis	Kidney sedge	T	----	W, J
Carex vestita	Velvet sedge	T	----	C
Cirsium carolinianum	Carolina thistle	E	----	W
Clematis catesbyana	Coastal virgin's-bower	SR-P	----	W
Collinsonia tuberosa	Piedmont horsebalm	SR-P	----	C
Corallorhiza wisteriana	Spring coral-root	SR-O	----	H
Crataegus munda	Batesburg hawthorn	SR-T	----	W

Table 4-13: Protected Species Listed for Chatham, Harnett, Johnston, Lee, and Wake Counties, North Carolina

Scientific Name	Common Name	State Status	Federal Status	County
Cyperus granitophilus	Granite flatsedge	T	----	W
Cyperus virens	Green flatsedge	SC-V	----	W
Danthonia epilis	Bog oatgrass	SR-T	----	H
Dichanthelium annulum	Ringed witch grass	E	----	W, L, C
Dichanthelium cryptanthum	Hidden-flowered witchgrass	SR-T	----	W, H, J
Didiplis diandra	Water purslane	SR-P	----	W, H, J
Echinacea laevigata	Smooth coneflower	----	E	W
Eleocharis robbinsii	Robbin's spikerush	SC-V	----	H
Enemion biternatum	Eastern isopyrum	SC-V	----	L, H, C
Eupatorium resinosum	Pine barren boneset	SR-O	----	H
Eurybia spectabilis	Showy aster	SR-O	----	L, J, C
Fothergilla major	Large witch-alder	SR-T	----	W, H, C
Gillenia stipulata	Indian physic	T	----	W, L, C
Helenium brevifolium	Littleleaf sneezeweed	E	----	W
Heteranthera pauciflora	Atlantic mud-plantain	SR-P	----	W
Hexalectris spicata	Crested coralroot	SR-P	----	H, J
Hottonia inflata	Featherfoil	SC-V	----	J
Ilex longipes	Georgia holly	SR-P	----	J
Iris prismatica	Slender blue iris	SR-T	----	H, J
Isoetes piedmontana	Piedmont quillwort	T	----	W
Isoetes virginica	Virginia quillwort	SR-L	----	C
Leersia lenticularis	Catchfly cutgrass	SR-P	----	J, C
Liatris squarrulosa	Earle's blazing-star	SR-P	----	W, H
Lilium pyrophilum	Sandhills lily	E	----	L, H
Lindera melissifolia	Pondberry	----	E	J
Lindera subcoriacea	Bog spicebush	SC-V	----	W, L, H, J, C
Ludwigia brevipes	Long beach seedbox	SR-T	----	H, J
Ludwigia sphaerocarpa	Globe-fruit seedbox	E	----	J
Lysimachia asperulifolia	Rough-leaf loosestrife	E	E	H, J, C, L
Macbridea caroliniana	Carolina bogmint	E	----	H, J
Magnolia macrophylla	Bigleaf magnolia	SC-V	----	W

Table 4-13: Protected Species Listed for Chatham, Harnett, Johnston, Lee, and Wake Counties, North Carolina

Scientific Name	Common Name	State Status	Federal Status	County
Micranthes pensylvanica	Swamp saxifrage	E	----	W
Monotropsis odorata	Sweet pinesap	SR-O	----	W, C
Parnassia caroliniana	Carolina grass-of-parnassus	T	----	L, H
Paspalum fluitans	Horsetail crown grass	SR-P	----	W, H, J, C
Phacelia covillei	Buttercup phacelia	SR-T	----	L, H, C
Polygala senega	Seneca snakeroot	SC-V	----	W
Portulaca smallii	Small's portulaca	T	----	W
Potamogeton confervoides	Conferva pondweed	SR-D	----	H
Pseudognaphalium helleri	Heller's rabbit-tobacco	E	----	W
Ptilimnium nodosum	Harperella	E	E	W, C, L, H
Pycnanthemum virginianum	Virginia mountain-mint	SR-P	----	W
Pyxidanthera barbulata	Sandhills pyxie-moss	T	----	H
Quercus austrina	Bluff oak	SR-P	----	J
Rhus michauxii	Michaux's sumac	E	E	W, J, H
Rhynchospora macra	Southern white beaksedge	T	----	H
Rudbeckia heliopsidis	Sun-facing coneflower	E	----	H
Ruellia humilis	Low wild-petunia	T	----	W
Ruellia purshiana	Pursh's wild-petunia	SC-V	----	W
Sagittaria weatherbiana	Grassleaf arrowhead	E	----	W
Schoenoplectus etuberculatus	Canby’s bulrush	SR-P	----	H, J
Scutellaria australis	Southern skullcap	E	----	W, L, J
Scutellaria nervosa	Veined skullcap	E	----	W, C
Silphium terebinthinaceum	Prairie dock	SR-P	----	W
Solidago radula	Western rough goldenrod	E	----	W
Solidago verna	Spring-flowering goldenrod	T	----	H, J
Stylisma pickeringii	Pickering’s dawnflower	SC-V	----	H
Symphyotrichum concinnum	Narrow-leaved smooth aster	E	----	W
Thermopsis mollis	Appalachian golden-banner	SR-T	----	W, C
Torreyochola pallida	Pale mannagrass	SR-P	----	H
Tradescantia virginiana	Virginia spiderwort	SR-O	----	W, H
Triadenum tubulosm	Marsh St.John’s-wort	SR-O	----	H

Table 4-13: Protected Species Listed for Chatham, Harnett, Johnston, Lee, and Wake Counties, North Carolina

Scientific Name	Common Name	State Status	Federal Status	County
Trichostema setaceum	Narrowleaf bluecurls	SR-T	----	W
Trifolium reflexum	Buffalo clover	T	----	W, H, C
Trillium pusillum var. 4	Carolina least trillium	SR-T	----	W, J
Urtica chamaedryoides	Dwarf stinging nettle	T	----	J
Warea cuneifolia	Carolina pineland-cress	E	----	H
Xyris chapmanii	Chapman's yellow-eyed-grass	SR-D	----	H
Xyris scabrifolia	Harper's yellow-eyed-grass	SC-V	----	H
Non-Vascular Plants				
Archidium donnellii	Donnell's aecidium	SR-O	----	W
Bruchia brevifolia	A pygmy moss	SR-T	----	H
Bruchia carolinae	A pygmy moss	SR-L	----	L
Bruchia fusca	A pygmy moss	SR-T	----	H
Campylopus oerstedianus	Oersted's campylopus	SR-D	----	W
Cleistocarpidium palustre	Phascum moss	SR-D	----	W
Fontinalis sphagnifolia	A water moss	SR-O	----	H
Lejeunea glaucescens	Raven rock liverwort	SR-L	----	H
Lindbergia brachyptera	Lindberg's maple-moss	SR-P	----	H
Pleuridium sullivantii	A moss	SR-O	----	H
Sphagnum subsecundum	Orange peatmoss	SR-P	----	W
Sphagnum torreyanum	Giant peatmoss	SR-P	----	H
Tortula plinthobia	A chain-teeth moss	SR-O	----	W
Weissia ludoviciana	A moss	SR-T	----	J

*Notes * - Proposed for delisting (February 15, 2023)*

Key to State Status:

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).

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).

SC – Special Concern: Any species of plant in North Carolina which required 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).

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).

D – Disjunct: The species is disjunct to North Carolina from a main range in a different part of the country or world.

Table 4-13: Protected Species Listed for Chatham, Harnett, Johnston, Lee, and Wake Counties, North Carolina

Scientific Name	Common Name	State Status	Federal Status	County

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.

O – Other: The range of the species is sporadic or cannot be described by the other Significantly Rare categories.

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.

T – Throughout: These species are rare throughout their ranges (fewer than 100 populations total).

V – 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.

Key to Federal Status:

E - Endangered. A taxon "in danger of extinction throughout all or a significant portion of its range."

T – Threatened. A taxon likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

BGPA – Bald and Golden Eagle Protection Act. The bald eagle was de-listed from the Federal List of Threatened and Endangered wildlife, and the primary law protecting the bald eagle became the BGPA.

Key to County of Occurrence:

W – Wake County, NC

L – Lee County, NC

H – Harnett County, NC

J – Johnston County, NC

C – Chatham County, NC

4.13.2.1 Vertebrates

Atlantic sturgeon (*Acipenser oxyrinchus*)

The Atlantic sturgeon is an anadromous fish that can grow up to 14 feet in length, weigh up to 800 pounds, and live up to 60 years of age. This fish is known to live in rivers and coastal waters from Canada to Florida. Sturgeon are anadromous, so this species hatches in freshwater streams, heads out to sea as juveniles, and then returns to their birthplace to spawn or lay eggs in adulthood. Atlantic sturgeons have five distinct rows of bony scute along their body. Their topside is a blueish black or olive brown color with pale sides and a white underside. The tail has one lobe that is larger than the other and there are four barbels on the snout. Spawning habitat requires hard bottom substrate in freshwater reaches. This fish is sensitive to sediment and water quality.

American alligator (*Alligator mississippiensis*)

The American alligator is 6 to 17 feet long. This species has a broadly rounded snout, which distinguishes it from the American crocodile (*Crocodylus aeutus*), a federally endangered species. Coloration of the alligator is generally black, with young having light markings of yellowish crossbands that may persist into adulthood. These alligators are residents of the great river swamps, lakes, bayous, marshes, and other water bodies of Florida, the Gulf, and Lower Atlantic Coastal Plains. Nests consist of mounds of vegetative debris in which the eggs are buried between spring and early autumn; incubation is 65 days. At hatching, most young are between 8 and 9 inches long.

Bald eagle (*Haliaeetus leucocephalus*)

The mature bald eagle (usually more than 4 years of age) can be identified by its large white head and short white tail. The body plumage is dark brown to chocolate-brown in color. Bald eagles can easily be distinguished from other birds by their flat wing soar. They are primarily associated with large bodies of water where food is plentiful. Eagle nests are found in proximity to water (usually within 0.5 mile) with a clear flight path to the water, in the largest living tree in an area with an open view of the surrounding land. Human disturbance may cause nest abandonment. The breeding season for the bald eagle begins in December and January. Fish are the major food source, although forage items include coots, herons, wounded ducks, and carrion.

The bald eagle was delisted from the ESA on June 28, 2007. Populations were monitored for a period of five years, which ended on June 27, 2012, to ensure that delisting the species did not result in a decline. Bald eagles remain protected under two federal laws, the MBTA, as amended, and the BGPA, as amended. In some states, additional protections are afforded to the bald eagle under state legislation.

Wood stork (*Mycteria americana*)

The wood stork is a large wading bird. These birds grow up to 50 inches tall with a wingspan of 60 to 65 inches. They have white plumage on the body with black edge feathers and tail. The head and neck are majorly unfeathered and have a dark gray color. The bill is a similar dark gray/black color, is curved downward slightly, and is thick at the base. Juveniles are a light gray color and have a yellowish bill. It has a large range that extends from the southeastern United States to Mexico and South America. The Wood

Stork nesting coincides with receding water levels. Incubation lasts 28 to 32 days. These birds are residents of marshes, swamps, lagoons, ponds, flooded fields, and brackish wetlands. Diet consists of mainly fish as well as a variety of other small animals.

Neuse River waterdog (*Necturus lewisi*)

The Neuse River waterdog is a large, aquatic salamander with external gills. It is dull, rusty brown in color with dark brown to blue-black spots. It is found only in larger streams and rivers of the Tar-Pamlico and Neuse River basins of North Carolina. This stream dweller requires relatively high oxygen levels and water quality and is generally found among large accumulations of submerged leaves in eddies or backwaters of streams.

Cape Fear shiner (*Notropis mekistocholas*)

The Cape Fear shiner is a small fish, rarely exceeding 2 inches in length, which is endemic to the Cape Fear drainage in North Carolina. This species is specifically found in Randolph, Moore, Lee, Harnett, and Chatham Counties of the lower Piedmont and upper Sandhills. The Cape Fear shiner is pale silvery yellow with a black band the length of its body. The fins are yellowish and somewhat pointed. Unlike other members of its genus, the Cape Fear shiner is thought to feed extensively on plant material. Information on breeding behavior is not available. The preferred habitat is clean streams with gravel, cobble, and boulder substrates with pools, riffles, shallow runs, and side channels and pools. The preferred water quality is good to excellent with low silt loads. Critical habitat has been designated for this species on several multi-mile reaches of Deep River, which is crossed by several project corridors.

Carolina madtom (*Noturus furiosus*)

The Carolina madtom is a 2- to 5-inch-long, tan-colored catfish. They have a wide black stripe on the side and four black saddles across their back. The Carolina madtom occurs in the lower Piedmont and Coastal Plain of the Tar and Neuse River basins. They prefer shallow, low gradient, riffles and runs in areas where substrate is comprised of fine to coarse sand, gravel, and detritus in small to medium rivers.

Red-cockaded woodpecker (*Picoides borealis*)

The red-cockaded woodpecker (RCW) is a medium-sized bird with entirely black and white plumage, except for small red streaks on the nape of the male. The back of the RCW is striped, and the bird has a large white cheek patch surrounded by a black cap, nape, and throat. The RCW's diet is composed mainly of insects, including ants, beetles, wood-boring insects, caterpillars, and corn earworms, if available. The RCW lays its eggs in April, May, and June; the eggs hatch approximately 38 days later.

The RCW is found in the southeastern U.S. In North Carolina, RCW are known to inhabit the Sandhills and northeast and southeast coastal plain. RCW is unique as this species nests exclusively in living pine trees. The RCW uses open, old-growth stands of southern pines, particularly longleaf pine, for foraging and nesting habitat. Slash, pond, or loblolly pines will also be utilized if longleaf is not available. The preferred forested stand contains at least 50 percent pine and lacks a hardwood midstory and thick understory.

RCW typically excavates nests in pines greater than 60 years old and contiguous with pine stands at least 30 years of age. Living pines infected with red-heart disease (*Formes pini*) are often selected for cavity excavation because the inner heartwood is usually weakened. Cavities are located from 12 to 100 feet above ground level and under live branches. These trees may be identified by candles, large encrustations of running sap that surrounds the tree. Clusters consist of one to multiple of these candle trees. The foraging range of the RCW may extend 500 acres and must be contiguous with suitable nesting sites. Foraging habitat should be within 0.5 mile of the nesting habitat. RCW are known or believed to occur in three out of the five counties in the project areas to include Chatham, Harnett, and Johnston.

4.13.2.2 Invertebrates

Dwarf wedgemussel (*Alasmidonta heterodon*)

The dwarf wedgemussel is a relatively small (from 0.9 to 1.8 inches in length) mussel with a subrhomboidal to subtrapezoidal shell. The exterior shell color is greenish-brown with green rays. The interior nacre is bluish to silvery white. This species is unique in the reversed arrangement of its lateral teeth; there are two teeth on the right valve and one on the left. The dwarf wedgemussel has an historic range from New Brunswick, Canada, south to the Neuse River in North Carolina. Currently, the range is greatly reduced in the northern portion of the range and fragmented throughout the southern portion. In the project vicinity, populations are known from the Tar and Neuse River basins in North Carolina. This mussel inhabits large rivers to small streams within its range. The preferred substrate is clay banks stabilized with the root systems of trees. Other bed substrates include coarse sands, mixed sand, gravel and cobble, and very soft silts. The most important feature of their preferred habitat appears to be excellent to good water quality.

Monarch butterfly (*Danaus plexippus*)

The monarch butterfly is a butterfly that has brilliant orange and black colors on the wings. The monarch butterfly has an annual migration with a range from North America, through Central America, and to northern South America. Milkweed and flowering plants are necessary for monarch butterfly habitat. The plant host for the caterpillars of this species are milkweeds, including common milkweed, swamp milkweed, and showy milkweed. Milkweed is necessary for the caterpillars to morph into their butterfly form. Monarch butterflies feed on the nectar of flowers.

Yellow lance (*Elliptio lanceolata*)

The yellow lance is an approximately 3-inch freshwater mussel in which the shells are more than twice as long as they are tall. The periostracum of the yellow lance is waxy, and the entire surface is bright yellow in younger specimens. Older specimens usually have brown discoloration on the posterior end of the shell. The nacre ranges from salmon to white to iridescent blue, and the posterior ridge is distinctly rounded and curves dorsally from the posterior end. Yellow lance are found in main channels of streams that range from less than three feet wide to more than 20 feet wide. The yellow lance prefers substrate composed of coarse to medium-sized sands; however, they are sometimes found in gravel substrates.

Tar River spinymussel (*Elliptio steinstansana*)

The Tar River spinymussel is a small mussel, up to 2.8 inches, with a subrhomboidal shell. It is one of only three freshwater mussels in the world with spines. The juveniles have up to 12 spines and an outer shell of orange-brown with greenish rays. Adults tend to lose spines as they mature, and their shells are darker with inconspicuous rays. The interior nacre is yellow to pinkish anteriorly and bluish white to iridescent posteriorly. The Tar River spinymussel is endemic to the Tar and Neuse River drainages of the lower Piedmont and upper Coastal Plain of North Carolina. This mussel lives in silt free, unconsolidated gravel or coarse sand usually in shallow water of fast flowing medium sized streams but will reside in deep water with appropriate substrates.

Atlantic pigtoe (*Fusconaia masoni*)

The Atlantic pigtoe is a freshwater mussel with a shell that reaches a length of 2.3 inches. This mussel has a medium, rhomboidal shaped shell that has a distinctive, angular posterior ridge. The periostracum is yellowish brown to greenish brown, and the nacre color ranges from iridescent blue or white to salmon. The adults are essentially sessile. Some passive movement downstream may occur. The Atlantic pigtoe inhabits relatively fast waters with high quality riverine/large creek habitat. The Atlantic pigtoe is typically found in headwater or rural watersheds in sand or gravel substrates below riffles.

Saint Francis' satyr butterfly (*Neonympha mitchellii francisci*)

The Saint Francis' satyr butterfly is only known to resides in and around the U.S. Army Base at Fort Bragg. Suitable habitats include open meadows and semi-open c*arex*-rich landscapes. The Saint Francis' satyr butterfly has been observed in closed canopy swamp forests and wetland habitats.

4.13.2.3 Vascular Plants

Smooth coneflower (*Echinacea laevigata*)

Smooth coneflower is a rhizomatous perennial herb of the Aster family. These robust plants can grow up to five feet tall. They have large basal leaves (up to nine inches long and three inches wide) that are sparse and reduced upwards. The flower heads are solitary on a stem and consist of long, narrow, drooping, pale to deep pink ray flowers and dark purple-brown disk flowers on a conic receptacle. Flowering occurs from May to July. Historically, this plant ranged from Pennsylvania south through Alabama and Arkansas. Currently, this species is extant in only four states (e.g., Virginia, North and South Carolina, and Georgia) that comprise the central portion of the historic range. This plant is shade intolerant, preferring open sunny habitats maintained by periodic disturbance to reduce the shade and competition of woody species. These habitats include open woods, cedar barrens, roadsides, clearcuts, dry limestone bluffs, and cleared rights-of-way. It is usually found on magnesium or calcium-rich soils associated with limestone, gabbro, diabase and marble rocks.

Harperella (*Harperella nodosum*)

Harperella is a fine, slender herb in the Apicaceae family. This annual plant grows a narrow stem from 6 to 36 inches tall, which supports reduced to hollow quill-like leaves. The flowers are terminal on the stem and

arranged as a compound umbel of small white flowers like those of Queen Anne's lace. Flowering begins in May to June and continues until frost. Seed set in this plant is usually prolific; thus, a large number of individuals may occur within a population at any given time. Populations of harperella are found in Alabama, Arkansas, Georgia, South and North Carolina, West Virginia, and Maryland. However, this species inhabits a narrow, precarious micro-environment in the known range. This species requires bare ground as rock and gravel shoals and margins of swift-flowing reaches of riverine sites in the Mountains or Piedmont, or exposed edges of intermittent pineland ponds in the Coastal Plain. Currently, this plant is known from only 12 populations throughout its range. There are known populations in Chatham and Lee counties in the project area.

Pondberry (*Lindera melissifolia*)

Pondberry is a deciduous aromatic shrub that is approximately 1.5 to 6.5 feet in height and is usually found in large clonal clumps. Pondberry has small, pale yellow flowers and blooms in early spring (March through April) before the leaves develop. Bright red fruits often persist on the plants after the leaves have died in the fall. Pondberry usually occurs in shady environments but can tolerate full sun. Pondberry inhabits hardwood forests in seasonally flooded floodplains and forested swales. Pondberry also occurs along the margins of sinks, ponds, and depressions in pinelands in the coastal areas of North Carolina (NatureServe, 2008).

Rough-leaved loosestrife (*Lysimachia asperulaefolia*)

The rough-leaved loosestrife is an erect perennial that reaches 1 to 2 feet in height. The slender stems rarely branch and are stipulate-glandular above and glabrous elsewhere. The leaves are stipitate-glandular near the base and along the veins and glabrous on the other portions of the leaf. The sessile leaves are arranged with three or four leaves per whorl. The shape of the leaf is lanceolate and acute with the base rounded to truncate. Racemes of yellow flowers are clustered along the main stem near the top of the plant. The sepals and petals are fused. Flowering occurs during May and June, and fruiting happens from August through October. The rough-leaved loosestrife requires full sun and prefers the edges between longleaf pine uplands and pond pine pocosins with moist to seasonally saturated sand, shallow organic soil over sand, or the deep peat soils of Carolina bays.

Michaux's sumac (*Rhus michauxii*)

Michaux's sumac is a densely pubescent, dioecious, rhizomatous shrub. It has a low stature, growing up to two feet high. The leaves are compound with seven to thirteen, serrately edged, hairy leaflets on a hairy rachis. Male or female flowers are found in the dense terminal panicles typical of the genus. Flowers bloom in June, and seed heads are visible from August to September. Due to habitat fragmentation, colonies of this dioecious plant, when they occur, often are only one large clone representing a single sex. This quality is a serious limitation to the reproduction and repopulation of this species. Michaux's sumac grows in dry, open woodlands and forest edges in scattered locations from Virginia to Georgia. In the Piedmont region, this species is usually associated with acidic to subacid clay loam or sandy clay loam soils over granites and occasionally found on clayey soils derived from mafic rock such as Carolina slates or gabbro. Populations of Michaux's sumac are often found along roadsides and maintained utility corridors along forested edges.

4.14 Water Resources (Surface Water and Groundwater)

4.14.1 Drainage Basins and Surface Water Supplies

The project area is in the Cape Fear River and Neuse River basins. Three alternatives are entirely in the Cape Fear River basin and three alternatives are entirely in the Neuse River basin. Portions of the remaining six alternatives are in both the Cape Fear and Neuse River basins. All but one alternative, Alternative 3, has either conveyance corridors that traverse designated Water Supply Watersheds (WSWs), project components in WSW(s), or both.

The USGS has mapped watersheds throughout the U.S., assigning each watershed a Hydrologic Unit Code (HUC) and name. The project components are located within eleven USGS 10-digit HUC areas, including 0303000206 (Jordan Lake – New Hope River), 0303000401 (Buckhorn Creek – Cape Fear River), 0303000405 (Buies Creek – Cape Fear), 0303000401 (White Oak Creek – Cape Fear), and 030300601 (Upper South River) in the Cape Fear River basin. Project components in the Neuse River basin include 0302020109 (Middle Creek), 0302020110 (Swift Creek), 0302020112 (Black Creek), 0302020111 (Walnut Creek – Neuse River), 0302020116 (Lower Little River), 0302020113 (Mill Creek), and 0302020117 (Moccasin Creek – Neuse River). The watersheds within the project areas are illustrated in Figure 4-7.

The Cape Fear River basin extends from northwest of Greensboro to southeast of Wilmington. The Cape Fear River is North Carolina's largest river system and the largest basin contained wholly within North Carolina with a drainage area greater than 9,000 square miles. The Cape Fear River is formed in Subbasin 03-06-07 from the confluence of the Haw River and Deep River downstream from Jordan Lake dam. The project area is in three USGS subbasins in the Cape Fear River basin.

The Neuse River basin is entirely within North Carolina. The Neuse River basin originates in Subbasin 03-04-02 in the north-central portion of North Carolina and extends southeast to the Pamlico Sound east of New Bern. The Neuse River watershed is the third largest in North Carolina. The upper portion of the Neuse River is impounded by Falls Lake dam, downstream of which the river flows southeast to an estuary prior to discharge to the Pamlico Sound. The Quaker Neck Dam near Goldsboro and the Milburnie Dam near Raleigh have been removed from the Neuse River, thereby restoring anadromous fish spawning areas in the Neuse River to Falls Lake dam. The project area is in seven USGS subbasins in the Neuse River basin.

4.14.2 Surface Water Use Classifications

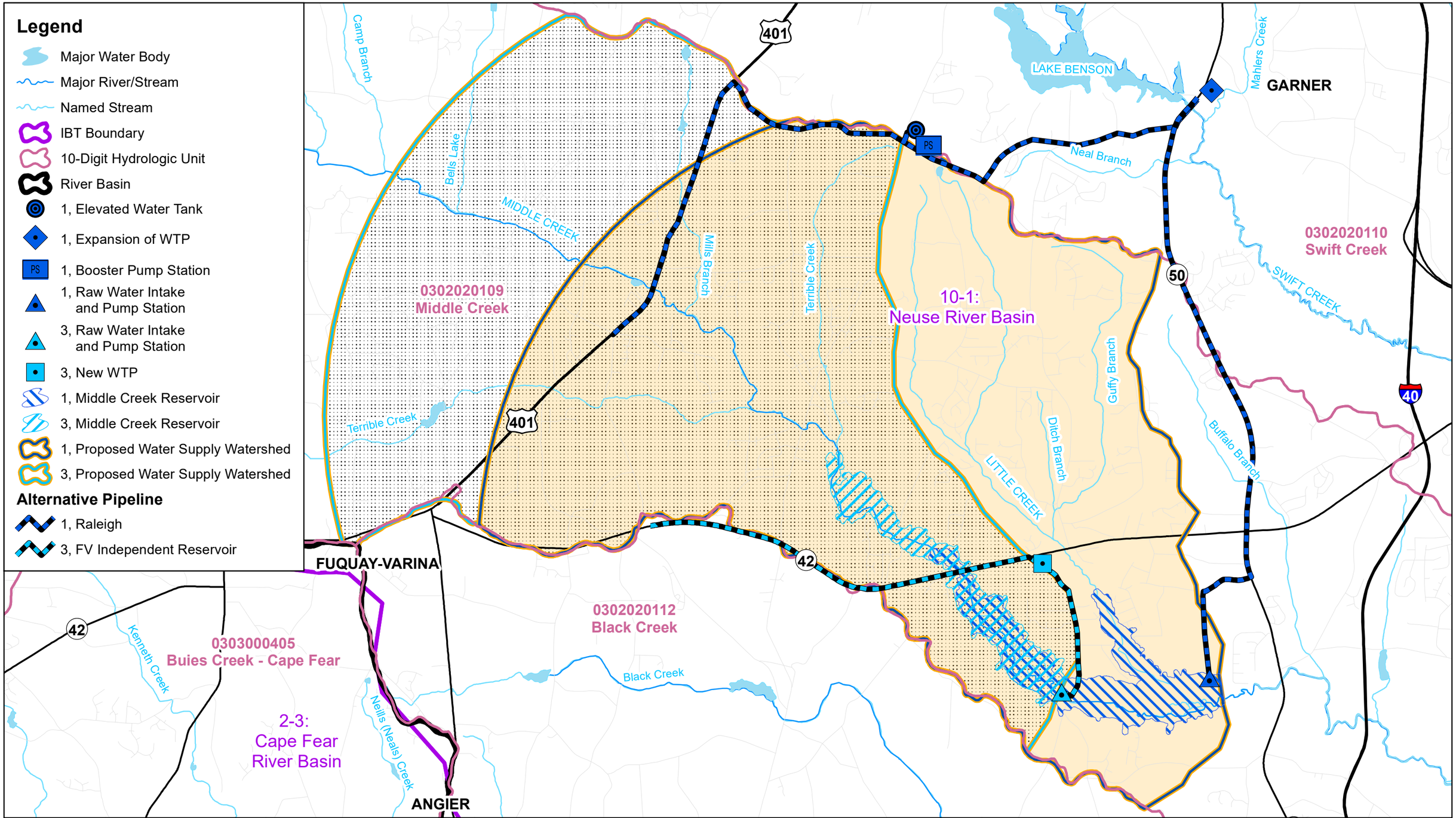
DWR classifies surface waters of the state based on their existing or proposed uses. The primary classification system distinguishes the following three basic usage categories: waters used as a source of water supply for drinking, culinary, or food-processing purposes (Classes WS-I through WS-V), waters used for primary recreation (Class B), and Class C. Class C waters are protected for aquatic life propagation, survival, and maintenance of biological integrity (including fishing and fish), wildlife, secondary contact recreation, and agriculture. All freshwaters in the state of North Carolina have a minimum classification of Class C.

Legend

- Major Water Body
- Major River/Stream
- Named Stream
- IBT Boundary
- 10-Digit Hydrologic Unit
- River Basin
- 1, Elevated Water Tank
- 1, Expansion of WTP
- 1, Booster Pump Station
- 1, Raw Water Intake and Pump Station
- 3, Raw Water Intake and Pump Station
- 3, New WTP
- 1, Middle Creek Reservoir
- 3, Middle Creek Reservoir
- 1, Proposed Water Supply Watershed
- 3, Proposed Water Supply Watershed

Alternative Pipeline

- 1, Raleigh
- 3, FV Independent Reservoir



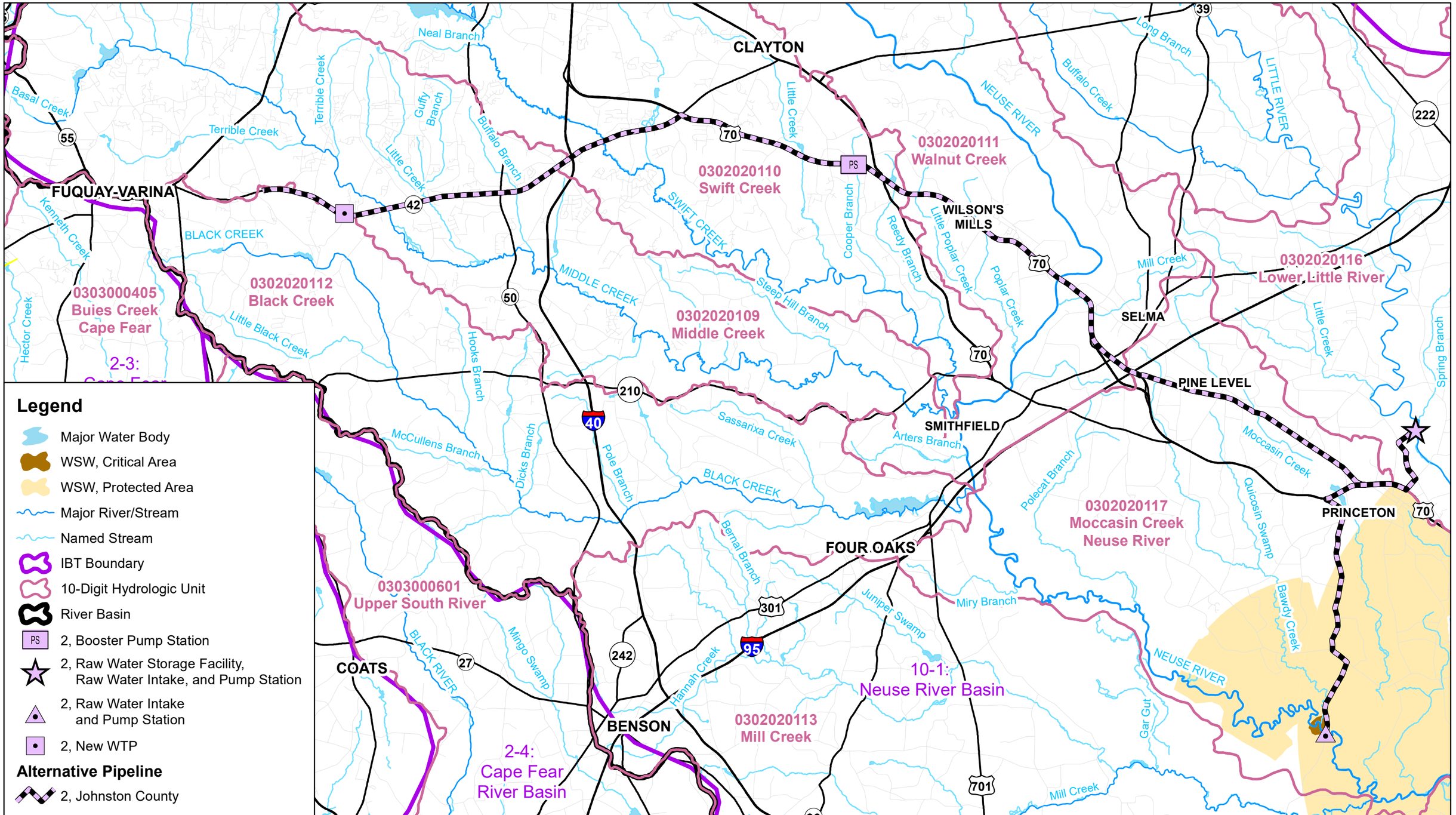
N W E S

SCALE
1 inch = 1 mile
0 0.5 1 Mile

FUQUAY-VARINA north carolina

Hazen

Figure 4-7a: Surface Waters and Hydrologic Units Alternatives 1 and 3
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River



Legend

- Major Water Body
- WSW, Critical Area
- WSW, Protected Area
- Major River/Stream
- Named Stream
- IBT Boundary
- 10-Digit Hydrologic Unit
- River Basin
- PS — 2, Booster Pump Station
- 2, Raw Water Storage Facility, Raw Water Intake, and Pump Station
- 2, Raw Water Intake and Pump Station
- 2, New WTP

Alternative Pipeline

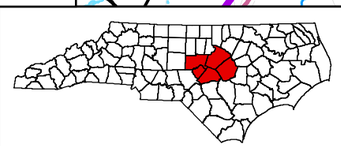
- 2, Johnston County

N W E S

SCALE

1 inch = 2.5 miles

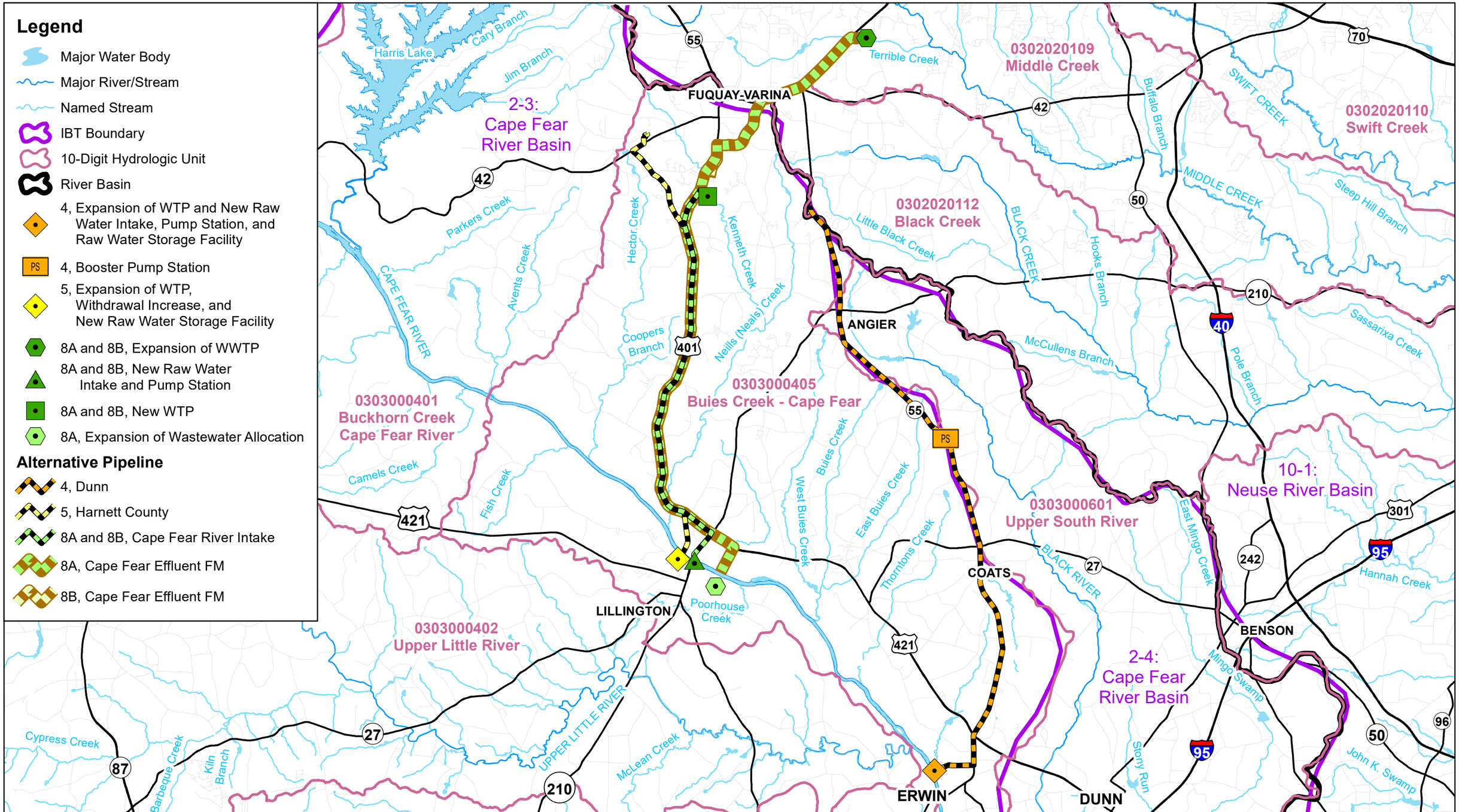
0 2.5 Miles



FUQUAY-VARINA north carolina

Hazen

Figure 4-7b: Surface Waters and Hydrologic Units
Alternative 2
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River



FUQUAY-VARINA north carolina

Hazen

Figure 4-7c: Surface Waters and Hydrologic Units Alternatives 4, 5, 8A, and 8B

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

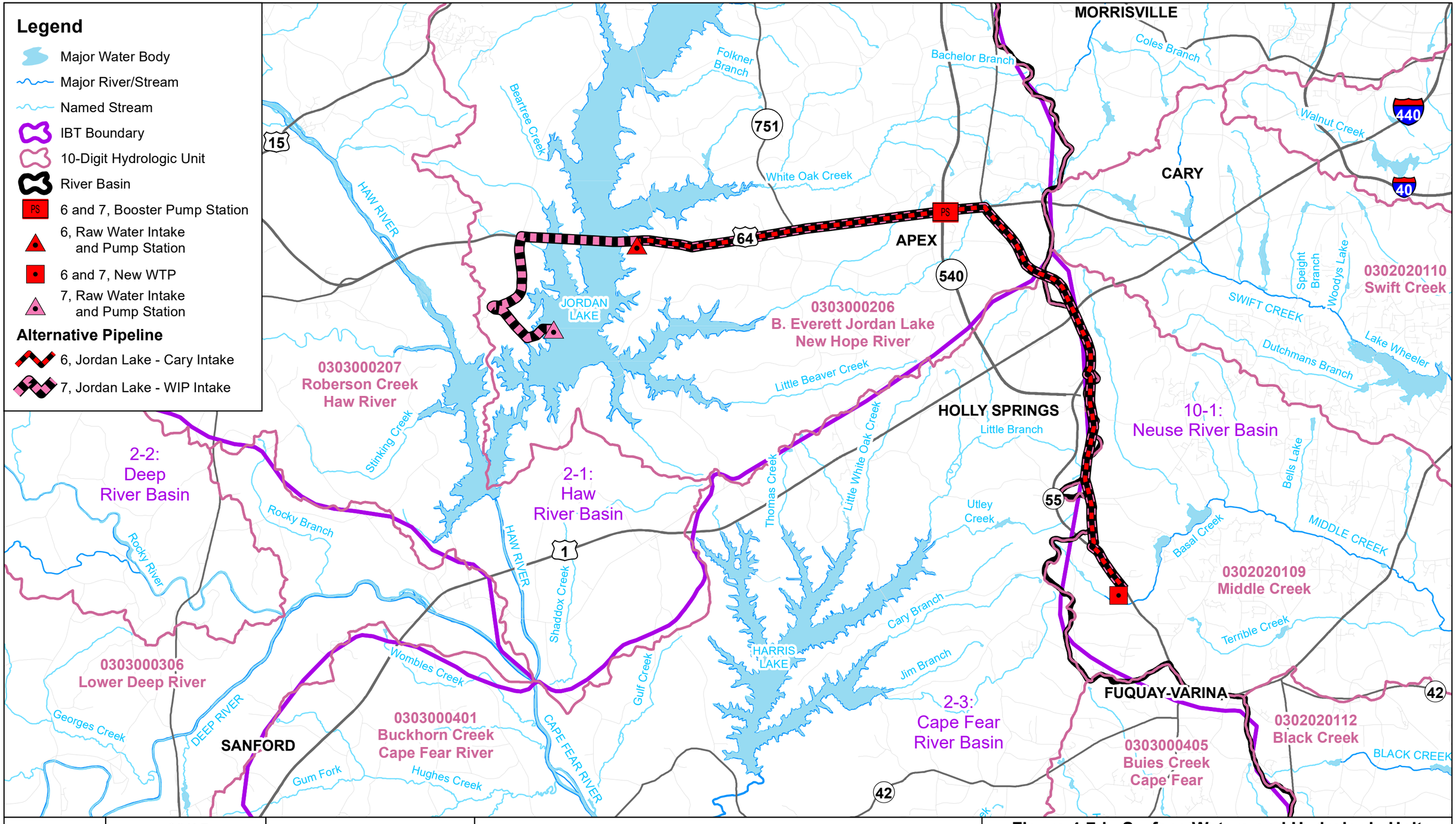


Figure 4-7d: Surface Waters and Hydrologic Units Alternatives 6 and 7

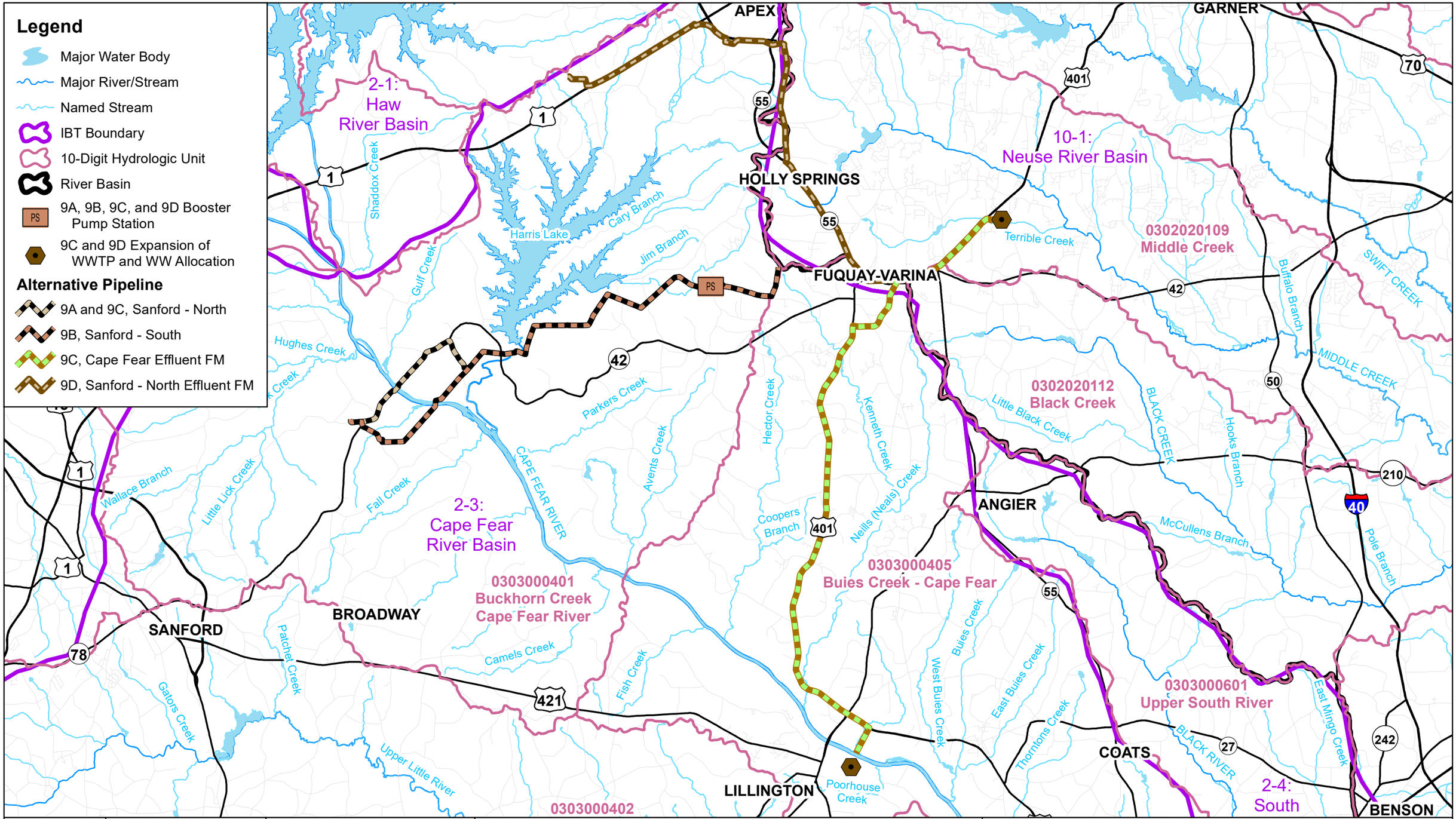
Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

Legend

- Major Water Body
- Major River/Stream
- Named Stream
- IBT Boundary
- 10-Digit Hydrologic Unit
- River Basin
- PS — 9A, 9B, 9C, and 9D Booster Pump Station
- 9C and 9D Expansion of WWTP and WW Allocation

Alternative Pipeline

- 9A and 9C, Sanford - North
- 9B, Sanford - South
- 9C, Cape Fear Effluent FM
- 9D, Sanford - North Effluent FM



N W E S

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-7e: Surface Waters and Hydrologic Units Alternatives 9A, 9B, 9C, and 9D
Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

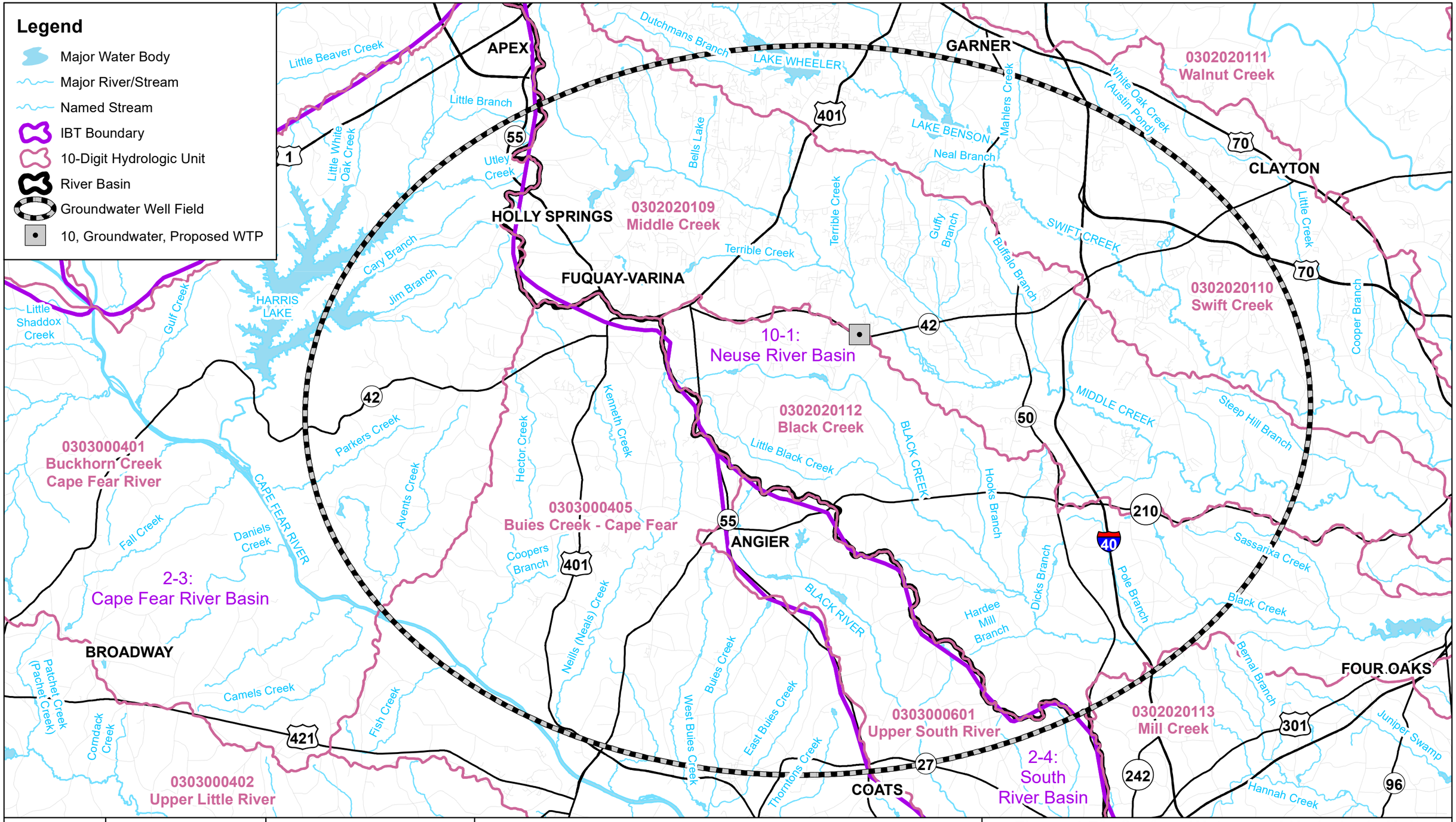


Figure 4-7f: Surface Waters and Hydrologic Units
Alternative 10
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Water supply surface water classifications are further classified into five categories based on the level of protection required for the water supply and the level of development in the watershed. Class WS-I waters offer the most protection to water supplies and are in natural and undeveloped watersheds in public ownership. Class WS-II waters are in predominantly undeveloped watersheds where WS-I classification is not feasible. WS-III classification applies to water supply waters where WS-I and WS-II classification is not feasible, and the watershed has low to moderate development. Class WS-IV waters are in moderately to highly developed watersheds where WS-I through WS-III classification is not feasible. Class WS-V waters are generally upstream of and draining to Class WS-IV waters, used by industry to supply their employees with drinking water, or waters formerly used as water supply.

DWR assigns supplemental classifications to provide additional protection, management, or recognition of certain waters in the state. High Quality Water (HQW) and Outstanding Resource Water (ORW) are protected waters with excellent water quality. Waters needing additional nutrient management due to excessive growth of vegetation are classified as NSWs. Swamp waters (Sw) and trout waters (Tr) are also classified to recognize or protect the water's specific characteristics.

The surface waters in the project area are mainly classified as C or WS. Several HQWs are in the Cape Fear River basin in Harnett County in Alternative 10 and west of the corridors associated with Alternatives 5, 8A, 8B, and 9C. The HQWs discharge into the Cape Fear River downstream of Alternatives 9A and 9B, and the 9C water line and upstream of Alternatives 5, 8A and 8B, and the 9C effluent force main. Numerous HQWs are in the Alternative 10 area. The watersheds associated with the HQWs are designated as ORWs. None of the project components are in the ORWs watersheds; however, the pipe corridors associated with Alternatives 5, 8A and 8B, and 9C effluent force mains traverse the easternmost portion of the watersheds of two of the HQWs, Coopers Branch and Hector Creek. Surface water classifications are illustrated on Figure 4-8: Surface Water Quality.

The classified streams in the project area are listed in Table 4-14. In addition to named streams, numerous unnamed tributaries (UTs) to the classified streams are in the project area. A stream that is not specifically classified by DWR is assumed to have the same classification as the stream into which it empties.

Table 4-14: Surface Water Use Classifications in the Project Area

Name	Description	Class
Alternative 1:		
Swift Creek	From dam at Lake Benson to Neuse River	C, NSW
Neal Branch	From source to Swift Creek	C, NSW
Middle Creek	From dam at Sunset Lake to Swift Creek	C, NSW
Little Creek	From source to Middle Creek	C, NSW
Buffalo Branch	From source to Middle Creek	C, NSW
Mills Branch	From source to Middle Creek	C, NSW
Mahlers Creek	From source to Swift Creek	C, NSW

Table 4-14: Surface Water Use Classifications in the Project Area

Name	Description	Class
Alternative 2:		
Neuse River	From Johnston County proposed water supply intake to a point 0.1 mile downstream of mouth of Poplar Creek	WS-IV, NSW
Neuse River	From a point 0.5 mile upstream of Richardson Bridge Road/SR 1201 to Johnston County's intake at Richardson Bridge Road/SR 1201	WS-IV, NSW CA
Mill Creek (at Selma)	From source to Neuse River	WS-IV, NSW
Poplar Creek (Poplar Branch)	From source to Neuse River	WS-IV, NSW
Little Poplar Creek	From source to Poplar Branch	WS-IV, NSW
Swift Creek	From dam at Lake Benson to Neuse River	C, NSW
White Oak Creek (Austin Pond)	From source to Swift Creek	C, NSW
Little Creek	From source to Swift Creek	C, NSW
Cooper Branch	From source to Swift Creek	C, NSW
Reedy Branch (Little Branch)	From source to Swift Creek	C, NSW
Middle Creek	From dam at Sunset Lake to Swift Creek	C, NSW
Little Creek	From source to Middle Creek	C, NSW
Buffalo Branch	From source to Middle Creek	C, NSW
Bawdy Swamp	From source to Bawdy Creek	C, NSW
Moccasin Creek (Holts Pond)	From source to a point 0.6 mile downstream of Holts Pond dam	C, NSW
Little River	From Spring Branch to a point 0.6 mile downstream of Smith Mill Run	WS-IV, NSW
Alternative 3:		
Middle Creek	From dam at Sunset Lake to Swift Creek	C, NSW
Alternative 4:		
Cape Fear River	From Dunn water supply intake to a point 8.2 miles upstream of Carvers Creek	WS-V
East Buies Creek	From source to a point 0.2 mile downstream of N.C. Hwy. 55	C
Juniper Creek	From source to Cape Fear River	C
Alternative 5:		
Cape Fear River	From a point 0.2 mile downstream of Neills Creek to Lillington water supply intake	WS-IV, CA
Cape Fear River	From Lillington water supply intake to Upper Little River	WS-IV
Neills Creek (Neals Creek)	From a point 0.3 mile upstream of Wake-Harnett County Line to Cape Fear River	WS-IV
Alternative 6:		
Beaver Creek	From N.C. Hwy. 55 to a point 0.3 mile downstream of Wake County SR 1141	WS-IV, NSW
Reedy Branch	From source to Beaver Creek	WS-IV, NSW

Table 4-14: Surface Water Use Classifications in the Project Area

Name	Description	Class
Basal Creek (Bass Lake, Mills Pond)	From source to Sunset Lake, Middle Creek	B, NSW
Alternative 7:		
New Hope River Arm of Jordan Lake (below normal pool elevation)	From Chatham County SR 1008 to Haw River Arm of Jordan Lake, Haw River	WS-IV, B NSW, CA
Beaver Creek	From NC Hwy 55 to a point 0.3 mile downstream of Wake County SR 1141	WS-IV, NSW
Reedy Branch	From source to Beaver Creek	WS-IV, NSW
Windfall Branch	From U.S. Hwy. 64 to New Hope River Arm of Jordan Lake	WS-IV, NSW, CA
Basal Creek (Bass Lake, Mills Pond)	From source to Sunset Lake, Middle Creek	B, NSW
Alternative 8A:		
Cape Fear River	From Lillington water supply intake to Upper Little River	WS-IV
Neills Creek (Neals Creek)	From a point 0.3 mile upstream of Wake-Harnett County Line to Cape Fear River	WS-IV
Kenneth Creek	From source to Wake-Harnett County Line	C
Dry Creek	From a point 0.9 mile upstream of Harnett County SR 1516 to Cape Fear River	WS-IV
Terrible Creek	From dam at Johnsons Pond to Middle Creek	C, NSW
Alternative 8B:		
Cape Fear River	From Lillington water supply intake to Upper Little River	WS-IV
Neills Creek (Neals Creek)	From a point 0.3 mile upstream of Wake-Harnett County Line to Cape Fear River	WS-IV
Kenneth Creek	From source to Wake-Harnett County Line	C
Terrible Creek	From dam at Johnsons Pond to Middle Creek	C, NSW
Alternative 9A:		
Cape Fear River	From N.C. Hwy. 42 to a point 0.6 mile downstream of mouth of Daniels Creek	WS-V
Buckhorn Creek	From source to Norfolk Southern Railroad	C
Buckhorn Creek	From dam at Harris Lake to Cape Fear River	C
Buckhorn Creek	From Norfolk Southern Railroad to backwaters of Harris Lake	B
Alternative 9B:		
Cape Fear River	From N.C. Hwy. 42 to a point 0.6 mile downstream of mouth of Daniels Creek	WS-V
Bush Creek	From Source to Cape Fear River	C
Buckhorn Creek	From source to Norfolk Southern Railroad	C
Buckhorn Creek	From dam at Harris Lake to Cape Fear River	C
Buckhorn Creek	From Norfolk Southern Railroad to backwaters of Harris Lake	B

Table 4-14: Surface Water Use Classifications in the Project Area

Name	Description	Class
Alternative 9C:		
Cape Fear River	From N.C. Hwy. 42 to a point 0.6 mile downstream of mouth of Daniels Creek	WS-V
Buckhorn Creek	From source to Norfolk Southern Railroad	C
Buckhorn Creek	From dam at Harris Lake to Cape Fear River	C
Buckhorn Creek	From Norfolk Southern Railroad to backwaters of Harris Lake	B
Cape Fear River	From Lillington water supply intake to Upper Little River	WS-IV
Neills Creek (Neals Creek)	From a point 0.3 mile upstream of Wake-Harnett County Line to Cape Fear River	WS-IV
Kenneth Creek	From source to Wake-Harnett County Line	C
Dry Creek	From a point 0.9 mile upstream of Harnett County SR 1516 to Cape Fear River	WS-IV
Terrible Creek	From dam at Johnsons Pond to Middle Creek	C, NSW
Alternative 9D:		
Cape Fear River	From N.C. Hwy. 42 to a point 0.6 mile downstream of mouth of Daniels Creek	WS-V
Buckhorn Creek	From source to Norfolk Southern Railroad	C
Buckhorn Creek	From dam at Harris Lake to Cape Fear River	C
Buckhorn Creek	From Norfolk Southern Railroad to backwaters of Harris Lake	B
Terrible Creek	From dam at Johnsons Pond to Middle Creek	C, NSW
Basal Creek (Bass Lake, Mills Pond)	From source to sunset Lake, Middle Creek	B, NSW
Little White Oak Creek	From source to Harris Lake, Buckhorn Creek	C
White Oak Creek	From source to Harris Lake, Buckhorn Creek	C
Big Branch	From source to White Oak Creek	C
Alternative 10:		
Cape Fear River	From a point 0.6 mile downstream of mouth of Daniels Creek to a point 0.2 mile downstream of Neills Creek	WS-IV
Avents Creek	From source to a point 1.3 miles upstream of Harnett County SR 1418	C, HQW
Avents Creek	From a point 1.3 miles upstream of Harnett County SR 1418 to Cape Fear River	WS-IV, HQW
Mill Creek	From source to Avents Creek	WS-IV, HQW
Fish Creek	From source to Cape Fear River	WS-IV
Hector Creek	From source to a point 1.1 miles upstream of Harnett County SR 1415	C, HQW
Hector Creek	From a point 1.1 miles upstream of Harnett County SR 1414 to Cape Fear River	WS-IV, HQW
Coopers Branch	From source to Hector Creek	WS-IV, HQW
Neills Creek (Neals Creek)	From source to a point 0.3 mile upstream of Wake-Harnett County Line	C

Table 4-14: Surface Water Use Classifications in the Project Area

Name	Description	Class
Neills Creek (Neals Creek)	From a point 0.3 mile upstream of Wake-Harnett County Line to Cape Fear River	WS-IV
Kenneth Creek	From source to Wake-Harnett County Line	C
Kenneth Creek	From Wake-Harnett County Line to Neills Creek	WS-IV
Dry Creek	From source to a point 0.9 mile upstream of Harnett County SR 1516	C
Dry Creek	From a point 0.9 mile upstream of Harnett County SR 1516 to Cape Fear River	WS-IV
Buies Creek	From source to Cape Fear River	WS-IV
East Buies Creek	From source to a point 0.2 mile downstream of N.C. Hwy. 55	C
East Buies Creek	From a point 0.2 mile downstream of N.C. Hwy. 55 to Buies Creek	WS-IV
West Buies Creek	From source to Harnett County SR 1510	C
West Buies Creek	From Harnett County SR 1510 to Buies Creek	WS-IV
Thorntons Creek	From source to Cape Fear River	WS-IV
Black River (Little Black River) (Popes Lake, Rhodes Pond)	From source to South River	C, Sw
Youngs Pond	Entire pond and connecting stream to Black River	C, Sw
Big Branch	From source to Black River	C, Sw
Mingo Swamp	From source to South River	C, Sw
East Mingo Creek	From source to Mingo Swamp	C, Sw
Buckhorn Creek	From source to Norfolk Southern Railroad	C
Buckhorn Creek	From Norfolk Southern Railroad to backwaters of Harris Lake	B
Buckhorn Creek (Harris Lake)	From backwaters of Harris Lake to dam at Harris Lake	WS-V
Jim Branch	From source to Harris Lake, Buckhorn Cr.	C
Cary Branch	From source to Harris Lake, Buckhorn Cr.	C
Norris Branch	From source to Cary Branch	C
Utley Creek	From source to Harris Lake, Buckhorn Cr.	C
Little Branch	From source to Big Branch	C
Parkers Creek	From source to Cape Fear River	C, HQW
Swift Creek (Lake Wheeler)	From source to a point 0.6 mile upstream of Wake County SR 1006	WS-III, NSW
Swift Creek (Lake Benson)	From a point 0.6 mile upstream of Wake County SR 1006 to dam at Lake Benson	WS-III, NSW, CA
Swift Creek	From dam at Lake Benson to Neuse River	C, NSW
Neal Branch	From source to Swift Creek	C, NSW
White Oak Creek (Austin Pond)	From source to Swift Creek	C, NSW
Middle Creek	From source to backwaters of Sunset Lake	C, NSW
Middle Creek (Sunset Lake)	From backwaters of Sunset Lake to dam at Sunset Lake	B, NSW
Middle Creek	From dam at Sunset Lake to Swift Creek	C, NSW

Table 4-14: Surface Water Use Classifications in the Project Area

Name	Description	Class
Little Creek	From source to Middle Creek	C, NSW
Juniper Creek	From source to Little Creek	C, NSW
Guffy Branch	From source to Little Creek	C, NSW
Ditch Branch	From source to Guffy Branch	C, NSW
Buffalo Branch	From source to Middle Creek	C, NSW
Mill Branch	From source to Middle Creek	C, NSW
Beaverdam Branch	From source to Middle Creek	C, NSW
Cow Branch	From source to Middle Creek	C, NSW
Shop Branch	From source to Middle Creek	C, NSW
Steep Hill Branch	From source to Middle Creek	C, NSW
Basal Creek (Bass Lake, Mills Pond)	From source to Sunset Lake, Middle Creek	B, NSW
Rocky Branch	From source to Middle Creek	C, NSW
Camp Branch	From source to Middle Creek	C, NSW
Bells Lake	Entire lake and connecting stream to Middle Creek	C, NSW
Mills Branch	From source to Middle Creek	C, NSW
Terrible Creek (Johnsons Pond)	From source to dam at Johnsons Pond	B, NSW
Terrible Creek	From dam at Johnsons Pond to Middle Creek	C, NSW
Panther Branch	From source to Middle Creek	C, NSW
Dutchmans Branch	From source to Swift Creek	WS-III, NSW
Unnamed Tributary to Swift Creek (Yates Mill Pond)	From dam at Silver Lake to a point 0.5 mile upstream of mouth	WS-III, NSW
Unnamed Tributary to Swift Creek	From a point 0.5 mile upstream of mouth to Swift Creek	WS-III, NSW, CA
Buck Branch	From source to a point 0.6 mile upstream of mouth	WS-III, NSW
Buck Branch	From a point 0.6 mile upstream of mouth to Lake Benson, Swift Creek	WS-III, NSW, CA
Reedy Branch	From source to a point 0.5 mile upstream of mouth	WS-III, NSW
Reedy Branch	From a point 0.5 mile upstream of mouth to Lake Benson, Swift Creek	WS-III, NSW, CA
Mahlers Creek	From source to Swift Creek	C, NSW
Black Creek (Partins Pond, Panther Lake)	From source to dam at Panther Lake	B, NSW
Black Creek	From dam at Panther Lake to mouth of Sassarixa Creek	C, NSW
Reedy Creek	From source to Black Creek	C, NSW
Sassarixa Creek (Sassarixa Swamp)	From source to Black Creek	C, NSW
Little Black Creek	From source to Black Creek	C, NSW
Hooks Branch	From source to Black Creek	C, NSW

Table 4-14: Surface Water Use Classifications in the Project Area

Name	Description	Class
McCullens Branch (McCullers Branch)	From source to Black Creek	C, NSW
Camp Branch	From source to Black Creek	C, NSW
Dicks Branch	From source to Black Creek	C, NSW
Hardee Mill Branch	From source to Black Creek	C, NSW
Pole Branch	From source to Black Creek	C, NSW

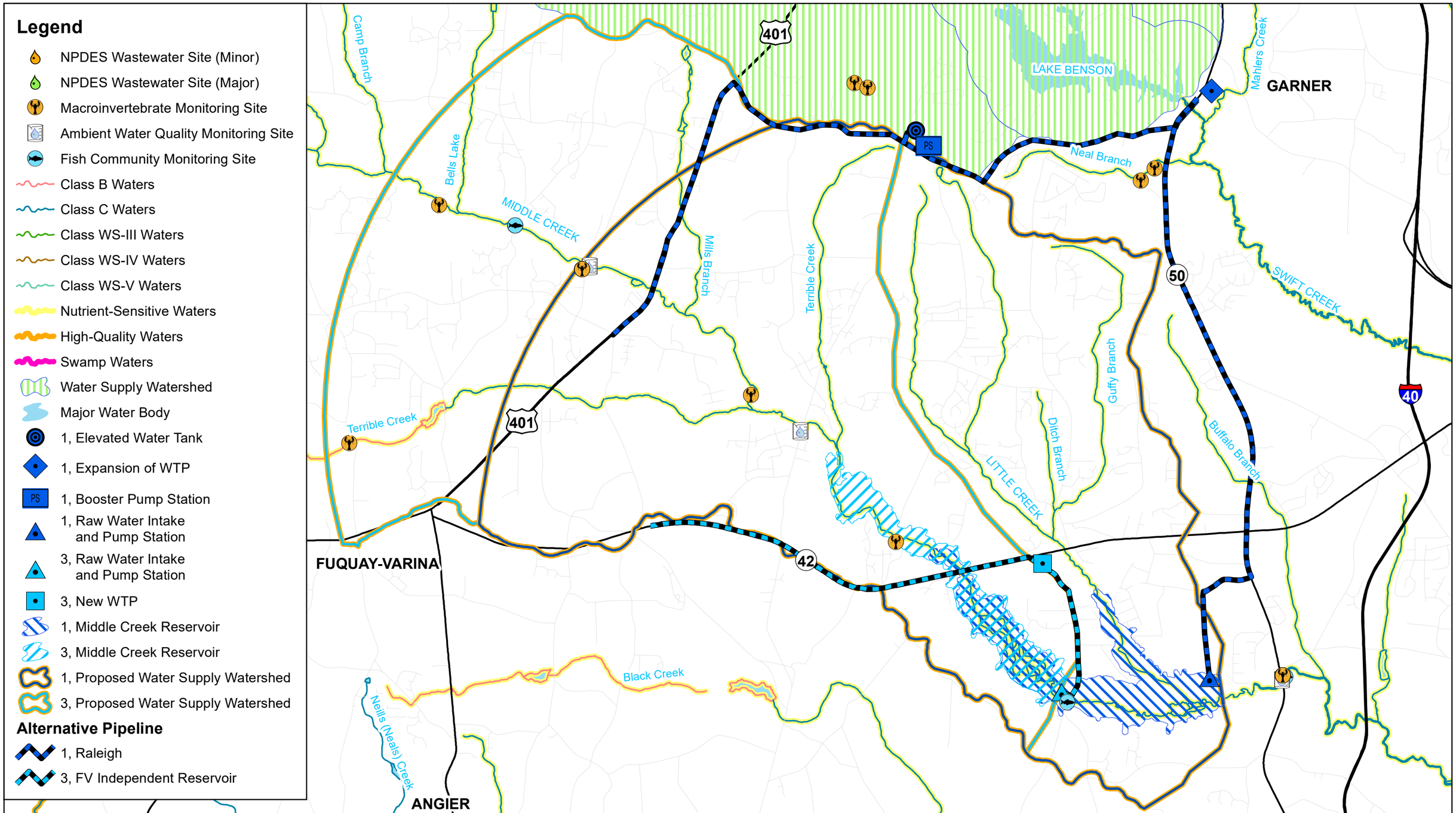
Notes:
B: Primary contact recreation, freshwater Sw: Swamp waters
C: Aquatic life, secondary contact recreation, freshwater WS-III: Water supply III
CA: Critical area WS-IV: Water supply IV
HQW: High quality waters WS-V: Water supply V
NSW: Nutrient sensitive waters

Legend

- NPDES Wastewater Site (Minor)
- NPDES Wastewater Site (Major)
- Macroinvertebrate Monitoring Site
- Ambient Water Quality Monitoring Site
- Fish Community Monitoring Site
- Class B Waters
- Class C Waters
- Class WS-III Waters
- Class WS-IV Waters
- Class WS-V Waters
- Nutrient-Sensitive Waters
- High-Quality Waters
- Swamp Waters
- Water Supply Watershed
- Major Water Body
- 1, Elevated Water Tank
- 1, Expansion of WTP
- 1, Booster Pump Station
- 1, Raw Water Intake and Pump Station
- 3, Raw Water Intake and Pump Station
- 3, New WTP
- 1, Middle Creek Reservoir
- 3, Middle Creek Reservoir
- 1, Proposed Water Supply Watershed
- 3, Proposed Water Supply Watershed

Alternative Pipeline

- 1, Raleigh
- 3, FV Independent Reservoir



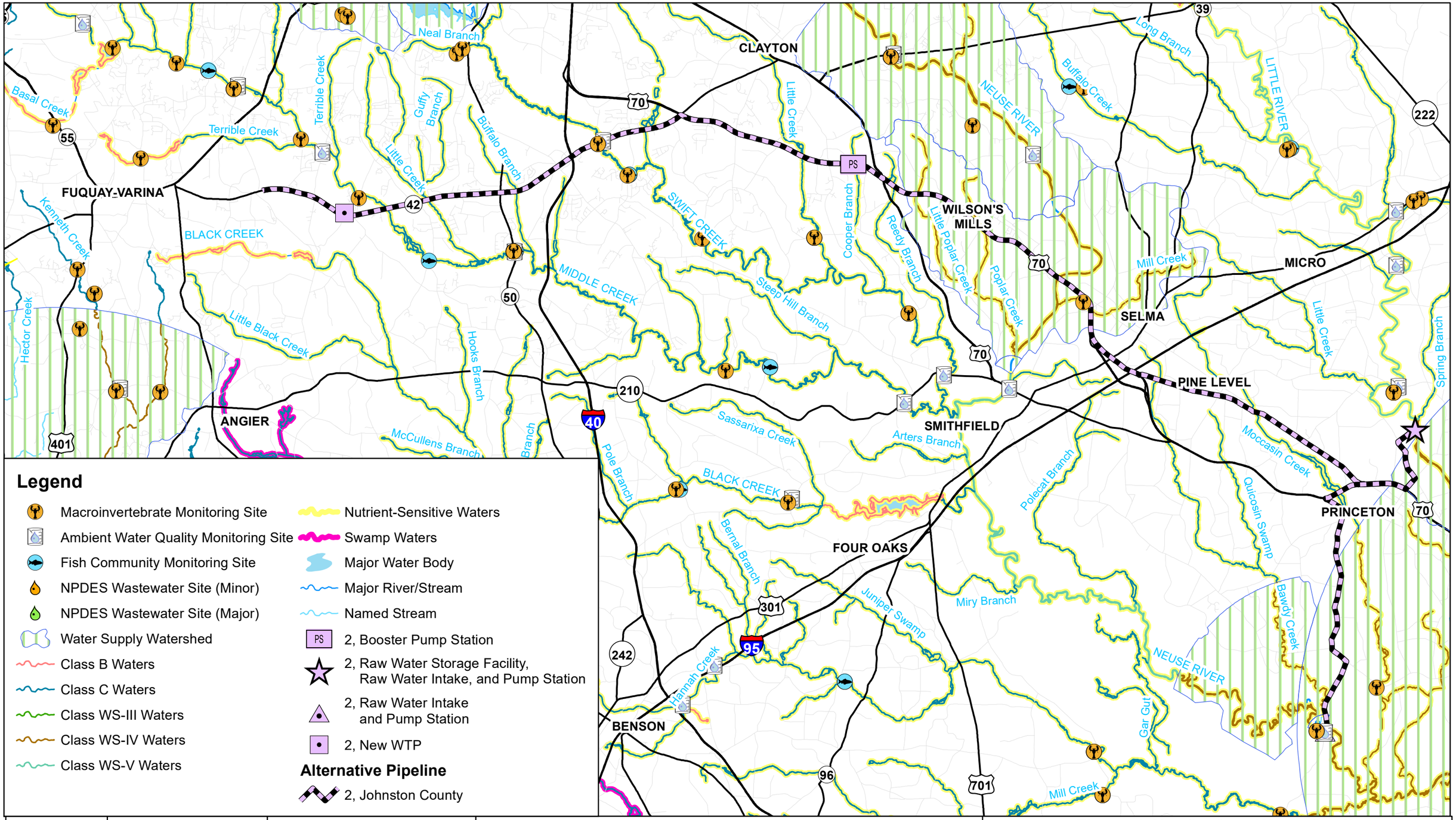
N W E S

SCALE
1 inch = 1 mile
0 0.5 1 Mile

FUQUAY-VARINA north carolina

Hazen

Figure 4-8a: Surface Water Quality Alternatives 1 and 3
Interbasin Transfer for Water Supply from Cape Fear River to Neuse River



Legend

- Macroinvertebrate Monitoring Site
- Ambient Water Quality Monitoring Site
- Fish Community Monitoring Site
- NPDES Wastewater Site (Minor)
- NPDES Wastewater Site (Major)
- Water Supply Watershed
- Class B Waters
- Class C Waters
- Class WS-III Waters
- Class WS-IV Waters
- Class WS-V Waters
- Nutrient-Sensitive Waters
- Swamp Waters
- Major Water Body
- Major River/Stream
- Named Stream
- PS 2, Booster Pump Station
- 2, Raw Water Storage Facility, Raw Water Intake, and Pump Station
- 2, Raw Water Intake and Pump Station
- 2, New WTP

Alternative Pipeline

- 2, Johnston County

N W E S

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

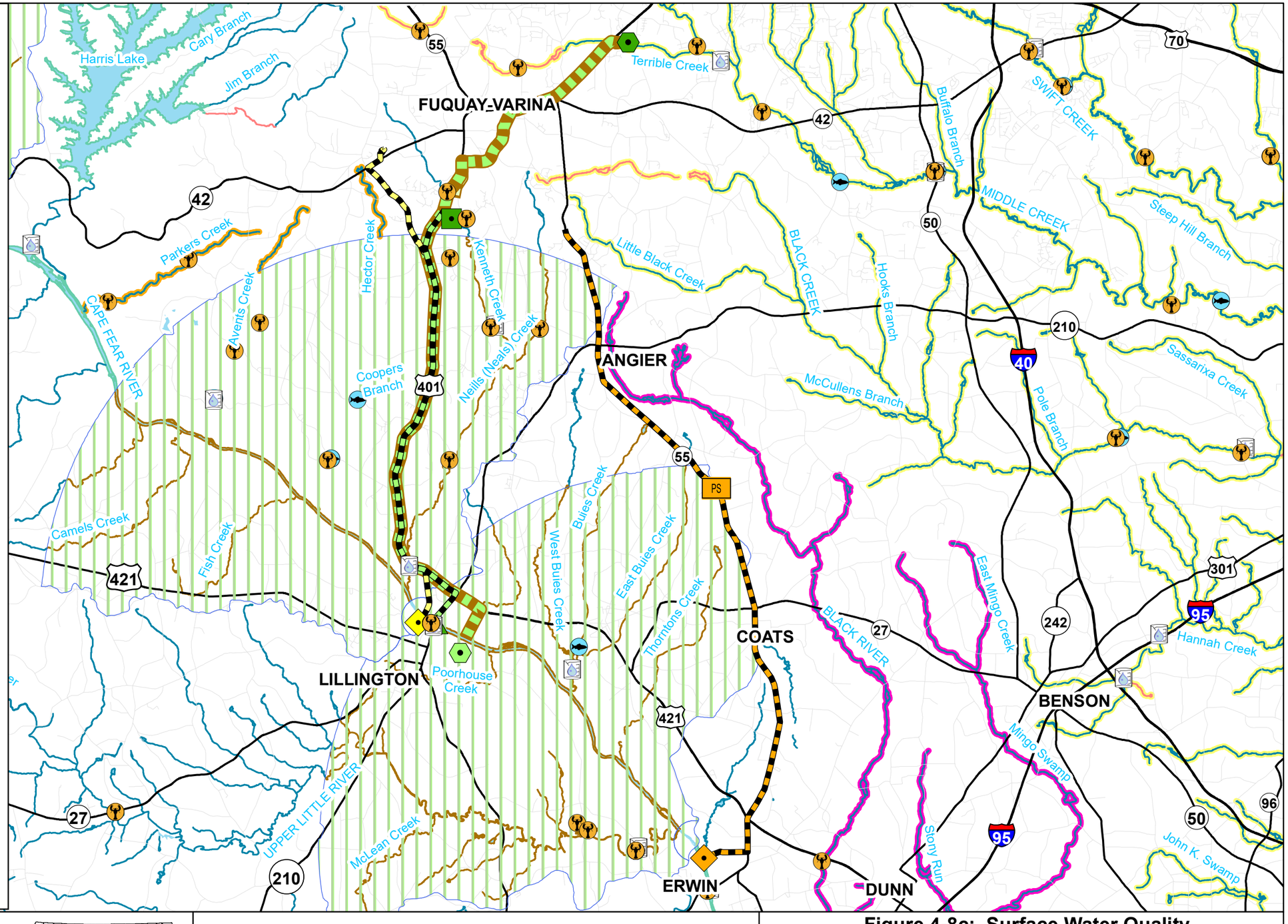
Figure 4-8b: Surface Water Quality Alternative 2
Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

Legend

- Macroinvertebrate Monitoring Site
- Ambient Water Quality Monitoring Site
- Fish Community Monitoring Site
- NPDES Wastewater Site (Minor)
- NPDES Wastewater Site (Major)
- Class B Waters
- Class C Waters
- Class WS-IV Waters
- Class WS-V Waters
- Nutrient-Sensitive Waters
- High-Quality Waters
- Swamp Waters
- Water Supply Watershed
- Major Water Body
- 4, Expansion of WTP and New Raw Water Intake, Pump Station, and Raw Water Storage Facility
- PS 4, Booster Pump Station
- 5, Expansion of WTP, Withdrawal Increase, and New Raw Water Storage Facility
- 8A and 8B, Expansion of WWTP
- 8A and 8B, New Raw Water Intake and Pump Station
- 8A and 8B, New WTP
- 8A, Expansion of Wastewater Allocation

Alternative Pipeline

- 4, Dunn
- 5, Harnett County
- 8A and 8B, Cape Fear River Intake
- 8A, Cape Fear Effluent FM
- 8B, Cape Fear Effluent FM



N
W E
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SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-8c: Surface Water Quality Alternatives 4, 5, 8A, and 8B
Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

Legend

- Macroinvertebrate Monitoring Site
- Ambient Water Quality Monitoring Site
- Fish Community Monitoring Site
- NPDES Wastewater Site (Minor)
- NPDES Wastewater Site (Major)
- Water Supply Watershed
- Class B Waters
- Class C Waters
- Class WS-III Waters
- Class WS-IV Waters
- Class WS-V Waters
- Nutrient-Sensitive Waters
- High-Quality Waters
- Swamp Waters
- Major Water Body
- PS — 6 and 7, Booster Pump Station
- 6, Raw Water Intake and Pump Station
- 6 and 7, New WTP
- 7, Raw Water Intake and Pump Station

Alternative Pipeline

- 6, Jordan Lake - Cary Intake
- 7, Jordan Lake - WIP Intake

MORRISVILLE
CARY
APEX
HOLLY SPRINGS
FUQUAY-VARINA
SANFORD
JORDAN LAKE
HARRIS LAKE
Folkner Branch
Bachelor Branch
Coles Branch
Walnut Creek
Bearfree Creek
White Oak Creek
HAW RIVER
Little Beaver Creek
Little White Oak Creek
Thomas Creek
Little Branch
Utley Creek
Basal Creek
Bells Lake
MIDDLE CREEK
Speight Branch
Woodys Lake
SWIFT CREEK
Dutchmans Branch
Lake Wheeler
Cary Branch
Jim Branch
Terrible Creek
BLACK CREEK
Stinking Creek
Shaddox Creek
Wombles Creek
Gulf Creek
CAPE FEAR RIVER
Hughes Creek
Georges Creek
DEEP RIVER
751
64
540
55
1
42
440
40
PS

N
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SCALE
1 inch = 2 miles
0 1 2 Miles

FUQUAY-VARINA
north carolina

Hazen

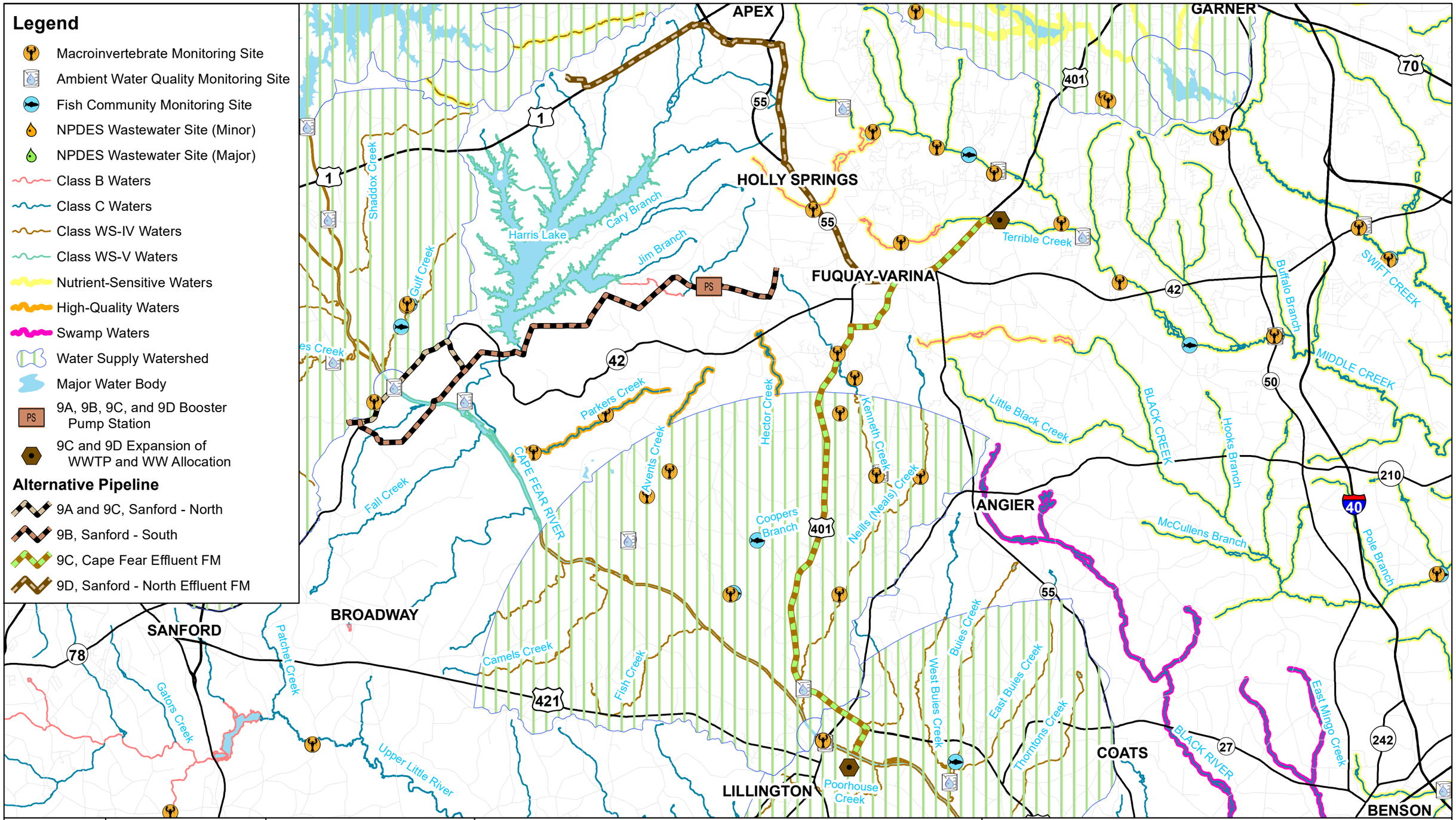
Figure 4-8d: Surface Water Quality Alternatives 6 and 7
Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

Legend

- Macroinvertebrate Monitoring Site
- Ambient Water Quality Monitoring Site
- Fish Community Monitoring Site
- NPDES Wastewater Site (Minor)
- NPDES Wastewater Site (Major)
- Class B Waters
- Class C Waters
- Class WS-IV Waters
- Class WS-V Waters
- Nutrient-Sensitive Waters
- High-Quality Waters
- Swamp Waters
- Water Supply Watershed
- Major Water Body
- PS — 9A, 9B, 9C, and 9D Booster Pump Station
- 9C and 9D Expansion of WWTP and WW Allocation

Alternative Pipeline

- 9A and 9C, Sanford - North
- 9B, Sanford - South
- 9C, Cape Fear Effluent FM
- 9D, Sanford - North Effluent FM



N W E S

SCALE
1 inch = 2.5 miles
0 2.5 Miles

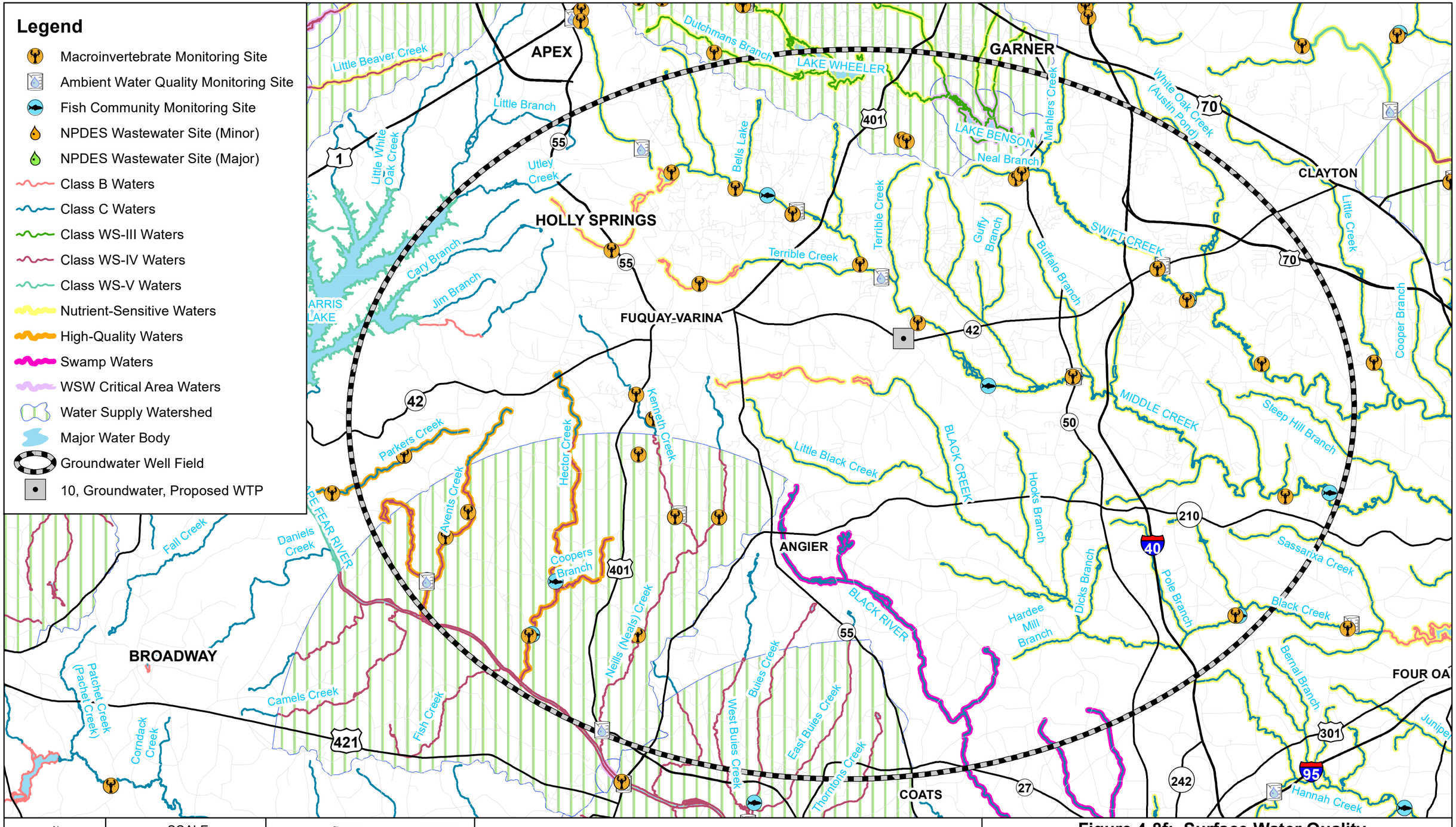
FUQUAY-VARINA north carolina

Hazen

Figure 4-8e: Surface Water Quality Alternatives 9A, 9B, 9C, and 9D
Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

Legend

- Macroinvertebrate Monitoring Site
- Ambient Water Quality Monitoring Site
- Fish Community Monitoring Site
- NPDES Wastewater Site (Minor)
- NPDES Wastewater Site (Major)
- Class B Waters
- Class C Waters
- Class WS-III Waters
- Class WS-IV Waters
- Class WS-V Waters
- Nutrient-Sensitive Waters
- High-Quality Waters
- Swamp Waters
- WSW Critical Area Waters
- Water Supply Watershed
- Major Water Body
- Groundwater Well Field
- 10, Groundwater, Proposed WTP



SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-8f: Surface Water Quality
Alternative 10
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

4.14.3 Existing Surface Water Quality

DWR monitors water quality using physical, chemical, and biological sampling and rates each monitored stream segment or lake with respect to its designated usage classification (DENR, 2008; DENR 2010). Biological monitoring, including benthic macroinvertebrate (benthos) and fish samples, is particularly useful in tracking water quality trends because these organisms reflect long-term interactions among many water quality and habitat parameters, including factors not detected by infrequent physical and chemical sampling. The data collected during ambient water quality monitoring supports evaluations and reporting requirements under the Clean Water Act (CWA).

One fish community sampling site abuts the Terrible Creek WWTP based on the Cape Fear Basinwide Water Quality Plan (NCDENR, 2005) and the Neuse River Basinwide Water Quality Plan (NCDENR, 2009). The community sampling site was observed within Terrible Creek, station number JF35, and is classified as "excellent." The next closest fish community sampling sites are two sites located 0.7 mile from a project corridor. Both sampling sites, JF34 and JF84, were observed within Middle Creek and are currently listed as "good." None of the fish community sampling sites in or in proximity to the project areas or in Alternative 10 area are listed as poor or severe stress. All sampling sites for Alternative 10 are listed as "good" or "excellent" aside from two sampling sites, SR1441 and JF92, which are currently listed as "fair." Sampling site SR1441 is located approximately 1.5 miles east of Alternative 5. Sampling site JF92 is located approximately 1.2 miles south of Alternative 2. Sampling site JF66, located within Black Creek, was not rated in the most recent survey data.

Several benthic monitoring sites are in, or abut, the project area. The monitoring sites include the following:

- A sampling site adjacent to the proposed WTP associated with Alternatives 6 and 7A.
- A sampling site adjacent to a stream crossing by two transmission lines associated with Alternative 8A and the effluent force main associated with Alternative 9C.
- A sampling site in the proposed Middle Creek Reservoir associated with Alternative 3.
- Sampling sites adjacent to two stream crossings associated with Alternative 2.

Additionally, benthic monitoring sites are within 0.1 mile of the project areas relative to Alternative 1, the raw water intake associated with Alternatives 8A and 8B, and the effluent force main associated with Alternative 9C. Twenty-seven benthic monitoring sites are in the Alternative 10 area. The bioclassification for one benthic monitoring site within the Alternative 2 project corridor and one benthic monitoring site for Alternative 10 are reported as poor.

Several ambient water quality monitoring sites abut or are within 0.1 mile of a stream crossing by a project corridor or proposed project component associated with Alternatives 2, 5, 6, 7, 8A, 8B, 9A, 9C, and 9D. Eight water quality monitoring sites are in the Alternative 10 area. None of the water quality monitoring sites in or in proximity to the project areas or within the Alternative 10 area are listed as severe. Numerous fish, benthic, and ambient monitoring sites are located on streams crossed by the proposed alternatives but are located a substantial distance either upstream or downstream of the alternative crossing thereof. The ambient water quality monitoring sites in the project area are illustrated on Figure 4-8.

Per Section 303(d) of the CWA, if a surface water quality standard is exceeded and the impaired waters do not have a total maximum daily load (TMDL) approved by EPA, an integrated reporting category of "5" is assigned to those waters and the waters are incorporated into the Section 303(d) list. Thirteen streams in the project areas have been designated as Category 5. If a TMDL is approved for the parameter resulting in the impairment of Category 5 waters, then the waterbody would be reclassified as Category 4 waters. Impaired waters that have an EPA-approved TMDL or other management strategy in place to address the impairment are assigned an integrated reporting category of "4." All waters in NC are Category 4 designated due to mercury. The 303(d) listed streams in the project area are summarized in Table 4-15 and illustrated in Figure 4-9.

Three streams in the project areas have been designated as Category 4 waters for parameters other than mercury. The New Hope Arm of Jordan Lake, which is traversed twice by Alternative 7, is designated as Category 4 due to a standard violation for chlorophyll-a. Jordan Lake is designated as Category 4 for aquatic life due to a poor bioclassification based on benthic community sampling results. A small portion of Swift Creek in Alternative 10 is designated as Category 4 for aquatic life due to a poor bioclassification based on benthic community sampling results. A portion of Middle Creek in the Alternative 10 project area is designated as Category 4 due to a standard violation for zinc. The Terrible Creek WWTP receiving stream (Alternative 9C) is listed as meeting designated uses.

The Cape Fear River basin is not officially classified as a nutrient sensitive waters. However, the Cape Fear is recognized by DWR as being nutrient over enriched. In a 2018 presentation to the EMC (DWR, 2018b), DWR cited recent algal blooms and nutrient over-enrichment as causes of impairment. DWR assembled a monitoring plan for the middle Cape Fear River basin with data collection initiated in 2019 and 2020. EPA Region 4 is currently conducting the modeling effort in the Cape Fear River basin for DWR. Per DWR, water quality conditions decline during periods of low flow, which potentially result in high chlorophyll-a concentrations. The Cape Fear River upstream and downstream of Lillington is currently not 303d listed for dissolved oxygen or chlorophyll-a. The Cape Fear River upstream and downstream of Lillington also does not list any category 4 or 5 impairments. In addition to the EPA modeling, DWR is planning to use the Middle stretch of the Cape Fear River as a pilot for run-of-river numeric nutrient criteria development. This effort has not been initiated by DWR.

Kenneth and Neals Creeks are both listed as impaired per the past several North Carolina Integrated Reports. Kenneth Creek is listed as category 5 for fish and benthic community impairment and turbidity impairment. Neals Creek is listed as category 5 for benthic community impairment. The impairment in Neals Creek is located upstream of the confluence with Kenneth Creek.

Point-source dischargers are regulated through the NPDES program and may be required to register for a permit. Major NPDES permit holders are authorized to discharge in excess of 1 mgd and minor permit holders are authorized to discharge less than 1 mgd. One major NPDES permit holder, the Apex WRF owned by the Town of Apex, is in the Alternatives 6 and 7 project corridors but is not associated with proposed infrastructure. The existing discharge from the Harnett County North Harnett Regional WWTP and the Town of Fuquay-Varina Terrible Creek WWTP are authorized to discharge effluent per a major NPDES permit. The North Harnett Regional WWTP and the Terrible Creek WWTP are discussed in Section 3 (Alternatives Analysis) as infrastructure incorporated into several alternatives. Two additional major NPDES

permit holders, the Town of Holly Springs Utley Creek WRF and the South Cary WRF, are located with the Alternative 10 project area. Alternative 8B is proposed to discharge via a former Town of Fuquay-Varina WWTP NPDES discharge site. There are seven minor dischargers in the immediate vicinity of a proposed pipe corridor that includes four municipal WTPs and three small domestic WTPs with one of the discharge permits being expired. Thirteen minor discharges are within the Alternative 10 project area and include municipal and privately owned WTPs and two WWTPs. NPDES dischargers are provided in Figure 4-8.

No wild and scenic rivers are listed in the project area. There are no areas designated as fish nursery areas or anadromous fish spawning areas in the vicinity of the project area. Surface water quality designations are illustrated on Figure 4-8.

Table 4-15: 303(d) Stream Reaches in Project Areas

Stream Name	Stream Reach	Standard Violation	Impairment Category	Benthic Bioclassification
Cape Fear River Basin				
Cape Fear River	• From NC Hwy 42 (Sanford water supply intake) to Buckhorn Dam	Chlorophyll-a	5	----
Neills Creek (Neals Creek)	• From source to a point 0.3 mile upstream of Wake-Harnett County line	Benthos	5	Fair, Poor, or Severe
	• From a point 0.3 mile upstream of Wake-Harnett County line to SR 1441	Benthos	5	Fair, Poor, or Severe
Kenneth Creek	• From Wake-Harnett County line to Neills Creek	Turbidity	5	----
		Benthos	5	Fair, Poor, or Severe
		Fish Community	5	Fair, Poor, or Severe
Neuse River Basin				
Neuse River	• From a point 0.5 miles upstream of Richardson Bridge Road/SR 1201 to Johnston County's intake at Richardson Bridge Road/SR 1201	Copper	5	----
Swift Creek	• From Lake Wheeler dam to a point 0.6 mile upstream of Wake County SR 1006	Benthos	5	Fair, Poor, or Severe
Swift Creek (Lake Benson)	• From a point 0.6 mile upstream of Wake County SR 1006 to backwaters of Lake Benson	Benthos	5	Fair, Poor, or Severe
Terrible Creek	• From dam at Johnsons Pond to Middle Creek	Benthos	5	Fair, Poor, or Severe

Table 4-15: 303(d) Stream Reaches in Project Areas

Stream Name	Stream Reach	Standard Violation	Impairment Category	Benthic Bioclassification
Moccasin Creek (Holts Pond)	• From source to a point 0.6 mile downstream of dam at Holts Pond	----	5	Fair, Poor, or Severe
Middle Creek	• From 0.8 mile south of US 1 to UT on west of creek 3.0 miles downstream	Benthos	5	Fair, Poor, or Severe
	• From UT on west side of creek 3.0 miles downstream to backwaters of Sunset Lake	Benthos	5	Fair, Poor, or Severe

4.14.4 Groundwater Supplies

The geology of the Blue Ridge and Piedmont Provinces may be characterized as a complex and fractured system of metamorphic and igneous rocks contained in a complex two-part, regolith-fractured crystalline rock aquifer system (Daniel and Dahlen, 2002). In the Piedmont province of North Carolina, aquifers are localized and consist of complex fractured metamorphic, igneous, and sedimentary rocks from the Triassic Basin. Regolith overlies most of the rocks and consists of soil, saprolite, alluvium, and colluvium. In the project area, groundwater is held in the regolith/fractured crystalline rock aquifer system. The fractured, crystalline, igneous and metamorphic rock generally has low porosity and therefore little storage capacity. As a result, the majority of the groundwater is located in the regolith that sits atop the bedrock. The Coastal Plain province in the project areas is located where the crystalline rocks of the Piedmont give way to Coastal Plain sediments. As with the Piedmont, the aquifers in the Coastal Plain province are located in the regolith.

Groundwater in the regolith recharges the water-holding fractures in the underlying bedrock. The water held in the regolith is recharged from infiltration of precipitation. The infiltration and recharge rates vary across the physiographic province as well as the project area based on variations in regolith thickness, arrangement of fractures in the regolith, and geology (Trapp and Horn, 1997). The infiltration and recharge rates are slower in the western part of the project area due to the clayey soils of the Triassic Basin. Recharge rates in project areas with more permeable rocks and soils may be as much as three times as fast as in the Triassic Basin (CDM, 2003).

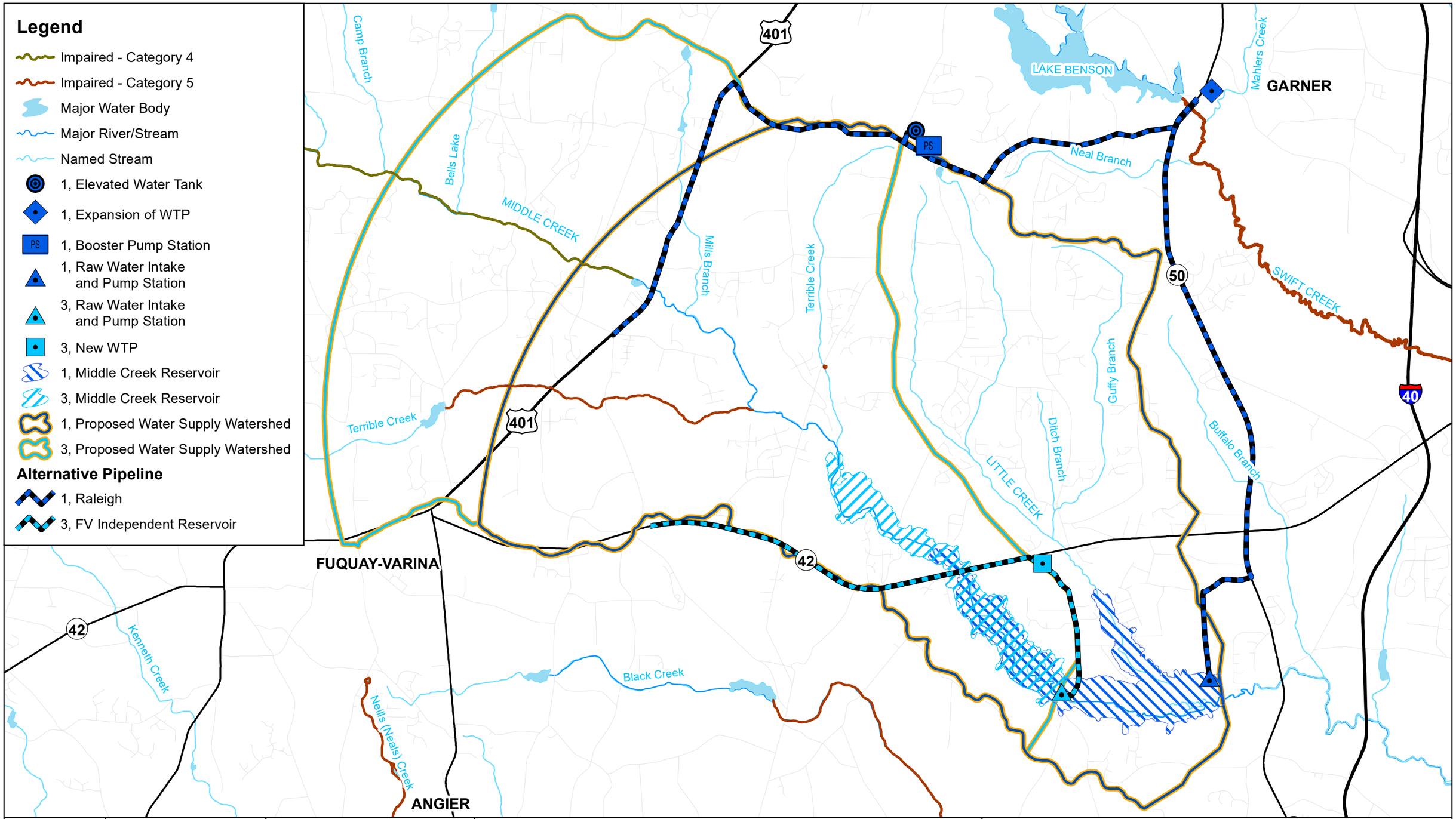
Groundwater well placement relative to bedrock and regolith fracture patterns is critical to maintain adequate and reliable yields. The most reliable yields are realized from wells that either penetrate several small fractures as well as one large fracture in intensely fractured rock or encounter numerous closely spaced fractures (Trap and Horn, 1997). Groundwater quality from the aquifers underlying the project areas is generally suitable for drinking and other uses. Dissolved constituents, typically including iron, manganese, fluoride, and sulfur, may require filtering and/or oxidation to make the water potable. Private groundwater wells are present in the vicinity of the project areas.

Legend

- Impaired - Category 4
- Impaired - Category 5
- Major Water Body
- Major River/Stream
- Named Stream
- 1, Elevated Water Tank
- 1, Expansion of WTP
- PS — 1, Booster Pump Station
- 1, Raw Water Intake and Pump Station
- 3, Raw Water Intake and Pump Station
- 3, New WTP
- 1, Middle Creek Reservoir
- 3, Middle Creek Reservoir
- 1, Proposed Water Supply Watershed
- 3, Proposed Water Supply Watershed

Alternative Pipeline

- 1, Raleigh
- 3, FV Independent Reservoir



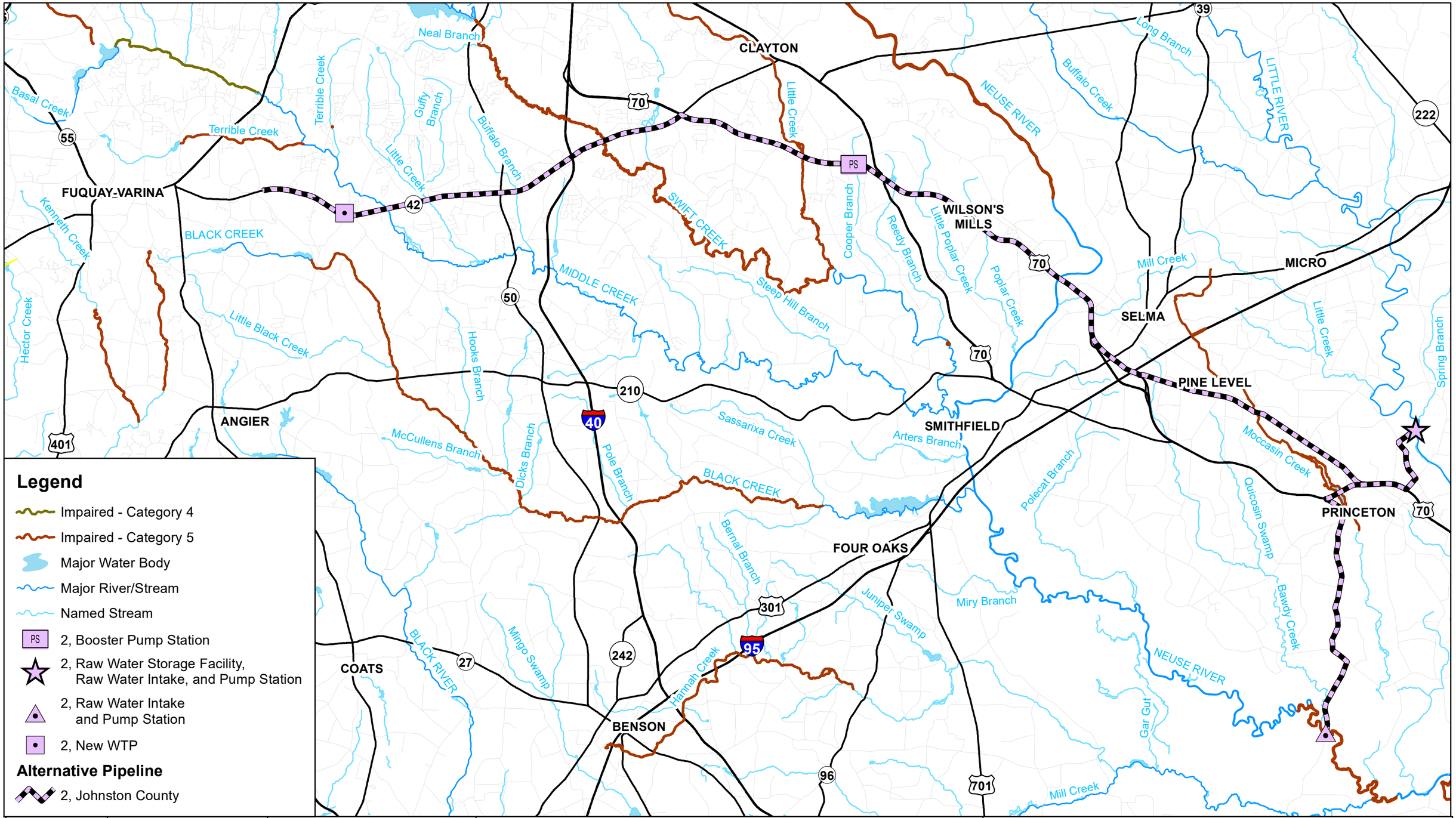
N W E S

SCALE
1 inch = 1 mile
0 0.5 1
Mile

FUQUAY-VARINA north carolina

Hazen

Figure 4-9a: Impaired Waters
Alternatives 1 and 3
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River



FUQUAY-VARINA north carolina

Hazen

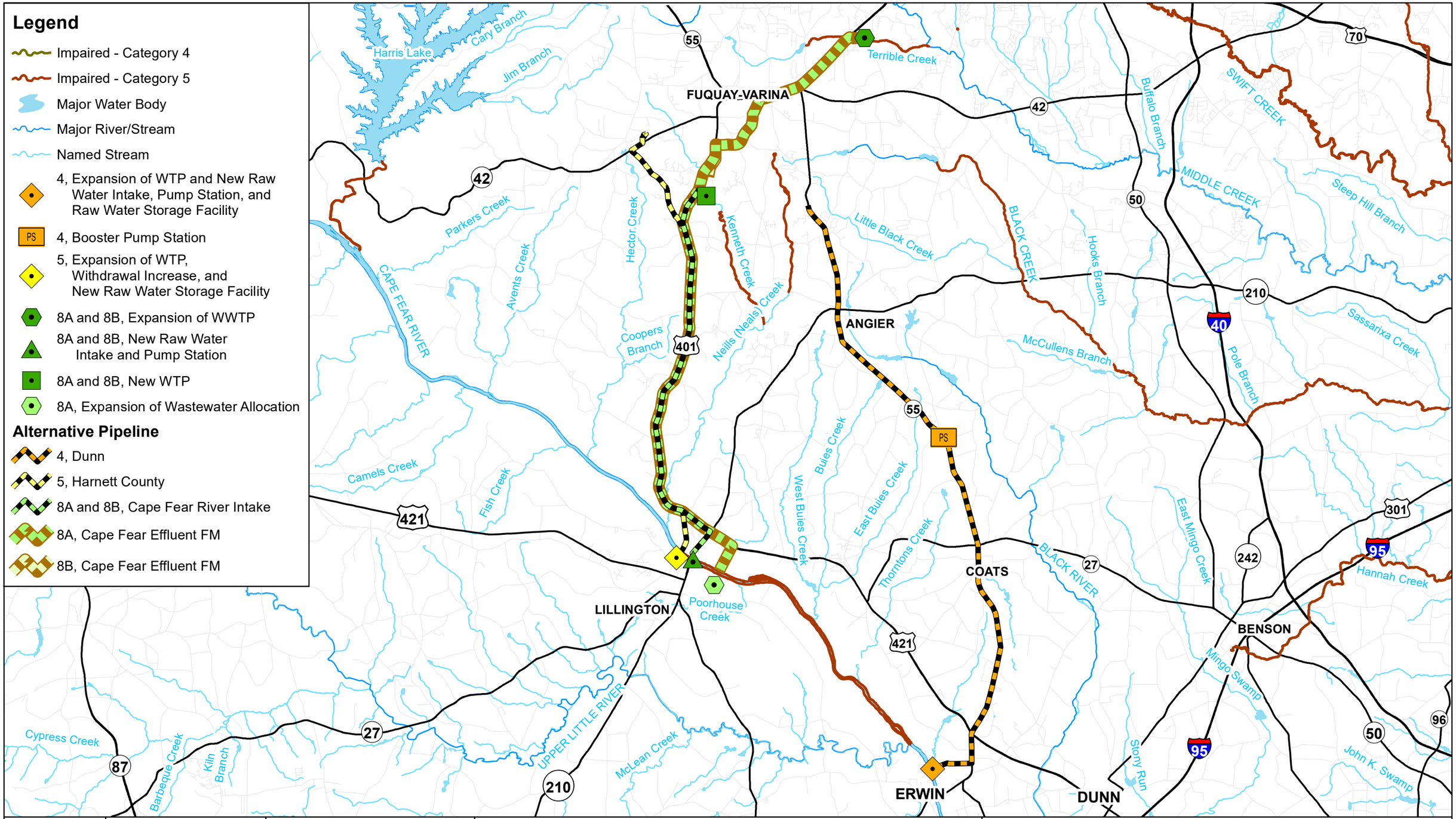
Figure 4-9b: Impaired Waters
Alternative 2
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Legend

- Impaired - Category 4
- Impaired - Category 5
- Major Water Body
- Major River/Stream
- Named Stream
- 4, Expansion of WTP and New Raw Water Intake, Pump Station, and Raw Water Storage Facility
- PS — 4, Booster Pump Station
- 5, Expansion of WTP, Withdrawal Increase, and New Raw Water Storage Facility
- 8A and 8B, Expansion of WWTP
- 8A and 8B, New Raw Water Intake and Pump Station
- 8A and 8B, New WTP
- 8A, Expansion of Wastewater Allocation

Alternative Pipeline

- 4, Dunn
- 5, Harnett County
- 8A and 8B, Cape Fear River Intake
- 8A, Cape Fear Effluent FM
- 8B, Cape Fear Effluent FM



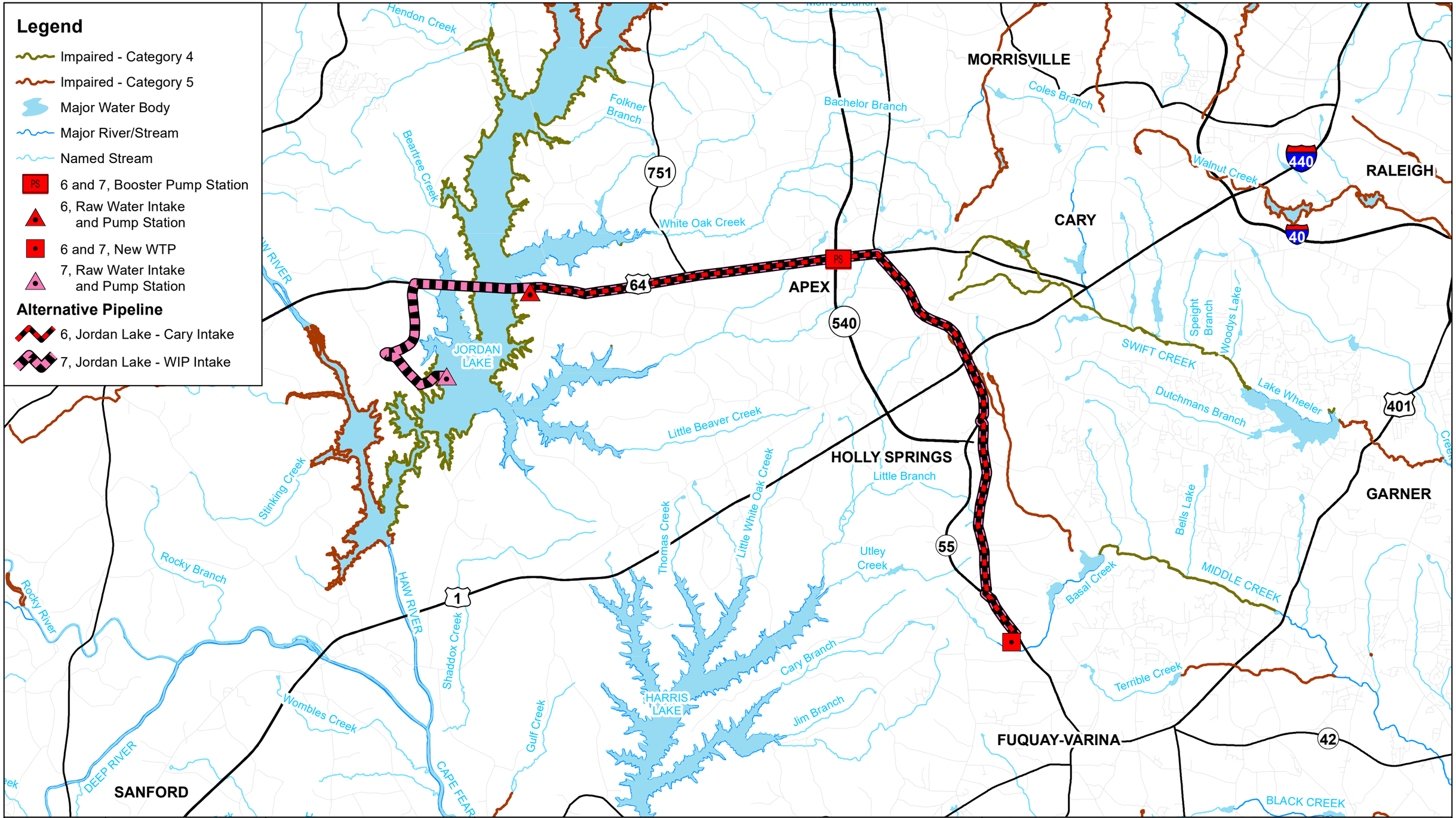
N W E S

SCALE
1 inch = 2.5 miles
0 2.5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-9c: Impaired Waters Alternatives 4, 5, 8A, and 8B
Interbasin Transfer for Water Supply from Cape Fear River to Neuse River



SCALE
1 inch = 2 miles
0 1 2 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-9d: Impaired Waters Alternatives 6 and 7
Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

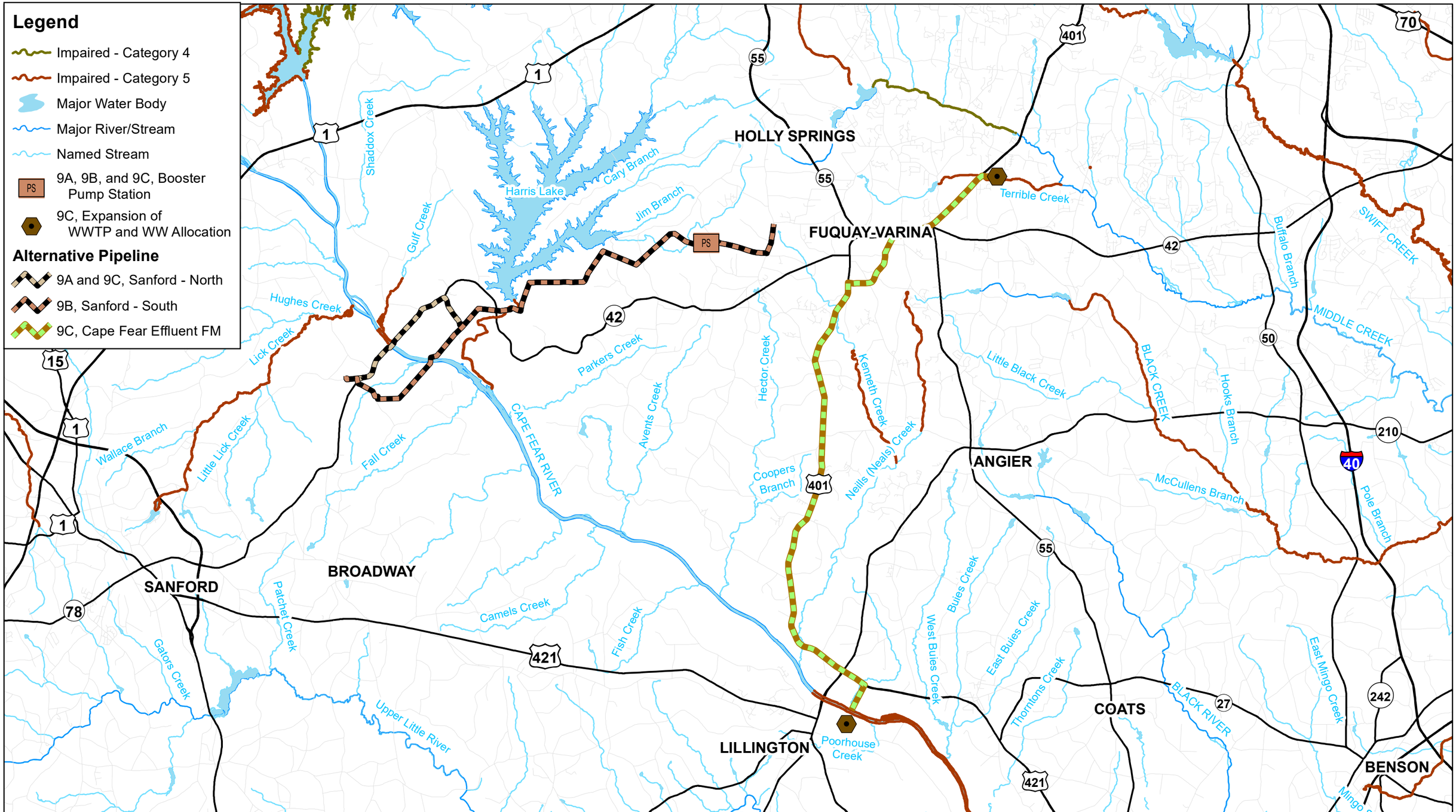


Figure 4-9e: Impaired Waters Alternatives 9A, 9B, and 9C

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

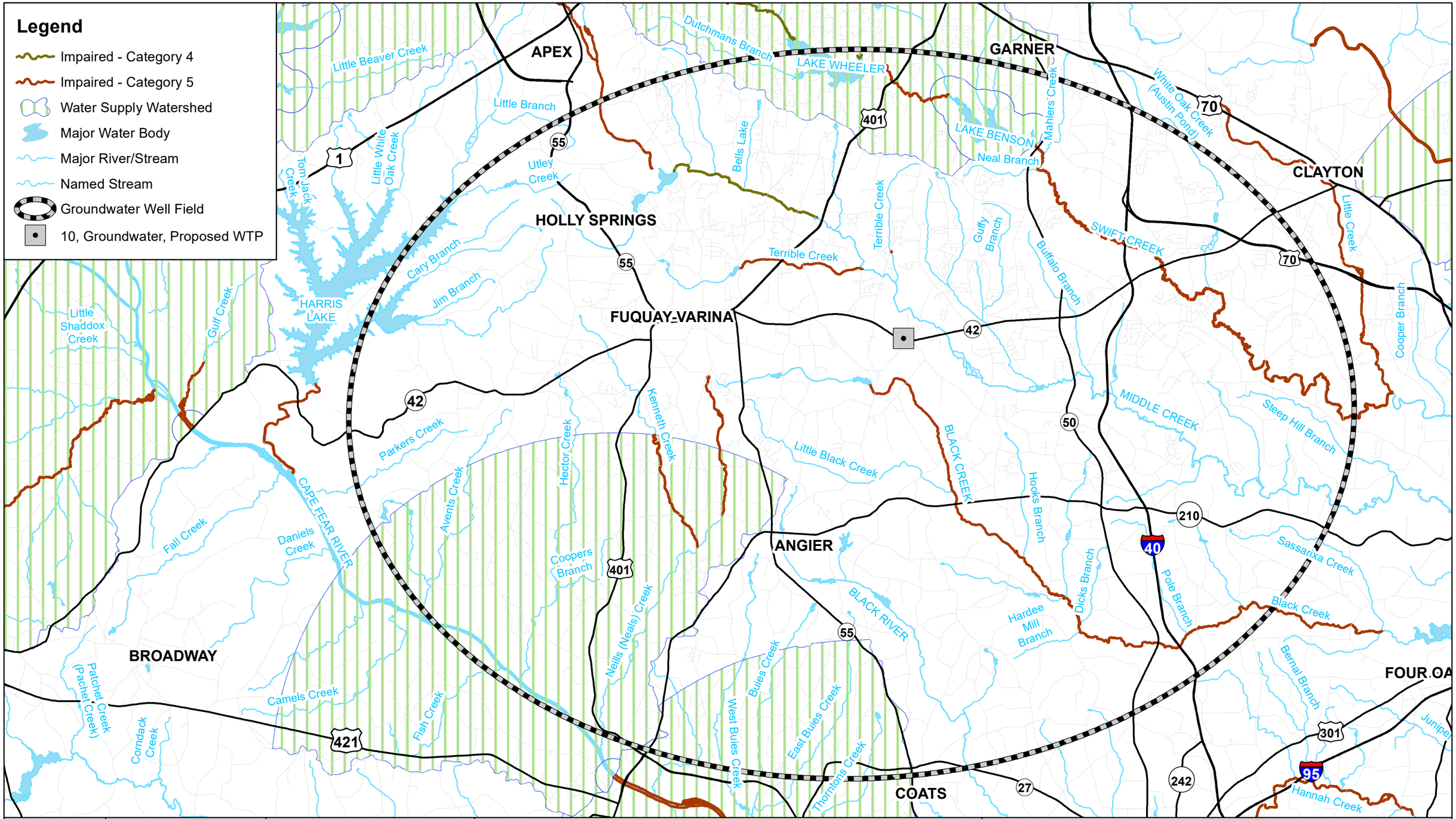


Figure 4-9f: Impaired Waters
Alternative 10
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

4.15 Environmental Justice

Executive Order 12898 Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (1994), amended by Executive Order 14008 Executive Order on Tackling the Climate Crisis at Home and Abroad (2021), requires the applicant to determine the impacts that the project will have on minority and low-income populations. EPA defines Environmental Justice as equitable treatment and involvement of all people regardless of race or income. The analysis of population demographics was performed following the federal Interagency Working Group on Environmental Justice and NEPA Committee's report titled Promising Practices for EJ Methodologies in NEPA Reviews (IWG, 2016) and the NC DEQ Community Mapping System Glossary of Terms and Definitions (DEQ, 2022a). Minority populations are identified in Section 4.15.1, and low-income populations are identified in Section 4.15.2. Guidance provided by DEQ states that underserved populations must be identified and disparities in the provision and location of sewer treatment and transport facilities between the general population and the underserved populations documented (DEQ, 2022b). Potentially underserved populations are identified in Section 4.15.3. Figure 4-10 illustrates the CDSA, SDSA, and the census tracts. Figure 4-11 illustrates the WDSA and the block groups.

The environmental justice assessment for the project was performed based on 2019 data reported by the U.S. Census Bureau for minority populations and for income data. The analysis was performed relative to three mechanisms of effect: construction of proposed project components (construction), provision of drinking water (service), and public water supplies (watershed). The minority and low-income population assessments include data from 67 census tracts for construction, thirteen census tracts for the service area, and 312 block groups across six counties for the watershed. The three mechanisms for the environmental justice assessment are described as follows:

- Construction Demographic Study Area (CDSA) – CDSA consists of the 2010 census tracts in which the project components are located and the 2010 census tracts along the border of which runs a pipeline alternative.
- Service Demographic Study Area (SDSA) – The SDS consists of the 2010 census tracts that intersect the Town of Fuquay-Varina's water service area and includes the populations to be provided drinking water by the proposed project. The SDSA does include residents of the included census tracts that reside outside the Town of Fuquay-Varina's water service area.
- Watershed Demographic Study Area (WDSA) – The WDSA includes the block groups in the Cape Fear River basin for which the raw water source has the potential to be affected by one or more proposed alternatives.

Legend

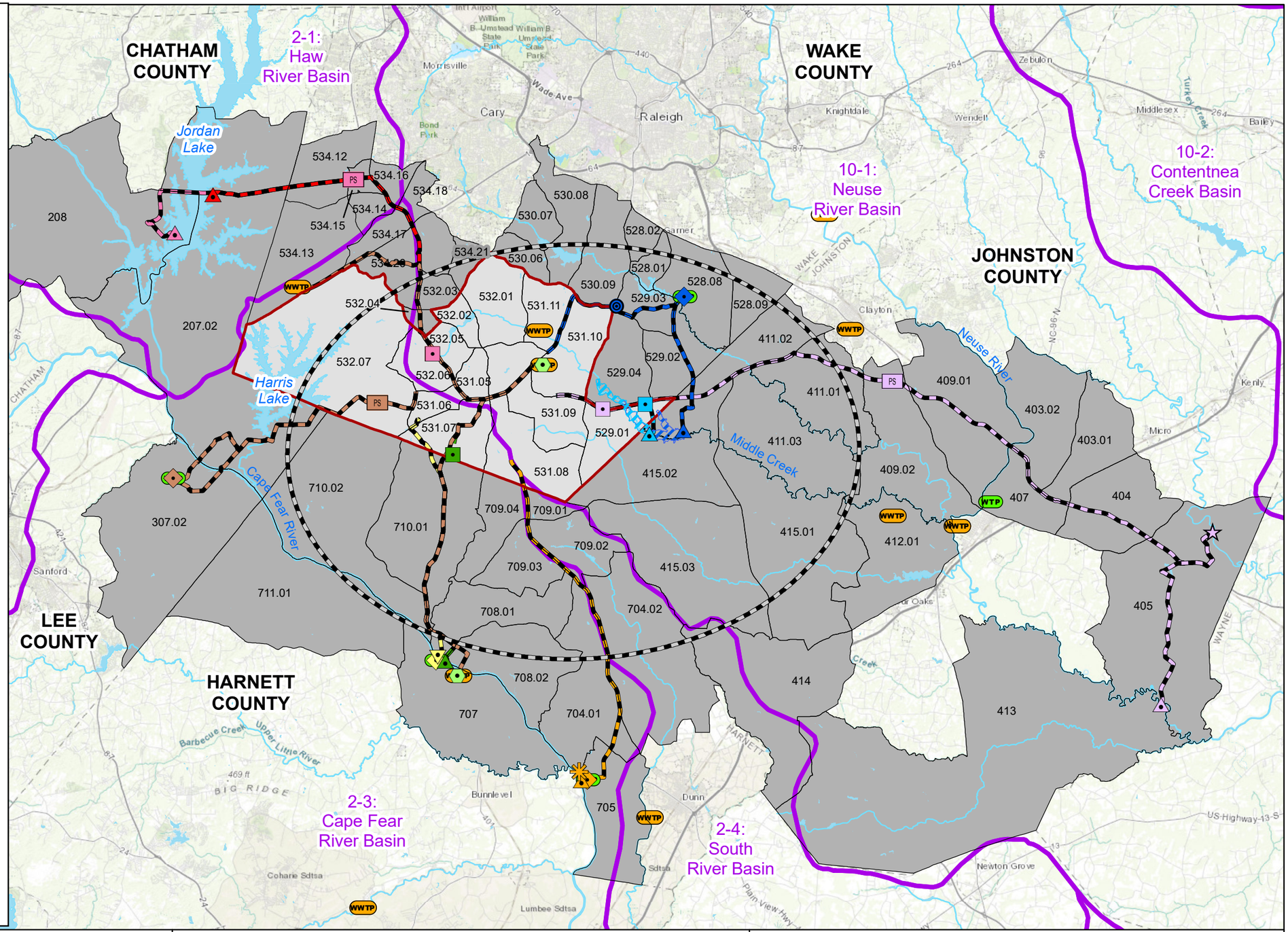
- Construction Demographic Service Area
- Service Demographic Study Area
- Wastewater Treatment Plant
- Water Treatment Plant
- IBT Boundary

Proposed Infrastructure

- Elevated Water Tank and Booster Pump Station
- Booster Pump Station
- Raw Water Intake and Pump Station
- Withdrawal Increase at Existing Intake
- Raw Water Storage Facility and Pump Station
- Raw Water Storage Facility, Raw Water Intake, and Pump Station
- New WTP
- Expansion of Existing WTP
- Expansion of Existing WWTP
- Middle Creek Reservoir

Alternative Pipeline

- 1, Raleigh
- 2, Johnston County
- 3, FV Independent Reservoir
- 4, Dunn
- 5, Harnett County
- 6, Jordan Lake - Cary Intake
- 7, Jordan Lake - WIP Intake
- 8, Cape Fear with Return Options
- 9, Sanford Options
- 10, Groundwater Well Field



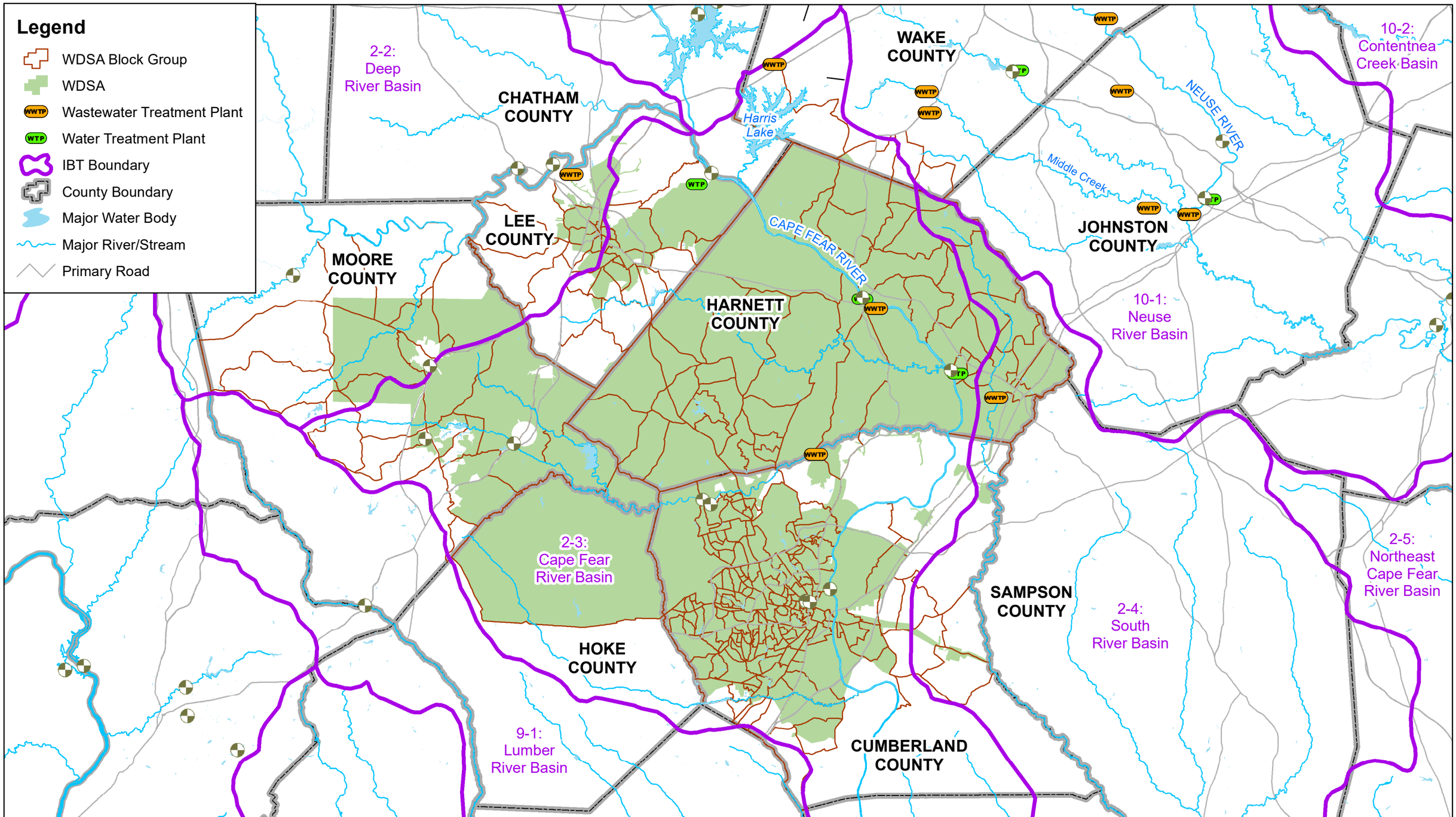
SCALE
1 inch = 5 miles
0 1 2 3 4 5 Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-10: Construction and Service Demographic Study Areas

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River



N
W E
S

SCALE
1 inch = 7 miles
0 3.5 7
Miles

FUQUAY-VARINA
north carolina

Hazen

Figure 4-11: Watershed Demographic Study Area

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

Analysis of the WDSA is included in this EIS as a result of a public comment received during initial project scoping relative to the impact of the proposed IBT on downstream water users. This issue was identified as a comment during scoping that downstream minority and/or low-income populations have the potential to be impacted. The analysis is focused on water supplies in the Cape Fear River basin and therefore is conducted for alternatives that source water in the Cape Fear River basin and involve a net interbasin transfer to the Neuse River basin, specifically alternatives 4, 5, 6, 7, 9A, and 9B. Alternative 13 is included in the WDSA analysis to provide a baseline for comparison. The other alternatives do not involve a net IBT and therefore do not impact downstream water supplies in the Cape Fear River. The WDSA includes the block groups that are currently served by a surface water source in the Cape Fear River basin that may be affected by the allocation of water to serve the Town of Fuquay-Varina's water customers.

4.15.1 Minority Populations

The EPA defines minorities as individuals of American Indian, Alaskan Native, Asian or Pacific Islander, Black, or Hispanic descent. Demographic information for the environmental justice assessment was obtained from the U.S. Census Bureau's 2019 data and analyzed on a census tract level. The 2019 Census Bureau data determined that North Carolina has a minority population of 31.3 percent. The minority population percentage in the census tracts associated with the project is compared against the threshold of 10 percent greater than the average of the state or county in which the census tract is located. If a project alternative is located in a census tract with a minority population greater than the stated threshold, then the determination must be made as to whether the project may disproportionately impact a minority population.

4.15.1.1 Minority Populations in the Construction Demographic Study Area

The CDSA is located in five counties in central North Carolina, including Chatham, Harnett, Johnston, Lee, and Wake counties. The 2019 Census Bureau data show the following minority population percentages by county: 19.1 percent in Chatham County, 32.9 percent in Harnett County, 22.8 percent in Johnston County, 26.3 percent in Lee County, and 34.6 percent in Wake County. The minority population of the CDSA overall is 22.7 percent, which is less than the minority population of the state of North Carolina and is within the range of minority population percentages of the five counties in the CDSA.

Table 4-16 summarizes the minority population percentage for each census tract in the CDSA. Of the 67 census tracts in the CDSA, 16 CDSA census tracts contain a minority population percentage that exceeds that of North Carolina (i.e., 31.3 percent). Refer to Figure 4-12 for an illustration of the minority population census tracts. Four of the CDSA census tracts contain a minority population that exceeds the analysis threshold of being equal to or greater than 10 percent higher than the state or county in which the census tract is located, specifically census tracts 403.01, 403.02, 407, and 707.

Legend

- Minority Population Less than NC Average
- Minority Population Greater than NC Average
- >10% Higher than State or County
- Wastewater Treatment Plant
- Water Treatment Plant
- IBT Boundary

Proposed Infrastructure

- Elevated Water Tank and Booster Pump Station
- Booster Pump Station
- Raw Water Intake and Pump Station
- Withdrawal Increase at Existing Intake
- Raw Water Storage Facility and Pump Station
- Raw Water Storage Facility, Raw Water Intake, and Pump Station
- New WTP
- Expansion of Existing WTP
- Expansion of Existing WWTP
- Middle Creek Reservoir
- 10, Groundwater Well Field

CHATHAM COUNTY
WAKE COUNTY
JOHNSTON COUNTY
LEE COUNTY
HARNETT COUNTY
2-1: Haw River Basin
10-1: Neuse River Basin
10-2: Contentnea Creek Basin
2-3: Cape Fear River Basin
2-4: South River Basin
Jordan Lake
Harris Lake
Cape Fear River
Middle Creek
Neuse River
534.20
532.04
532.06
528.02
528.01
530.09
528.08
709.04
707
403.02
403.01
407

SCALE
1 inch = 5 miles
0 1 2 3 4 5
Miles

FUQUAY-VARINA north carolina

Hazen

Figure 4-12: Minority Populations in the Construction Demographic Study Area

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

Table 4-16: Minority Populations for Construction Demographic Study Area per 2019 American Community Survey Data

Alternative	Census Tract	Total Population	Minority Population [1, 2]	
			Number of Persons	Percent of Population
1	411.02	14,095	3,236	23.0%
	528.08	11,485	3,663	31.9%
	529.03	2,930	647	22.1%
	530.09	7,775	2,640	34.0%
	531.10	6,071	1,394	23.0%
	531.11	5,977	1,785	29.9%
	Alternative Total	**48,333**	**13,365**	**27.7%**
2	403.01	4,899	2177	44.4%
	403.02	5,573	2399	43.0%
	404	4,422	708	16.0%
	405	6,673	677	10.1%
	407	3,901	1315	33.7%
	409.01	11,817	2438	20.6%
	409.02	7,895	1974	25.0%
	411.01	8,118	1465	18.0%
	411.02	14,095	3236	23.0%
	411.03	15,881	3049	19.2%
	413	6,502	138	2.1%
	529.01	2,796	97	3.5%
	529.02	5,999	1,263	21.1%
	529.04	7,801	1,964	25.2%
	531.09	9,478	1,365	14.4%
	531.10	6,071	1,394	23.0%
	Alternative Total	**121,921**	**25,659**	**21.0%**
3	411.02	14,095	3,236	23.0%
	415.02	8,365	1,427	17.1%
	529.01	2,796	97	3.5%
	529.02	5,999	1,263	21.1%
	529.04	7,801	1,964	25.2%
	531.09	9,478	1,365	14.4%
	531.10	6,071	1,394	23.0%
	Alternative Total	**54,605**	**10,746**	**19.7%**
4	704.01	3,904	983	25.2%
	704.02	6,773	1,754	25.9%
	705	6,224	1,649	26.5%
	709.01	3,103	815	26.3%

Table 4-16: Minority Populations for Construction Demographic Study Area per 2019 American Community Survey Data

Alternative	Census Tract	Total Population	Minority Population [1, 2]	
			Number of Persons	Percent of Population
	709.02	2,779	815	29.3%
	709.03	2,186	510	23.3%
	709.04	3,785	1,554	41.1%
	531.08	8,550	1,530	17.9%
	Alternative Total	**37,304**	**9,613**	**25.8%**
5	707	5,321	2,404	45.2%
	708.01	2,430	688	28.3%
	710.01	5,517	1,017	18.4%
	710.02	3,524	657	18.6%
	531.06	3,323	1,003	30.2%
	531.07	10,561	2,741	26.0%
	Alternative Total	**30,676**	**8,510**	**27.7%**
6	207.02	3,996	516	12.9%
	532.03	9,166	2,305	25.1%
	532.04	5,093	1,614	31.7%
	532.06	5,130	1,784	34.8%
	534.12	7,685	2,099	27.3%
	534.14	9,996	1,648	16.5%
	534.15	4,002	689	17.2%
	534.16	7,311	1,366	18.7%
	534.17	4,316	1,144	26.5%
	534.18	7,389	1,660	22.5%
	534.20	7,863	2,931	37.3%
	Alternative Total	**71,947**	**17,756**	**24.7%**
7	207.02	3,996	516	12.9%
	208	9,288	1,874	20.2%
	532.03	9,166	2,305	25.1%
	532.04	5,093	1,614	31.7%
	532.06	5,130	1,784	34.8%
	534.12	7,685	2,099	27.3%
	534.14	9,996	1,648	16.5%
	534.15	4,002	689	17.2%
	534.16	7,311	1,366	18.7%
	534.17	4,316	1,144	26.5%
	534.18	7,389	1,660	22.5%
	534.20	7,863	2,931	37.3%

Table 4-16: Minority Populations for Construction Demographic Study Area per 2019 American Community Survey Data

Alternative	Census Tract	Total Population	Minority Population [1, 2]	
			Number of Persons	Percent of Population
	Alternative Total	**81,235**	**19,630**	**24.2%**
8A/B	707	5,321	2,404	45.2%
	708.01	2,430	688	28.3%
	708.02	4,924	1,138	23.1%
	710.01	5,517	1,017	18.4%
	710.02	3,524	657	18.6%
	531.07	10,561	2,741	26.0%
	531.08	8,550	1,530	17.9%
	531.09	9,478	1,365	14.4%
	531.10	6,071	1,394	23.0%
	Alternative Total	**56,376**	**12,934**	**22.9%**
9A/B	710.02	3,524	657	18.6%
	307.02	4,394	708	16.1%
	531.06	3,323	1,003	30.2%
	532.06	5,130	1,784	34.8%
	532.07	10,934	1,565	14.3%
	Alternative Total	**27,305**	**5,717**	**20.9%**
9C	707	5,321	2,404	45.2%
	708.01	2,430	688	28.3%
	708.02	4,924	1,138	23.1%
	710.01	5,517	1,017	18.4%
	710.02	3,524	657	18.6%
	307.02	4,394	708	16.1%
	531.06	3,323	1,003	30.2%
	531.07	10,561	2,741	26.0%
	531.08	8,550	1,530	17.9%
	531.09	9,478	1,365	14.4%
	531.10	6,071	1,394	23.0%
	532.06	5,130	1,784	34.8%
	532.07	10,934	1,565	14.3%
	Alternative Total	**80,157**	**17,994**	**22.4%**
9D	710.02	3,524	657	18.6%
	307.02	4,394	708	16.1%
	531.05	4,346	415	9.5%
	531.06	3,323	1,003	30.2%
	531.08	8,550	1,530	17.9%

Table 4-16: Minority Populations for Construction Demographic Study Area per 2019 American Community Survey Data

Alternative	Census Tract	Total Population	Minority Population [1, 2]	
			Number of Persons	Percent of Population
	531.09	9,478	1,365	14.4%
	531.10	6,071	1,394	23.0%
	532.03	9,166	2,305	25.1%
	532.04	5,093	1,614	31.7%
	532.05	4,450	819	18.4%
	532.06	5,130	1,784	34.8%
	532.07	10,934	1,565	14.3%
	534.13	8,189	1,634	20.0%
	534.17	4,316	1,144	26.5%
	534.20	7,863	2,931	37.3%
	Alternative Total	**94,827**	**20,868**	**22.0%**
10	207.02	3,996	516	12.9%
	704.01	3,904	983	25.2%
	704.02	6,773	1,754	25.9%
	707	5,321	2,404	45.2%
	708.01	2,430	688	28.3%
	708.02	4,924	1,138	23.1%
	709.01	3,103	815	26.3%
	709.02	2,779	815	29.3%
	709.03	2,186	510	23.3%
	709.04	3,785	1,554	41.1%
	710.01	5,517	1,017	18.4%
	710.02	3,524	657	18.6%
	711.01	3,677	914	24.9%
	528.01	6,512	2,319	35.6%
	528.02	6,538	2,313	35.4%
	528.08	11,485	3,663	31.9%
	528.09	3,068	950	31.0%
	529.01	2,796	97	3.5%
	529.02	5,999	1,263	21.1%
	529.03	2,930	647	22.1%
	529.04	7,801	1,964	25.2%
	530.06	3,123	173	5.5%
	530.07	3,018	303	10.0%
	530.08	8,492	2,651	31.2%
	530.09	7,775	2,640	34.0%

Table 4-16: Minority Populations for Construction Demographic Study Area per 2019 American Community Survey Data

Alternative	Census Tract	Total Population	Minority Population [1, 2]	
			Number of Persons	Percent of Population
	531.05	4,346	415	5.9%
	531.06	3,323	1,003	30.2%
	531.07	10,561	2,741	26.0%
	531.08	8,550	1,530	17.9%
	531.09	9,478	1,365	14.4%
	531.10	6,071	1,394	23.0%
	531.11	5,977	1,785	29.9%
	532.01	12,450	1,318	10.6%
	532.02	4,315	442	10.2%
	532.03	9,166	2,305	25.1%
	532.04	5,093	412	8.1%
	532.05	4,450	819	18.4%
	532.07	10,934	1,565	14.3%
	534.06	5,078	231	4.5%
	534.20	7,863	2,931	37.3%
	534.21	5,737	1,272	22.2%
	409.02	7,895	2,438	25.0%
	411.01	8,118	1,465	18.0%
	411.02	14,095	3,236	23.0%
	411.03	15,881	3,049	19.2%
	412.01	4,153	773	18.6%
	414	7,159	1,987	27.8%
	415.01	7,603	849	11.2%
	415.02	8,365	1,427	17.1%
	415.03	8,363	1,041	12.4%
	Alternative Total	**316,480**	**70,541**	**22.3%**
Totals	**Total for CDSA**	**429,113**	**97,619**	**22.7%**
	North Carolina	**10,264,876**	**3,214,957**	**31.3%**

[1] *Minority population includes all races that are Non-White and Hispanic populations that are also White.*
[2] *Source: U.S. Census Bureau, American Community Survey 5-year Estimates (2015-2019), Table B02001, "Race."*

4.15.1.2 Minority Populations in the Service Demographic Study Area

The SDSA is located entirely in Wake County. The minority population percentage of Wake County is shown in the 2019 Census Bureau data as 34.6 percent. The minority population of the SDSA overall is 18.4 percent, which is less than the minority population percentage of North Carolina and of Wake County. One of the 13 SDSA census tracts contains a minority population percentage greater than North Carolina and Wake County. None of the SDSA census tracts contain a minority population representing 50 percent or more of the total tract population. The minority population percentage for each census tract in the SDSA is summarized in Table 4-17. The census tract with a minority population percentage greater than the North Carolina average is illustrated in Figure 4-13.

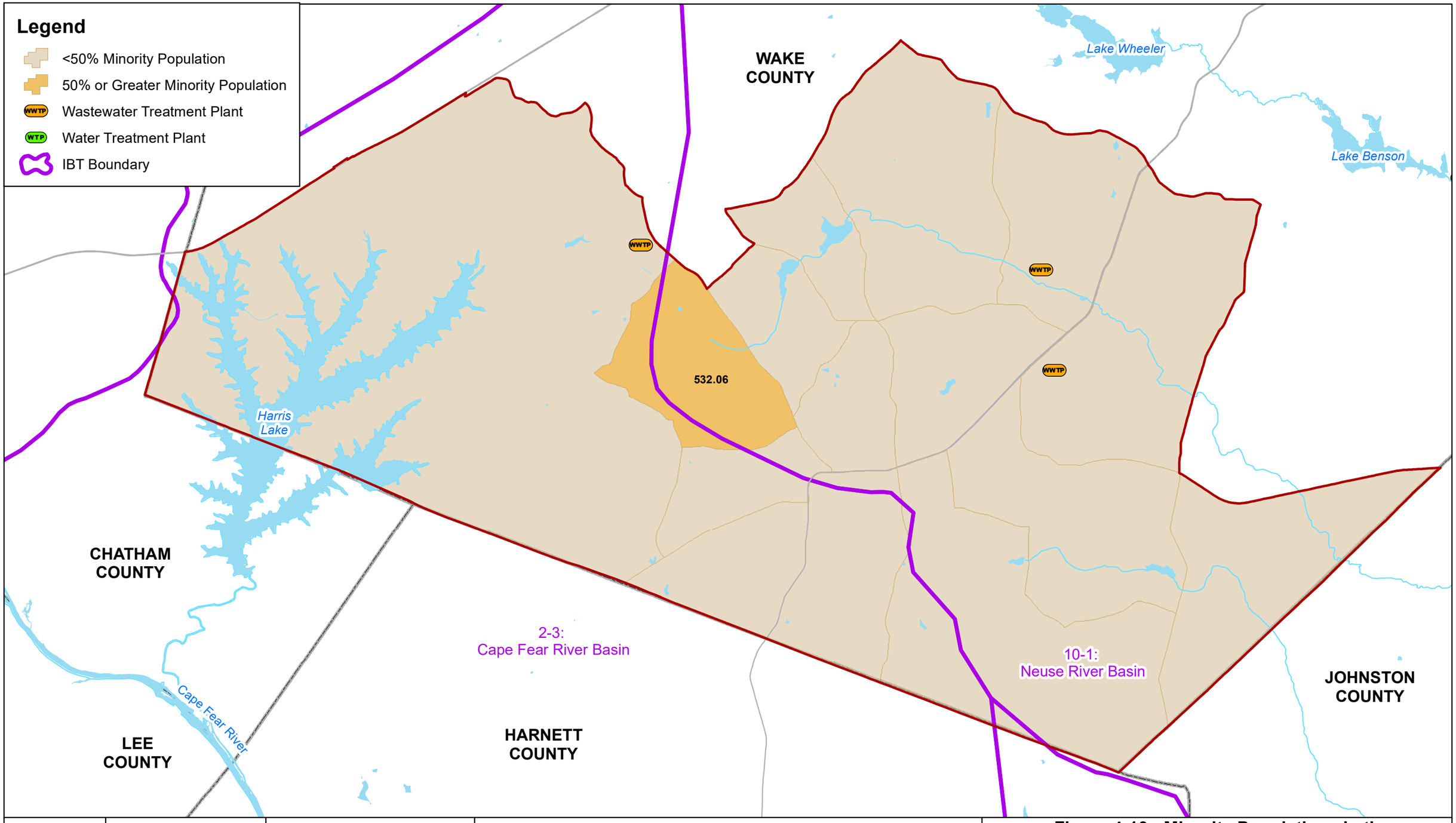


Figure 4-13: Minority Populations in the Service Demographic Study Area

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

Table 4-17: Minority Populations for Service Demographic Study Area per 2019 American Community Survey Data

Census Tract	Total Population	Minority Population [1, 2]	
		Number of Persons	Percent of Population
529.01	2,796	97	3.5%
531.05	4,346	415	9.5%
531.06	3,323	1,003	30.2%
531.07	10,561	2,741	26.0%
531.08	8,550	1,530	17.9%
531.09	9,478	1,365	14.4%
531.10	6,071	1,394	23.0%
531.11	5,977	1,785	29.9%
532.01	12,450	1,318	10.6%
532.02	4,315	442	10.2%
532.05	4,450	819	18.4%
532.06	5,130	1,784	34.8%
532.07	10,934	1,565	14.3%
Total for SDSA	88,381	16,258	18.4%
Wake County	1,069,079	370,320	34.6%
North Carolina	10,264,876	3,214,957	31.3%

[1] *Minority population includes all races that are Non-White and Hispanic populations that are also White.*
[2] *Source: US Census Bureau, American Community Survey 5-year Estimates (2015-2019), Table B02001, "Race."*

4.15.1.3 Minority Populations in the Watershed Demographic Study Area

The WDSA contains all or part of 312 block groups across six counties in North Carolina. Of the six WDSA counties, four counties have a minority population greater than that of North Carolinae. Two of these four counties have a minority population that is equal to or greater than the analysis threshold of 50 percent: 50 percent in Cumberland County and 55.6 percent in Hoke County. Of the 312 block groups in the WDSA, 203 block groups have a minority population percentage of at least 10 percent higher than the average for the state or county in which the block group is located. The 203 block groups with minority population percentage above the analysis threshold are presented in Table 4-18 and identified on Figure 4-14.

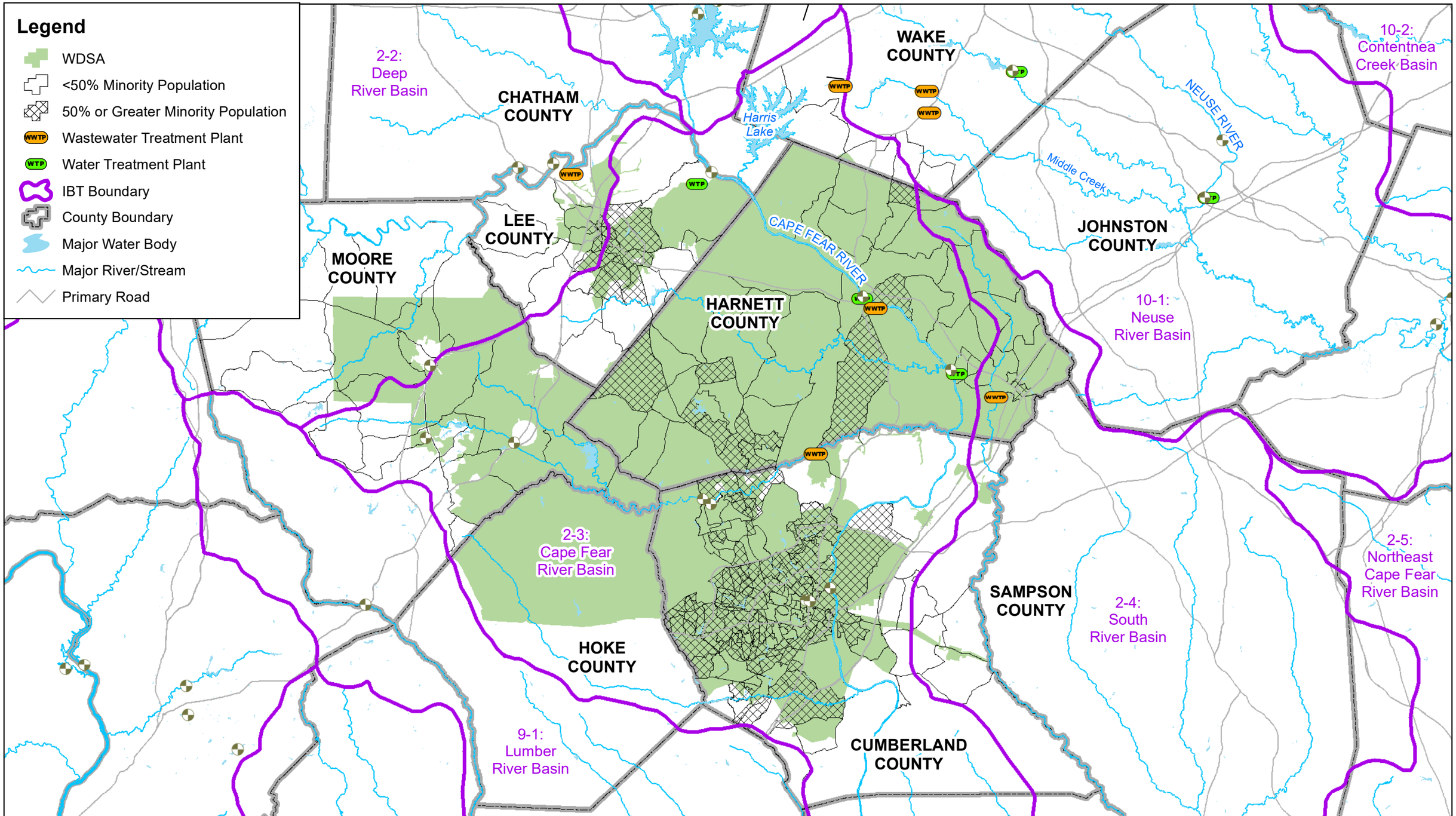


Figure 4-14: Minority Populations in the Watershed Demographic Study Area

Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Table 4-18: Block Groups with Percentage of Minority Population Above Analysis Threshold for Watershed Demographic Study Area per 2019 American Community Survey Data

Census Tract	Block Group	County	Total Population	Minority Population [1, 2]	
				Number of Persons	Percent of Population
2.00	1	Cumberland	431	372	86.3%
2.00	2	Cumberland	1,280	1,251	97.7%
2.00	3	Cumberland	575	447	77.7%
5.00	1	Cumberland	1,258	822	65.3%
5.00	2	Cumberland	532	334	62.8%
5.00	3	Cumberland	503	370	73.6%
6.00	1	Cumberland	1,268	916	72.2%
6.00	2	Cumberland	954	420	44.0%
6.00	4	Cumberland	444	417	93.9%
8.00	3	Cumberland	1,177	489	41.5%
9.00	2	Cumberland	603	274	45.4%
9.00	3	Cumberland	1,001	434	43.4%
9.00	4	Cumberland	744	342	46.0%
10.00	1	Cumberland	1,082	704	65.1%
10.00	2	Cumberland	1,694	1,602	94.6%
11.00	1	Cumberland	1,306	1,201	92.0%
11.00	2	Cumberland	849	810	95.4%
11.00	3	Cumberland	1,840	1,552	84.3%
12.00	1	Cumberland	1,450	983	67.8%
12.00	2	Cumberland	901	889	98.7%
12.00	3	Cumberland	1,164	1,136	97.6%
12.00	4	Cumberland	1,830	1,259	68.8%
14.00	1	Cumberland	1,665	1,334	80.1%
14.00	2	Cumberland	940	654	69.6%
14.00	4	Cumberland	1,324	606	45.8%
14.00	5	Cumberland	1,646	776	47.1%
15.00	2	Cumberland	1,595	1,043	65.4%
16.01	1	Cumberland	1,783	770	43.2%
16.01	3	Cumberland	3,912	2,099	53.7%
16.03	1	Cumberland	1,682	952	56.6%
16.03	2	Cumberland	2,202	1,088	49.4%
16.04	2	Cumberland	2,882	2,333	81.0%
16.04	3	Cumberland	3,623	1,889	52.1%
17.00	1	Cumberland	2,029	937	46.2%
17.00	2	Cumberland	1,232	776	63.0%
17.00	3	Cumberland	1,457	935	64.2%
17.00	4	Cumberland	4,405	2,725	61.9%

Table 4-18: Block Groups with Percentage of Minority Population Above Analysis Threshold for Watershed Demographic Study Area per 2019 American Community Survey Data

Census Tract	Block Group	County	Total Population	Minority Population [1, 2]	
				Number of Persons	Percent of Population
18.00	1	Cumberland	1,081	523	48.4%
18.00	2	Cumberland	1,193	677	56.7%
19.01	1	Cumberland	2,017	1,103	54.7%
19.02	1	Cumberland	2,054	1,324	64.5%
19.02	2	Cumberland	2,419	1,333	55.1%
19.03	1	Cumberland	1,156	764	66.1%
19.03	2	Cumberland	1,503	781	52.0%
19.03	4	Cumberland	859	513	59.7%
20.01	1	Cumberland	1,335	724	54.2%
20.01	2	Cumberland	1,493	963	64.5%
20.02	1	Cumberland	350	212	60.6%
20.02	2	Cumberland	1,997	1,332	66.7%
20.02	3	Cumberland	987	532	53.9%
20.02	4	Cumberland	1,433	641	44.7%
21.00	1	Cumberland	1,251	784	62.7%
21.00	2	Cumberland	1,230	843	68.5%
22.00	1	Cumberland	809	480	59.3%
22.00	2	Cumberland	1,280	831	64.9%
23.00	1	Cumberland	1,057	760	71.9%
23.00	2	Cumberland	2,111	1,442	68.3%
23.00	3	Cumberland	1,302	1,024	78.6%
24.01	1	Cumberland	796	709	89.1%
24.01	2	Cumberland	746	636	85.3%
24.02	1	Cumberland	748	699	93.4%
24.02	2	Cumberland	1,367	1,045	76.4%
24.02	3	Cumberland	1,175	835	71.1%
25.01	1	Cumberland	1,539	1,437	93.4%
25.01	2	Cumberland	1,263	820	64.9%
25.01	3	Cumberland	4,619	2,668	57.8%
25.02	1	Cumberland	3,581	2,196	61.3%
25.02	2	Cumberland	2,316	1,130	48.8%
25.02	3	Cumberland	1,725	1,238	71.8%
25.03	1	Cumberland	1,346	829	61.6%
25.03	2	Cumberland	1,472	700	27.6%
25.03	3	Cumberland	1,754	878	50.1%
25.04	1	Cumberland	1,127	634	56.3%
25.04	2	Cumberland	3,867	2,062	53.3%

Table 4-18: Block Groups with Percentage of Minority Population Above Analysis Threshold for Watershed Demographic Study Area per 2019 American Community Survey Data

Census Tract	Block Group	County	Total Population	Minority Population [1, 2]	
				Number of Persons	Percent of Population
25.04	3	Cumberland	2,427	1,357	55.9%
26.00	2	Cumberland	1,725	933	54.1%
27.00	4	Cumberland	2,538	1,098	43.3%
30.01	1	Cumberland	2,237	1,133	50.6%
30.01	2	Cumberland	5,079	2,119	41.7%
31.02	1	Cumberland	4,305	1,869	43.4%
31.03	2	Cumberland	2,519	1,492	59.2%
31.03	3	Cumberland	1,842	826	44.8%
31.04	1	Cumberland	2,215	1,176	53.1%
31.04	2	Cumberland	2,538	1,277	50.3%
32.01	1	Cumberland	2,026	1,035	51.1%
32.01	2	Cumberland	3,715	2,075	55.9%
32.03	1	Cumberland	1,350	955	70.7%
32.03	2	Cumberland	1,264	624	49.4%
32.03	3	Cumberland	2,659	1,384	52.0%
32.04	1	Cumberland	1,203	793	65.9%
32.04	2	Cumberland	1,104	905	82.0%
32.04	3	Cumberland	1,645	1,086	66.0%
32.04	4	Cumberland	1,127	587	52.1%
32.04	5	Cumberland	3,191	1,877	58.8%
32.05	1	Cumberland	2,312	1,480	64.0%
32.05	2	Cumberland	2,179	1,492	68.5%
32.05	3	Cumberland	885	719	81.2%
33.02	1	Cumberland	2,542	2,177	85.6%
33.02	2	Cumberland	3,329	2,329	70.0%
33.04	1	Cumberland	829	419	50.5%
33.04	2	Cumberland	917	791	86.3%
33.04	3	Cumberland	2,796	1,862	66.6%
33.04	4	Cumberland	885	654	73.9%
33.04	5	Cumberland	998	742	74.3%
33.04	6	Cumberland	463	426	92.0%
33.05	1	Cumberland	2,482	1,523	61.4%
33.05	2	Cumberland	1,645	1,185	72.0%
33.05	3	Cumberland	2,037	1,673	82.1%
33.07	1	Cumberland	1,101	763	69.3%
33.07	2	Cumberland	3,295	2,522	76.5%
33.09	1	Cumberland	2,451	1,400	57.1%

Table 4-18: Block Groups with Percentage of Minority Population Above Analysis Threshold for Watershed Demographic Study Area per 2019 American Community Survey Data

Census Tract	Block Group	County	Total Population	Minority Population [1, 2]	
				Number of Persons	Percent of Population
33.09	2	Cumberland	2,115	1,215	57.4%
33.09	3	Cumberland	2,264	1,447	63.9%
33.10	1	Cumberland	1,118	700	62.6%
33.10	2	Cumberland	582	388	66.7%
33.10	3	Cumberland	1,550	1,196	77.2%
33.10	4	Cumberland	1,585	1,331	84.0%
33.11	1	Cumberland	2,813	1,938	68.9%
33.12	1	Cumberland	1,214	950	78.3%
33.12	2	Cumberland	2,076	1,291	62.2%
33.12	3	Cumberland	1,833	1,251	68.2%
33.12	4	Cumberland	1,720	1,267	73.7%
33.13	1	Cumberland	4,041	2,890	71.5%
33.13	2	Cumberland	3,842	2,953	76.9%
33.14	1	Cumberland	2,196	1,643	74.8%
33.14	2	Cumberland	2,380	1,727	72.6%
33.14	3	Cumberland	3,012	2,396	79.5%
34.01	2	Cumberland	3,385	1,497	44.2%
34.02	1	Cumberland	1,112	525	47.2%
34.03	1	Cumberland	1,904	962	50.5%
34.03	2	Cumberland	2,556	1,307	51.1%
34.04	2	Cumberland	1,275	591	46.4%
34.05	1	Cumberland	1,932	858	44.4%
34.07	1	Cumberland	1,861	931	50.0%
34.08	1	Cumberland	2,726	1,531	56.2%
34.08	2	Cumberland	2,434	1,100	45.2%
35.00	1	Cumberland	2,816	1,817	64.5%
35.00	2	Cumberland	485	394	81.2%
35.00	3	Cumberland	418	271	64.8%
35.00	4	Cumberland	1,003	759	75.7%
36.00	1	Cumberland	889	519	58.4%
36.00	2	Cumberland	619	439	70.9%
36.00	3	Cumberland	1,656	841	50.8%
36.00	4	Cumberland	2,519	1,788	71.0%
37.00	1	Cumberland	2,532	1,082	42.7%
37.00	2	Cumberland	1,675	724	43.2%
38.00	1	Cumberland	1,168	1,160	99.3%
38.00	2	Cumberland	1,102	799	72.5%

Table 4-18: Block Groups with Percentage of Minority Population Above Analysis Threshold for Watershed Demographic Study Area per 2019 American Community Survey Data

Census Tract	Block Group	County	Total Population	Minority Population [1, 2]	
				Number of Persons	Percent of Population
38.00	3	Cumberland	655	615	93.9%
301.01	1	Lee	1,321	630	47.7%
301.01	2	Lee	1,996	1,049	52.6%
301.01	3	Lee	1,923	735	38.2%
302.00	1	Lee	1,197	798	66.7%
302.00	2	Lee	1,341	1,073	80.0%
302.00	3	Lee	1,083	926	85.5%
303.00	1	Lee	1,199	979	81.7%
303.00	2	Lee	1,652	1,472	89.1%
304.01	1	Lee	2,188	1,273	58.2%
304.01	2	Lee	807	500	62.0%
304.01	3	Lee	1,058	1,047	99.0%
304.02	1	Lee	2,402	1,518	63.2%
304.02	2	Lee	1,554	1,296	83.4%
304.02	3	Lee	894	622	69.6%
304.02	4	Lee	2,554	1,473	57.7%
305.01	1	Lee	974	553	56.8%
305.02	1	Lee	963	357	37.1%
305.02	2	Lee	1,120	565	50.4%
307.01	2	Lee	3,148	1,231	39.1%
9503.01	2	Moore	756	317	41.9%
9503.01	3	Moore	1,583	771	48.7%
9504.02	1	Moore	1,393	396	28.4%
9504.02	2	Moore	1,180	344	29.2%
9504.02	3	Moore	2,566	1,063	41.4%
9505.01	2	Moore	1,298	492	37.9%
9506.02	1	Moore	1,458	561	38.5%
701.00	2	Harnett	1,072	726	67.7%
702.00	2	Harnett	1,602	725	45.3%
702.00	3	Harnett	955	884	92.6%
703.00	2	Harnett	436	227	52.1%
703.00	4	Harnett	1,962	893	45.5%
706.00	1	Harnett	2,469	1,422	57.6%
706.00	2	Harnett	2,141	996	46.5%
707.00	1	Harnett	2,663	1,156	43.4%
707.00	2	Harnett	892	538	60.3%
707.00	3	Harnett	1,804	848	47.0%

Table 4-18: Block Groups with Percentage of Minority Population Above Analysis Threshold for Watershed Demographic Study Area per 2019 American Community Survey Data

Census Tract	Block Group	County	Total Population	Minority Population [1, 2]	
				Number of Persons	Percent of Population
708.02	1	Harnett	1,064	536	50.4%
709.04	1	Harnett	1,187	633	53.3%
712.02	1	Harnett	3,762	2,191	58.2%
712.02	2	Harnett	1,310	595	45.4%
712.03	1	Harnett	1,225	624	50.9%
712.03	2	Harnett	1,046	571	54.6%
713.01	2	Harnett	1,716	734	42.8%
713.02	2	Harnett	3,595	1,816	50.5%
713.03	1	Harnett	2,821	1,518	53.8%
713.03	2	Harnett	3,665	2,106	57.5%
714.01	1	Harnett	3,339	1,670	50.0%
714.02	3	Harnett	1,240	575	46.4%
Totals		**4,007,369**	**599,565**	**35.3%**	**Total for WDSA**
		10,264,876	**3,214,957**	**31.3%**	**North Carolina**

[1] Minority population includes all races that are Non-White and Hispanic populations that are also White.
[2] Source: U.S. Census Bureau, American Community Survey 5-year Estimates (2015-2019), Table B02001, "Race."

4.15.2 Low-Income Populations

Low-income is defined by the U.S. Health and Human Services poverty guidelines. The census poverty thresholds are similar to the U.S. Health and Human Services thresholds. Low-income population data was extracted from the ACS data available from the U.S. Census Bureau for 2019 and is presented relative to the census tracts from the 2010 Census. The analysis was performed relative to the CDSA, SDSA, and WDSA.

The 2019 Census Bureau data determined that the state of North Carolina has a low-income population of 14.7 percent. The low-income population percentage in the census tracts associated with the project is compared against the threshold of equal to or greater than 10 percent higher than the state or county in which the census tract is located. If a project alternative is located in a census tract with a low-income population that exceeds the stated analysis threshold, then the determination must be made as to whether the project may disproportionately impact a low-income population (refer to Section 5.15).

4.15.2.1 Low-Income Populations in the Construction Demographic Study Area

The CDSA is located in five counties in central North Carolina, including Chatham, Harnett, Johnston, Lee, and Wake counties. The 2019 Census Bureau data shows the following low-income population percentages by county: 10.2 percent in Chatham County, 15.8 percent in Harnett County, 12.5 percent in Johnston

County, 16.1 percent in Lee County, and 9.1 percent in Wake County. The low-income population of the CDSA overall is 9.4 percent, which is less than the low-income population in North Carolina and is in the low end of the range of low-income population percentages of the five counties in the CDSA.

The low-income population percentage for each census tract in the CDSA is summarized in Table 4-19. Of the 67 census tracts in the CDSA, 12 CDSA census tracts contain a low-income population percentage that exceeds that of North Carolina (Figure 4-15). Nine of the CDSA census tracts contain a low-income population representing a larger percentage of the total population of the tract than the analysis threshold.

Table 4-19: Low-Income Populations for Construction Demographic Study Area per 2019 American Community Survey Data

Alternative	Census Tract	Population for whom Poverty Status is Determined [1]	Population Below Poverty Level	% Below Poverty Level
1	411.02	14,095	725	5.1%
	528.08	11,298	915	8.1%
	529.03	2,901	88	3.0%
	530.09	7,775	660	8.5%
	531.10	6,071	594	9.8%
	531.11	5,977	425	7.1%
	Alternative Total	**42,134**	**3,021**	**7.2%**
2	403.01	4,862	1,755	36.1%
	403.02	5,541	1,016	18.3%
	404	4,398	575	13.1%
	405	6,618	1,069	16.2%
	407	3,716	793	21.3%
	409.01	1,113	660	5.9%
	409.02	7,892	848	10.7%
	411.01	8,112	339	4.2%
	411.02	14,095	725	5.1%
	411.03	15,836	931	5.9%
	413	6,425	1,657	25.8%
	529.01	2,757	55	2.0%
	529.02	5,991	155	2.6%
	529.04	7,765	684	8.8%
	531.09	9,478	656	6.9%
	531.10	6,071	594	9.8%
	Alternative Total	**120,670**	**12,512**	**10.4%**
3	411.02	14,095	725	5.1%
	415.02	8,344	563	6.7%
	529.01	2,757	55	2.0%
	529.02	5,991	155	2.6%

Table 4-19: Low-Income Populations for Construction Demographic Study Area per 2019 American Community Survey Data

Alternative	Census Tract	Population for whom Poverty Status is Determined [1]	Population Below Poverty Level	% Below Poverty Level
	529.04	7,765	684	8.8%
	531.09	9,478	656	6.9%
	531.10	6,071	594	9.8%
	Alternative Total	**54,501**	**3,432**	**6.3%**
4	704.01	3,888	720	18.5%
	704.02	6,773	1,483	21.9%
	705	6,093	945	15.5%
	709.01	3,059	138	4.5%
	709.02	2,779	290	10.4%
	709.03	2,184	186	8.5%
	709.04	3,760	607	16.1%
	531.08	8,529	731	8.6%
	Alternative Total	**37,067**	**5,100**	**13.8%**
5	707	4,237	718	16.9%
	708.01	2,430	499	20.5%
	710.01	5,455	566	10.4%
	710.02	3,524	326	9.3%
	531.06	3,241	384	11.8%
	531.07	10,512	984	9.4%
	Alternative Total	**29,399**	**3,477**	**11.8%**
6	207.02	3,996	337	8.4%
	532.03	9,166	284	3.1%
	532.04	5,093	412	8.1%
	532.06	5,078	231	4.5%
	534.12	7,680	184	2.4%
	534.14	9,950	905	9.1%
	534.15	4,002	454	11.3%
	534.16	7,311	167	2.3%
	534.17	4,215	528	12.5%
	534.18	7,389	277	3.7%
	534.20	7,846	461	5.9%
	Alternative Total	**71,726**	**4,240**	**5.9%**
7	207.02	3,996	337	8.4%
	208	9,057	603	6.7%
	532.03	9,166	284	3.1%
	532.04	5,093	412	8.1%

Table 4-19: Low-Income Populations for Construction Demographic Study Area per 2019 American Community Survey Data

Alternative	Census Tract	Population for whom Poverty Status is Determined [1]	Population Below Poverty Level	% Below Poverty Level
	532.06	5,078	231	4.5%
	534.12	7,680	184	2.4%
	534.14	9,950	905	9.1%
	534.15	4,002	454	11.3%
	534.16	7,311	167	2.3%
	534.17	4,215	528	12.5%
	534.18	7,389	277	3.7%
	534.20	7,846	461	5.9%
	Alternative Total	**80,783**	**4,843**	**6.0%**
8A/B	707	4,237	718	16.9%
	708.01	2,430	499	20.5%
	708.02	3,329	975	29.3%
	710.01	5,455	566	10.4%
	710.02	3,524	326	9.3%
	531.07	10,512	984	9.4%
	531.08	8,529	731	8.6%
	531.09	9,478	656	6.9%
	531.10	6,071	594	9.8%
	Alternative Total	**53,565**	**6,049**	**11.3%**
9A/B	710.02	3,524	326	9.3%
	307.02	4,326	422	9.8%
	531.06	3,241	384	11.8%
	532.06	5,078	231	4.5%
	532.07	10,763	396	3.7%
	Alternative Total	**26,932**	**1,759**	**6.5%**
9C	707	4,237	718	16.9%
	708.01	2,430	499	20.5%
	708.02	3,329	975	29.3%
	710.01	5,455	566	10.4%
	710.02	3,524	326	9.3%
	307.02	4,326	422	9.8%
	531.06	3,241	384	11.8%
	531.07	10,512	984	9.4%
	531.08	8,529	731	8.6%
	531.09	9,478	656	6.9%
	531.10	6,071	594	9.8%

Table 4-19: Low-Income Populations for Construction Demographic Study Area per 2019 American Community Survey Data

Alternative	Census Tract	Population for whom Poverty Status is Determined [1]	Population Below Poverty Level	% Below Poverty Level
	532.06	5,078	231	4.5%
	532.07	10,763	396	3.7%
	Alternative Total	**76,973**	**7,482**	**9.7%**
9D	710.02	3,524	326	9.3%
	307.02	4,326	422	9.8%
	531.05	4,308	439	10.2%
	531.06	3,241	384	11.8%
	531.08	8,529	731	8.6%
	531.09	9,478	656	6.9%
	531.10	6,071	594	9.8%
	532.03	9,166	284	3.1%
	532.04	5,093	412	8.1%
	532.05	4,450	337	7.6%
	532.06	5,078	231	4.5%
	532.07	10,763	396	3.7%
	534.13	8,189	248	3.0%
	Alternative Total	**82,216**	**5,460**	**6.6%**
10	207.02	3,996	337	8.4%
	704.01	3,888	720	18.5%
	704.02	6,773	1,483	21.9%
	707	4,237	718	16.9%
	708.01	2,430	499	20.5%
	708.02	3,329	975	29.3%
	709.01	3,059	138	4.5%
	709.02	2,779	290	10.4%
	709.03	2,184	186	8.5%
	709.04	3,760	607	16.1%
	710.01	5,455	566	10.4%
	710.02	3,524	326	9.3%
	711.01	3,641	630	17.3%
	528.01	6,354	233	3.7%
	528.02	6,538	1,054	16.1%
	528.08	11,298	915	8.1%
	528.09	3,068	516	16.8%
	529.01	2,757	55	2.0%
	529.02	5,991	155	2.6%

Table 4-19: Low-Income Populations for Construction Demographic Study Area per 2019 American Community Survey Data

Alternative	Census Tract	Population for whom Poverty Status is Determined [1]	Population Below Poverty Level	% Below Poverty Level
	529.03	2,901	88	3.0%
	529.04	7,765	684	8.8%
	530.06	3,110	13	0.4%
	530.07	3,018	56	1.9%
	530.08	8,492	329	3.9%
	530.09	7,775	660	8.5%
	531.05	4,308	439	10.2%
	531.06	3,241	384	11.8%
	531.07	10,512	954	9.4%
	531.08	8,529	731	8.6%
	531.09	9,478	656	6.9%
	531.10	6,071	594	9.8%
	531.11	5,977	425	7.1%
	532.01	12,437	214	1.7%
	532.02	4,310	83	1.9%
	532.03	9,166	284	3.1%
	532.04	5,093	412	8.1%
	532.05	4,450	337	7.6%
	532.06	5,078	231	4.5%
	532.07	10,763	396	3.7%
	534.20	7,846	461	5.9%
	534.21	5,737	209	3.6%
	409.02	7,892	848	10.7%
	411.01	8,112	339	4.2%
	411.02	14,095	725	5.1%
	411.03	15,836	931	5.9%
	412.01	4,087	640	15.7%
	414	7,030	1,769	25.2%
	415.01	7,600	932	12.3%
	415.02	8,344	563	6.7%
	415.03	8,363	551	6.6%
	Alternative Total	**312,477**	**26,341**	**8.4%**
Totals	**Total for CDSA**	**413,362**	**38,599**	**9.3%**
	North Carolina	**9,984,891**	**1,467,591**	**14.7%**

[1] *Source: U.S. Census Bureau, American Community Survey 5-year Estimates (2015-2019), Table C17002, "Ratio of Income to Poverty Level in the Past 12 Months."*

Legend

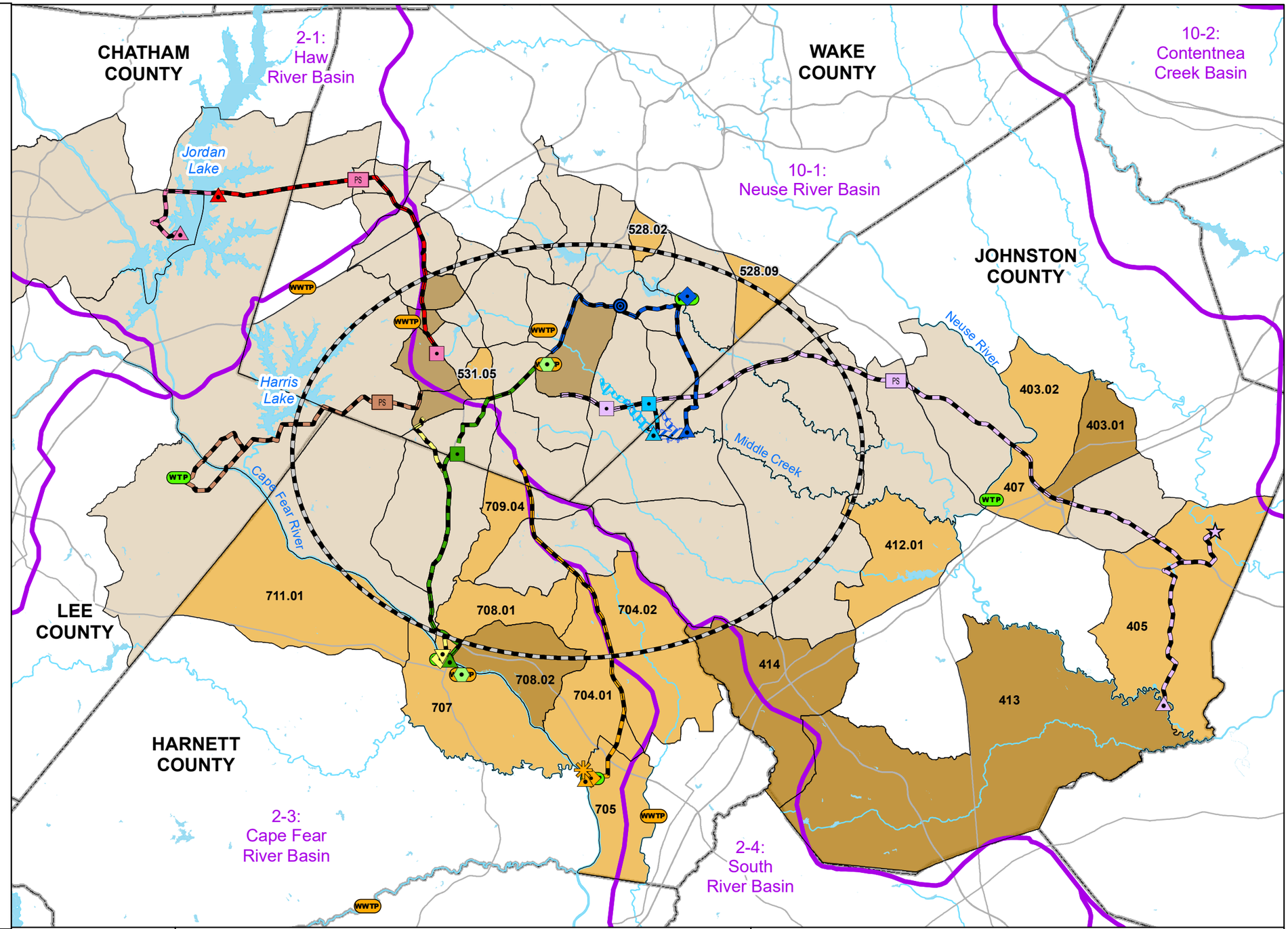
- Low-Income Population Less Than NC
- Low-Income Population Greater than NC
- >10% Higher than County or State
- Wastewater Treatment Plant
- Water Treatment Plant
- IBT Boundary

Proposed Infrastructure

- Elevated Water Tank and Booster Pump Station
- Booster Pump Station
- Raw Water Intake and Pump Station
- Withdrawal Increase at Existing Intake
- Raw Water Storage Facility and Pump Station
- Raw Water Storage Facility, Raw Water Intake, and Pump Station
- New WTP
- Expansion of Existing WTP
- Expansion of Existing WWTP
- Middle Creek Reservoir

Alternative Pipeline

- 1, Raleigh
- 2, Johnston County
- 3, FV Independent Reservoir
- 4, Dunn
- 5, Harnett County
- 6, Jordan Lake - Cary Intake
- 7, Jordan Lake - WIP Intake
- 8, Cape Fear with Return Options
- 9, Sanford Options
- 10, Groundwater Well Field



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1 inch = 5 miles
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Figure 4-15: Low-Income Populations in the Construction Demographic Study Area

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

4.15.2.2 Low-Income Populations in the Service Demographic Study Area

The SDSA is located entirely in Wake County. The low-income population percentage of Wake County per the 2019 Census Bureau data is 9.1 percent. The low-income population of the SDSA overall is 6.3 percent, which is less than the low-income population percentage of North Carolina and of Wake County. Four of the 13 SDSA census tracts contain a low-income population percentage that is greater than that of Wake County. None of the SDSA census tracts contain a low-income population that is greater than North Carolina or greater than 10 percent for Wake County. The low-income population percentage for each census tract in the SDSA is presented in Table 4-20 and illustrated on Figure 4-16.

4.15.2.3 Low-Income Populations in the Watershed Demographic Study Area

The WDSA contains all or part of 312 block groups across six counties in North Carolina. Of the six WDSA counties, four counties have a low-income population greater than that of North Carolina. None of the WDSA counties have a low-income population that is equal to or greater than the analysis threshold of at least 10 percent higher than the state or the county. Of the 312 block groups within the WDSA, 82 block groups have a minority population percentage that is equal to or greater than 10 percent higher than the state or the county in which the block group is located. The 82 block groups with minority population percentage greater than the analysis threshold are presented in Table 4-21 and identified on Figure 4-17.

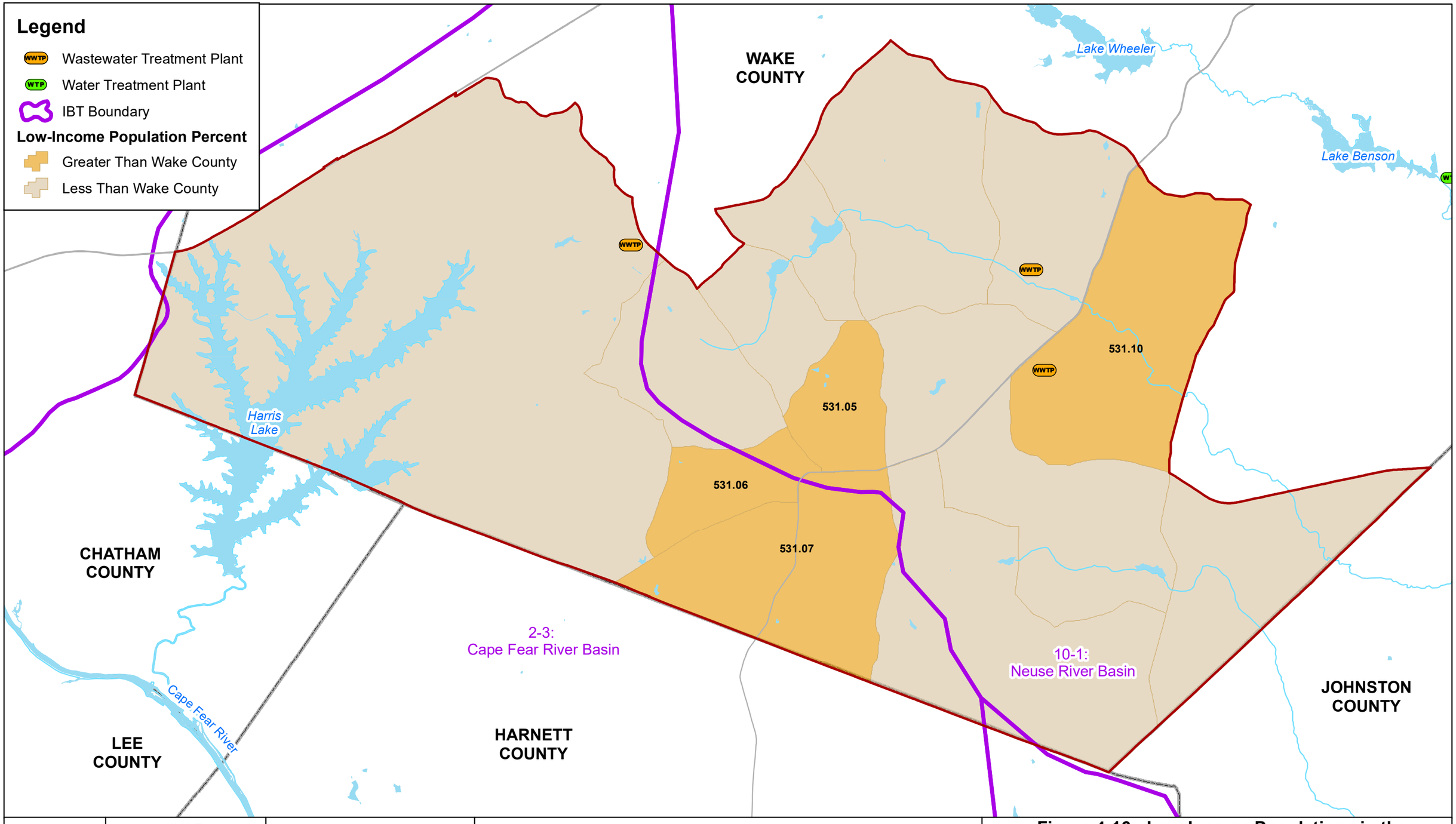


Figure 4-16: Low-Income Populations in the Service Demographic Study Area

Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

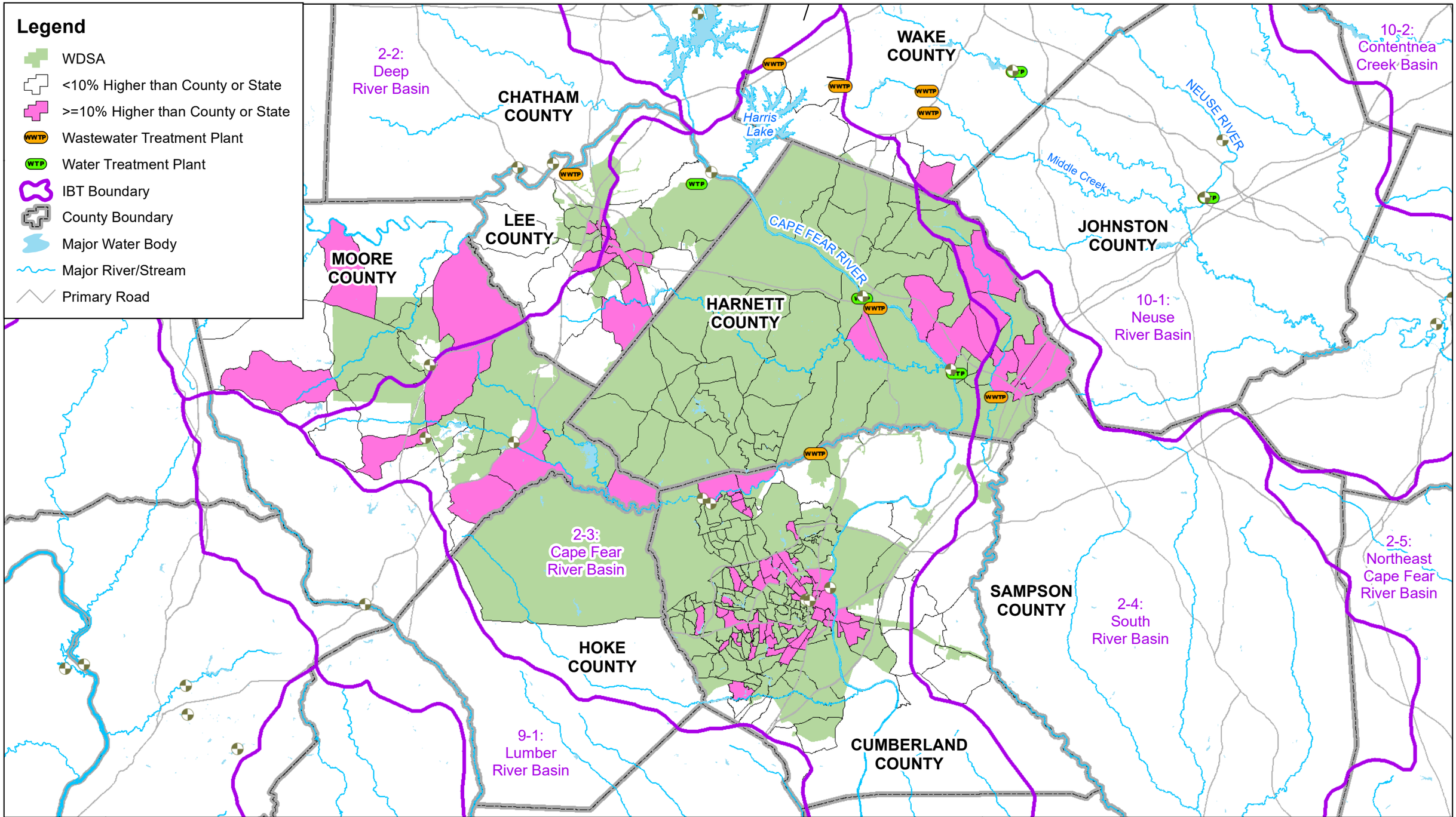


Figure 4-17: Low-Income Populations in the Watershed Demographic Study Area

Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Table 4-20: Low-Income Populations for Service Demographic Study Area per 2019 American Community Survey Data

Census Tract	Population for whom Poverty Status is Determined [1]	Below Poverty Level	
		Number of Persons	Percent of Population
529.01	2,757	55	2.0%
531.05	4,308	439	10.2%
531.06	3,241	384	11.8%
531.07	10,512	984	9.4%
531.08	8,529	731	8.6%
531.09	9,478	656	6.9%
531.10	6,071	594	9.8%
531.11	5,977	425	7.1%
532.01	12,437	214	1.7%
532.02	4,310	83	1.9%
532.05	4,450	337	7.6%
532.06	5,078	231	4.5%
532.07	10,763	396	3.7%
Total for SDSA	**87,911**	**5,529**	**6.3%**
Wake County	**1,046,544**	**95,198**	**9.1%**
North Carolina	**9,984,891**	**1,467,591**	**14.7%**

[1] *Source: U.S. Census Bureau, American Community Survey 5-year Estimates (2015-2019), Table C17002, "Ratio of Income to Poverty Level in the Past 12 Months."*

Table 4-21: Low-Income Populations for Watershed Demographic Study Area per 2019 American Community Survey Data

Census Tract	Block Group	Population for whom Poverty Status is Determined [1]	Below Poverty Level	
			Number of Persons	Percent of Population
2.00	1	431	324	75.2%
2.00	2	1,280	842	65.8%
5.00	1	1,258	457	36.3%
5.00	2	532	385	72.4%
5.00	3	503	245	48.7%
6.00	1	1,174	601	51.2%
6.00	4	444	183	41.2%
9.00	4	744	277	37.2%
10.00	1	871	302	34.7%
10.00	2	1,671	684	40.9%
11.00	2	849	323	38.0%
12.00	1	1,347	530	39.3%

Table 4-21: Low-Income Populations for Watershed Demographic Study Area per 2019 American Community Survey Data

Census Tract	Block Group	Population for whom Poverty Status is Determined [1]	Below Poverty Level	
			Number of Persons	Percent of Population
12.00	2	901	491	54.5%
12.00	3	1,164	458	39.3%
12.00	4	1,785	529	29.6%
14.00	1	1,665	558	33.5%
14.00	2	907	622	68.6%
16.03	1	1,682	696	41.4%
17.00	1	2,029	508	25.0%
17.00	3	1,457	419	28.8%
18.00	2	1,193	296	24.8%
19.02	1	2,046	556	27.2%
19.03	1	1,156	334	28.9%
19.03	4	831	265	31.9%
20.02	2	1,997	521	26.1%
22.00	2	1,274	418	32.8%
23.00	1	1,057	323	30.6%
23.00	2	2,111	969	45.9%
24.01	1	796	403	50.6%
24.01	2	746	274	36.7%
24.02	1	748	346	46.3%
24.02	2	1,367	464	33.9%
25.04	1	1,127	318	28.2%
31.03	2	2,519	645	25.6%
32.03	1	1,350	450	33.3%
32.04	3	1,645	510	31.0%
32.05	3	844	227	26.9%
33.02	1	2,537	1,006	39.7%
33.04	2	917	285	31.1%
33.05	3	2,031	695	34.2%
33.07	1	1,046	277	26.5%
33.10	3	1,550	494	31.9%
33.14	1	2,196	588	26.8%
35.00	1	2,812	903	32.1%
35.00	3	418	158	37.8%
36.00	1	889	341	38.4%
36.00	2	618	175	28.3%
36.00	3	1,652	619	37.5%

Table 4-21: Low-Income Populations for Watershed Demographic Study Area per 2019 American Community Survey Data

Census Tract	Block Group	Population for whom Poverty Status is Determined [1]	Below Poverty Level	
			Number of Persons	Percent of Population
38.00	1	1,159	572	49.4%
38.00	2	407	199	48.9%
301.01	2	1,996	505	25.3%
302.00	1	1,197	554	46.3%
302.00	2	1,327	628	47.3%
302.00	3	1,083	445	41.1%
303.00	2	1,246	548	44.0%
304.01	3	1,058	385	36.4%
304.02	1	2,402	637	26.5%
304.02	2	1,533	388	25.3%
305.01	1	906	311	34.3%
305.03	4	1,744	860	49.3%
531.08	1	2,085	407	19.5%
701.00	2	1,072	310	28.9%
701.00	3	2,166	690	31.9%
702.00	1	570	159	27.9%
702.00	2	1,600	432	27.0%
702.00	3	955	463	48.5%
703.00	1	1,779	459	25.8%
703.00	2	369	122	33.1%
703.00	4	1,953	605	31.0%
704.01	1	1,969	606	30.8%
704.02	1	3,271	858	26.2%
704.02	3	2,241	711	31.7%
707.00	2	892	238	26.7%
708.02	2	2,184	720	33.0%
9501.00	3	1,518	426	28.1%
9503.01	2	756	204	27.0%
9504.02	1	1,383	384	27.8%
9504.02	3	2,566	558	21.7%
9505.01	4	668	175	26.2%
9502.02	1	1,128	315	27.9%
9506.02	1	1,458	390	26.7%
9510.00	1	1,730	392	22.7%
Totals	**Total for WDSA**	**4,007,369**	**599,565**	**15.0%**
	North Carolina	**9,984,891**	**1,467,591**	**14.7%**

Table 4-21: Low-Income Populations for Watershed Demographic Study Area per 2019 American Community Survey Data

Census Tract	Block Group	Population for whom Poverty Status is Determined [1]	Below Poverty Level	
			Number of Persons	Percent of Population

[1] Source: U.S. Census Bureau, American Community Survey 5-year Estimates (2015-2019), Table C17002, "Ratio of Income to Poverty Level in the Past 12 Months."

4.15.2.4 Potentially Underserved Populations

DEQ guidance identifies census block groups as potentially underserved if their populations are both disproportionately nonwhite and disproportionately experiencing poverty. Underserved populations are defined in the DEQ guidance as those with (a) nonwhite population that is over fifty percent or at least ten percent higher than the county or state average, and (b) poverty rate that is over twenty percent and at least five percent higher than the county or state percentage. The percentages of non-white population and the poverty rate with the percentage at which the population is determined to be disproportionate are provided in Table 4-22.

Table 4-22: Nonwhite and Below-Poverty Population Thresholds Relative to County and State Rates per 2019 American Community Survey Data

County	Nonwhite Population	Nonwhite Population Analysis Threshold (County or State + 10%) [1]	Poverty Rate	Poverty Rate Analysis Threshold (County or State + 5%)
Chatham	19.1%	29.1%	10.2%	15.2%
Lee	26.3%	36.3%	16.1%	19.7%
Wake	34.6%	41.3%	9.1%	14.1%
Harnett	32.9%	41.3%	15.8%	19.7%
Johnston	22.8%	32.8%	12.5%	17.5%
Moore	17.8%	27.8%	11.3%	16.3%
Hoke	55.6%	41.3%	20.4%	19.7%
Cumberland	50.0%	41.3%	18.4%	19.7%
North Carolina	**31.3%**	**41.3%**	**14.7%**	**19.7%**

[1] Source: U.S. Census Bureau, American Community Survey 5-year Estimates (2015-2019), Table C17002, "Ratio of Income to Poverty Level in the Past 12 Months", and B02001, "Race".

4.15.2.4.1 Potentially Underserved Populations in the Construction Demographic Study Area

The CDSA is located in Chatham, Lee, Wake, Harnett, and Johnston counties. The block groups in the CDSA were evaluated against the thresholds stated in Table 4-23 and the potentially underserved populations by block group were identified. The population percentages of the potentially underserved populations in the CDSA are summarized in Table 4-23. The identified block groups are illustrated on Figure 4-18.

Legend

- Potentially Underserved Population
- Block Group
- Wastewater Treatment Plant
- Water Treatment Plant
- IBT Boundary

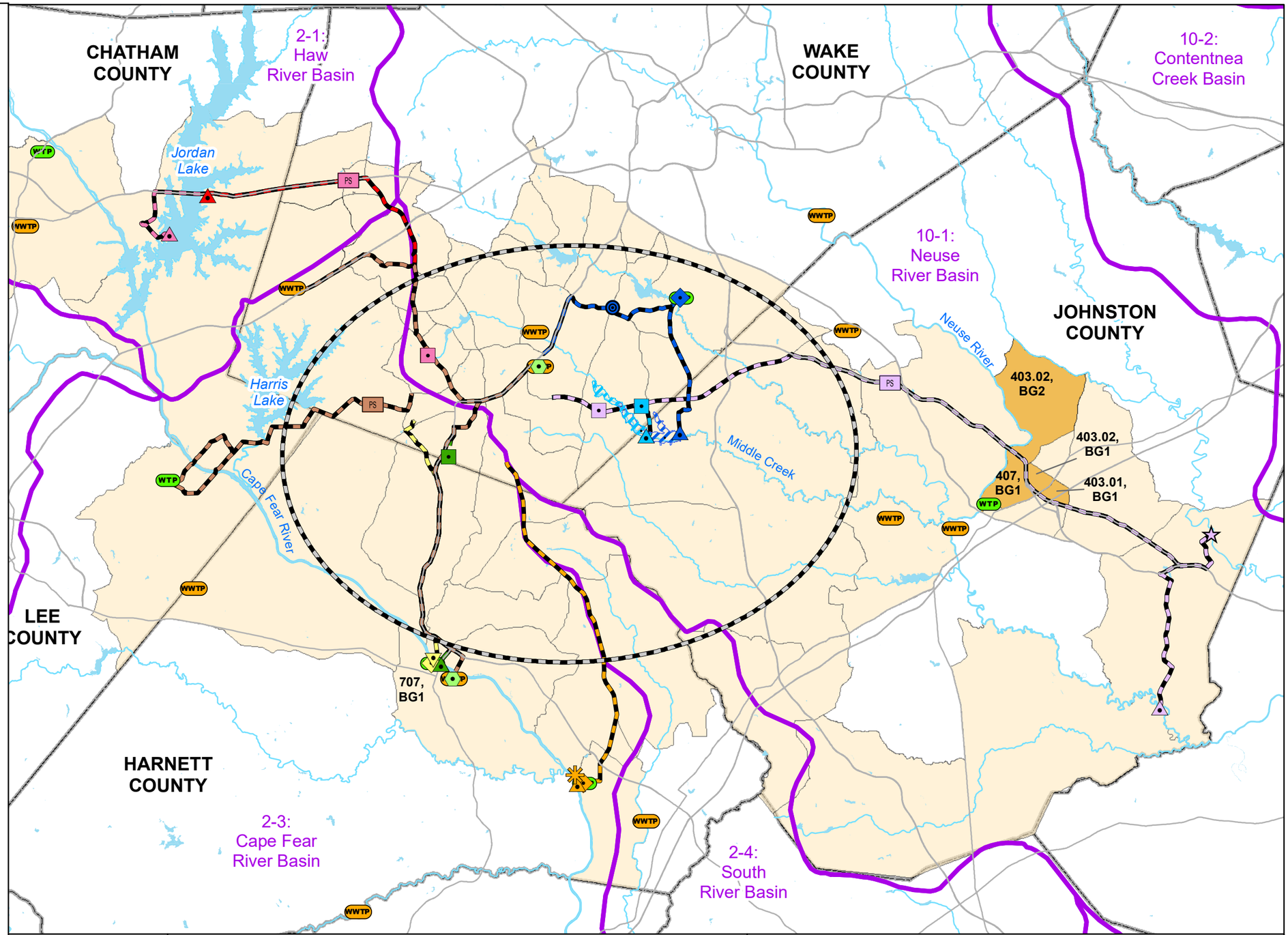
Proposed Infrastructure

- Elevated Water Tank and Booster Pump Station
- Booster Pump Station
- Raw Water Intake and Pump Station
- Withdrawal Increase at Existing Intake
- Raw Water Storage Facility and Pump Station
- Raw Water Storage Facility, Raw Water Intake, and Pump Station
- New WTP
- Expansion of Existing WTP
- Expansion of Existing WWTP
- Middle Creek Reservoir
- 10, Groundwater Well Field

Transmission_Lines_by_Alternative

Alternative Pipeline

- 1, Raleigh
- 2, Johnston County
- 3, FV Independent Reservoir
- 4, Dunn
- 5, Harnett County
- 6, Jordan Lake - Cary Intake
- 7, Jordan Lake - WIP Intake
- 8, Cape Fear with Return Options
- 9, Sanford Options



SCALE

1 inch = 5 miles

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Hazen

Figure 4-18: Potentially Underserved Populations in the Construction Demographic Study Area

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

Table 4-23: Potentially Underserved Populations for Construction Demographic Study Area per 2019 American Community Survey Data

Census Tract	Block Group	County	Nonwhite Population over 50%?	Nonwhite Population at Least 10% Higher than County or State? [1]	Poverty Rate over 20%?	Poverty Rate at Least 5% Higher than County or State?
707	1	Harnett	No	Yes	Yes	Yes
403.01	1	Johnston	Yes	Yes	Yes	Yes
403.02	1	Johnston	Yes	Yes	Yes	Yes
403.02	2	Johnston	No	Yes	Yes	Yes
407	1	Johnston	No	Yes	Yes	Yes

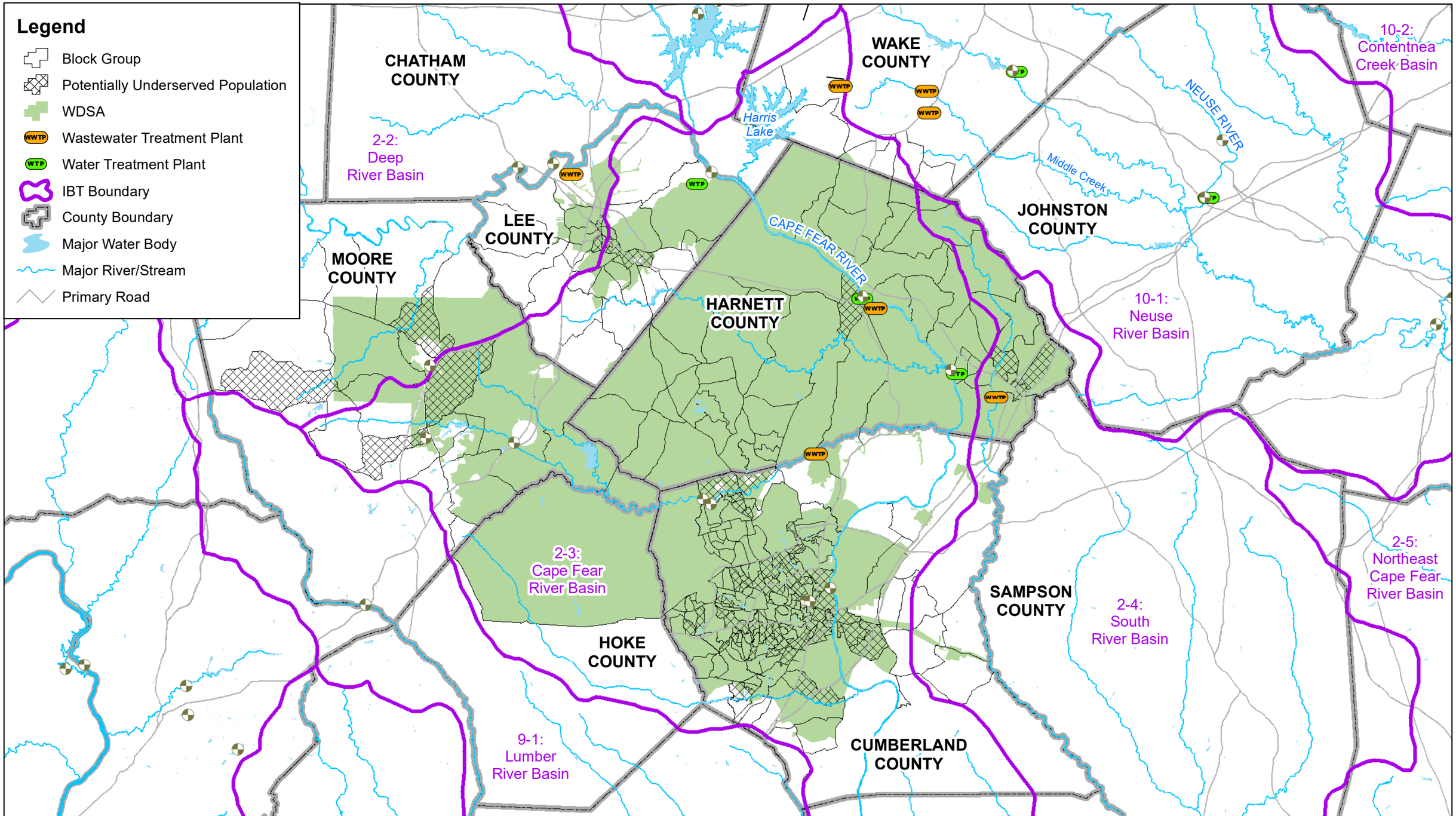
[1] *Source: U.S. Census Bureau, American Community Survey 5-year Estimates (2015-2019), Table C17002, "Ratio of Income to Poverty Level in the Past 12 Months", and B02001, "Race".*

4.15.2.4.2 Potentially Underserved Populations in the Service Demographic Study Area

The SDSA is located in the southern part of Wake County. The block groups in the SDSA were evaluated against the thresholds stated in Table 4-23. No block group was found to meet the criteria to be considered a potentially underserved population.

4.15.2.4.3 Potentially Underserved Populations in the Watershed Demographic Study Area

The WDSA is located in portions of Chatham, Lee, Moore, Wake, Hoke, Cumberland, and Johnston counties and all of Harnett County. The block groups in the WDSA were evaluated against the thresholds stated in Table 4-23 and the potentially underserved populations by block group were identified. The population percentages of the 80 block groups with potentially underserved populations in the WDSA are presented in Table 4-24 and the identified block groups are provided in Figure 4-19.



FUQUAY-VARINA north carolina

Hazen

Figure 4-19: Potentially Underserved Populations in the Watershed Demographic Study Area

Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

Table 4-24: Potentially Underserved Populations for Watershed Demographic Study Area per 2019 American Community Survey Data

Census Tract	Block Group	County	Nonwhite Population over 50%?	Nonwhite Population at Least 10% Higher than County or State? [1]	Poverty Rate over 20%?	Poverty Rate at Least 5% Higher than County or State?
2	1	Cumberland	Yes	Yes	Yes	Yes
2	2	Cumberland	Yes	Yes	Yes	Yes
2	3	Cumberland	Yes	Yes	Yes	Yes
5	1	Cumberland	Yes	Yes	Yes	Yes
5	2	Cumberland	Yes	Yes	Yes	Yes
5	3	Cumberland	Yes	Yes	Yes	Yes
6	1	Cumberland	Yes	Yes	Yes	Yes
6	4	Cumberland	Yes	Yes	Yes	Yes
9	4	Cumberland	No	Yes	Yes	Yes
10	1	Cumberland	Yes	Yes	Yes	Yes
10	2	Cumberland	Yes	Yes	Yes	Yes
11	1	Cumberland	Yes	Yes	Yes	Yes
11	2	Cumberland	Yes	Yes	Yes	Yes
12	1	Cumberland	Yes	Yes	Yes	Yes
12	2	Cumberland	Yes	Yes	Yes	Yes
12	3	Cumberland	Yes	Yes	Yes	Yes
12	4	Cumberland	Yes	Yes	Yes	Yes
14	1	Cumberland	Yes	Yes	Yes	Yes
14	2	Cumberland	Yes	Yes	Yes	Yes
14	4	Cumberland	No	Yes	Yes	Yes
15	2	Cumberland	Yes	Yes	Yes	Yes
16.03	1	Cumberland	Yes	Yes	Yes	Yes
17	1	Cumberland	No	Yes	Yes	Yes
17	2	Cumberland	Yes	Yes	Yes	Yes
17	3	Cumberland	Yes	Yes	Yes	Yes
18	1	Cumberland	No	Yes	Yes	Yes
18	2	Cumberland	Yes	Yes	Yes	Yes
19.02	1	Cumberland	Yes	Yes	Yes	Yes
19.03	1	Cumberland	Yes	Yes	Yes	Yes
19.03	4	Cumberland	Yes	Yes	Yes	Yes
20.02	2	Cumberland	No	Yes	Yes	Yes
21	1	Cumberland	Yes	Yes	Yes	Yes
21	2	Cumberland	No	Yes	Yes	Yes
22	2	Cumberland	Yes	Yes	Yes	Yes
23	1	Cumberland	Yes	Yes	Yes	Yes

Table 4-24: Potentially Underserved Populations for Watershed Demographic Study Area per 2019 American Community Survey Data

Census Tract	Block Group	County	Nonwhite Population over 50%?	Nonwhite Population at Least 10% Higher than County or State? [1]	Poverty Rate over 20%?	Poverty Rate at Least 5% Higher than County or State?
23	2	Cumberland	Yes	Yes	Yes	Yes
24.01	1	Cumberland	Yes	Yes	Yes	Yes
24.01	2	Cumberland	Yes	Yes	Yes	Yes
24.02	1	Cumberland	Yes	Yes	Yes	Yes
24.02	2	Cumberland	Yes	Yes	Yes	Yes
25.01	1	Cumberland	Yes	Yes	Yes	Yes
25.01	2	Cumberland	Yes	Yes	Yes	Yes
25.04	1	Cumberland	Yes	Yes	Yes	Yes
31.03	2	Cumberland	Yes	Yes	Yes	Yes
32.03	1	Cumberland	Yes	Yes	Yes	Yes
32.04	1	Cumberland	Yes	Yes	Yes	Yes
32.04	3	Cumberland	Yes	Yes	Yes	Yes
32.05	3	Cumberland	Yes	Yes	Yes	Yes
33.02	1	Cumberland	Yes	Yes	Yes	Yes
33.04	2	Cumberland	Yes	Yes	Yes	Yes
33.04	4	Cumberland	Yes	Yes	Yes	Yes
33.05	3	Cumberland	Yes	Yes	Yes	Yes
33.07	1	Cumberland	Yes	Yes	Yes	Yes
33.10	3	Cumberland	Yes	Yes	Yes	Yes
33.10	4	Cumberland	Yes	Yes	Yes	Yes
33.14	1	Cumberland	Yes	Yes	Yes	Yes
33.14	2	Cumberland	Yes	Yes	Yes	Yes
35	1	Cumberland	Yes	Yes	Yes	Yes
35	3	Cumberland	Yes	Yes	Yes	Yes
36	1	Cumberland	Yes	Yes	Yes	Yes
36	2	Cumberland	Yes	Yes	Yes	Yes
36	3	Cumberland	No	Yes	Yes	Yes
38	1	Cumberland	Yes	Yes	Yes	Yes
38	2	Cumberland	Yes	Yes	Yes	Yes
38	3	Cumberland	Yes	Yes	Yes	Yes
701	2	Harnett	Yes	Yes	Yes	Yes
702	2	Harnett	No	Yes	Yes	Yes
702	3	Harnett	Yes	Yes	Yes	Yes
703	2	Harnett	Yes	Yes	Yes	Yes
703	4	Harnett	No	Yes	Yes	Yes

Table 4-24: Potentially Underserved Populations for Watershed Demographic Study Area per 2019 American Community Survey Data

Census Tract	Block Group	County	Nonwhite Population over 50%?	Nonwhite Population at Least 10% Higher than County or State? [1]	Poverty Rate over 20%?	Poverty Rate at Least 5% Higher than County or State?
707	1	Harnett	No	Yes	Yes	Yes
302	1	Lee	No	Yes	Yes	Yes
303	1	Lee	Yes	Yes	Yes	Yes
303	2	Lee	Yes	Yes	Yes	Yes
304.01	3	Lee	Yes	Yes	Yes	Yes
304.02	2	Lee	No	Yes	Yes	Yes
9503.01	2	Moore	No	Yes	Yes	Yes
9504.02	2	Moore	No	Yes	Yes	Yes
9504.02	3	Moore	No	Yes	Yes	Yes
9506.02	1	Moore	No	Yes	Yes	Yes

[1] *Source: U.S. Census Bureau, American Community Survey 5-year Estimates (2015-2019), Table C17002, "Ratio of Income to Poverty Level in the Past 12 Months", and B02001, "Race".*

5. Environmental Consequences

An assessment of the potential direct, indirect, and cumulative impacts that may result from the proposed project is provided in this section. Per 40 CFR § 1508.1 Direct impacts are immediate impacts related to construction associated with the proposed project. Indirect impacts are the result of a specific activity that occurs later in time and are reasonably foreseeable. Cumulative effects result from the incremental impact of the proposed activity when added to other past, present, and reasonably foreseeable future activities regardless of the constituents originating from any other activity.

The duration of an impact is denoted in this EIS as temporary or permanent. Temporary impacts are those impacts that are not expected to persist more than one year following completion of construction activities associated with the proposed project. Permanent impacts are those impacts that are expected to last longer than one year after completion of construction and may not have a definite end.

Impacts can be beneficial or adverse. An adverse effect is when an undertaking may alter or affect, directly or indirectly, a resource in a negative or detrimental way. A beneficial effect is when the effect, directly or indirectly, of an undertaking is positive.

The relative severity of an impact is defined in this EIS as negligible, minor, moderate, or major. Negligible impacts are those impacts that may occur but may not be detectable. Minor impacts are those impacts that are measurable but are clearly not significant. Moderate impacts are those in which effects may require additional care, employment of best management practices (BMPs), application of precautionary measures to minimize adverse impacts, or have some uncertainty inherent in whether the effects forecast by a predictive model would occur. Major impacts are those effects that significantly affect the quality of the human or natural environment.

Discussion of the environmental consequences on the affected environment for each alternative is provided in this section. The easement locations and widths as well as the pump station, booster pump station, raw water storage areas/reservoirs, and treatment plant site boundaries used for quantification of the project alternative impacts are within the accuracy of conceptual design. Revisions to portions of the easements are anticipated during the design and construction phases of the project to account for construction width required for installation of pipe at depth and relocation around infrastructure constraints, such as fiber optic lines. Slight modifications to the easement width and location of an alternative are not anticipated to have significant impact to the resources discussed herein. Any modifications to easement location and width during later phases of the project will consider impacts to natural resources via the appropriate construction permits.

The well field associated with Alternative 10 consists of 281,205 acres. Implementation of Alternative 10 will not require development of the entire 281,205-acre area; however, the location and size of the infrastructure associated with each individual well and the associated manifold system and infrastructure is not known at this time. Therefore, quantification of impacts associated with the well field for Alternative 10 has not been provided.

5.1 Topography and Geology

5.1.1 Common Elements of All Alternatives

Temporary and permanent direct impacts to topography and geology from construction of the proposed transmission lines, raw water storage facilities, raw water intakes or discharge structures, pump stations and booster pump stations, WTPs, WWTPs, and other miscellaneous infrastructure associated with the alternatives are expected to be minor. Installation of transmission lines involves excavation of soils, placement of the pipe, and backfilling of the trench to original grade and elevation. Installation of proposed transmission lines will not significantly modify the existing topography, as all areas disturbed for this purpose will be returned as nearly as possible to original grade and elevation.

Construction of pump stations, booster pump stations, or an elevated water tank; construction or expansion of WTPs; or expansion of WWTPs will require excavation of soils, concrete construction, installation of equipment, and final grading. Excavation and fill may be required for the raw water storage facilities and reservoirs. Grading small areas to accommodate raw water intake and discharge structures may be necessary. Regardless of the alternative chosen, minor indirect and cumulative impacts to topography and geology in and in proximity to the project alternatives due to the anticipated growth and development in the service area are expected to occur. Table 5-1 provides a summary of the temporary and permanent impacts of the project alternatives to topography.

Table 5-1: Impacts to Topography per Alternative

Alternative	Temporary Impact Area, acres [1, 2]	Permanent Impact Area, acres [1, 2]
1	195	25
2	573	45
3	77	60
4	226	5
5	162	19
6	212	88
7	288	41
8A	275	92
8B	222	78
9A	197	1
9B	195	1
9C	457	1
9D	423	1

[1] *Impacts do not include construction or expansion of WTPs or WWTP expansions as the layouts thereof have not yet been determined.*

[2] *The well field area is not included since the footprint of impact for the infrastructure will be significantly less than the study area.*

5.1.2 Common Elements of Alternatives 1, 2, 3, and 4

Alternatives 1, 2, 3, and 4 contain raw water storage facilities. Alternatives 1 and 3 involve creation of a new raw water reservoir along Middle Creek. Alternative 4 includes construction of a new terminal reservoir in proximity to the A.B. Uzzle WTP. Excavation and fill will be required for construction of the reservoirs and their associated outfall features. The Alternative 2 raw water reservoir is an existing quarry, and changes in the existing topography and geology will be minimal. Alternatives 1, 3, and 4 reservoirs will have direct, moderate, and permanent impact to the topography and geology in the dam areas.

5.1.3 Elements of Alternative 10

Impacts to geology from construction and operation of Alternative 10 are anticipated. The purpose of the groundwater wells proposed under Alternative 10 will be to extract water from the fractured regolith crystalline rock aquifer. To install the well to the required depth, geology will be impacted. The impacts are expected to be direct, minor, and permanent.

5.1.4 No-Action Alternative

The No-Action Alternative includes no excavation, grading, or other disturbance of the existing land surface and will therefore not directly impact topography or geology. There is anticipated growth and development expected to occur even with implementation of the No-Action Alternative. Minor indirect and cumulative impacts to topography and geology from future growth and development in the service area are expected to occur.

5.2 Soils

5.2.1 Common Elements of All Alternatives

Impacts to soils from construction activities associated with the proposed alternatives are anticipated to be direct, minor, adverse, and temporary. The impacts may result from land clearing, excavation, fill, and grading. Fuel, oil, and other emissions from construction vehicles may also cause minor, localized impacts to soils. The construction-related effects will be minimized to the extent practicable via the implementation of an Erosion and Sediment Control Plan, which will be approved by Division of Energy, Mining, and Land Resources (DEMLR) prior to the commencement of work.

Long-term, permanent impacts to soils will result from the aboveground structures proposed for Alternatives 1, 2, 3, 4, 5, 6, 7, 8A, 8B, 9A, 9B, 9C, 9D and 10. The aboveground structures include the proposed pump stations, booster pump stations, raw water reservoirs, groundwater wells, an elevated water tank, WTP construction and expansion, and WWTP expansion. The impacts will be confined to the footprint of the proposed structures and the immediate adjacent areas. Permanent impacts are expected to be direct, minor, and adverse. Minor indirect and cumulative impacts to soils from anticipated growth and development in the service area are expected to occur. Temporary and permanent impacts to soils are quantified by alternative in Table 5-2.

5.2.2 Common Elements of Alternatives 1, 2, 3, and 4

Raw water storage facilities are associated with Alternatives 1, 2, 3, and 4. Permanent inundation of soil will occur from these alternatives. The impact on soils from inundation will be minor.

5.2.3 No-Action Alternative

The No-Action Alternative includes no land disturbance activities and will therefore have no direct impact on soils. Growth and development in the service area is expected to occur even with the implementation of the No-Action Alternative. Therefore, minor indirect and cumulative impacts to soils due to growth and development are anticipated to occur.

Table 5-2: Impacts to Soils per Alternative

Alternative	Temporary Impact Area, acres [1, 2]	Permanent Impact Area, acres [1, 2]
1	195	1,161
2	573	95
3	77	802
4	226	74
5	162	19
6	212	88
7	288	41
8A	275	92
8B	222	78
9A	197	1
9B	195	1
9C	457	1
9D	423	1

[1] *Impacts do not include construction or expansion of WTPs or WWTP expansions as the layouts thereof have not yet been determined.*

[2] *The well field area is not included since the footprint of impact for the infrastructure will be significantly less than the study area.*

5.3 Land Use

5.3.1 Zoning

5.3.1.1 Common Elements of All Alternatives

The current zoning of the project areas is primarily residential, commercial, industrial, and agricultural. Small areas of office and apartments, manufacturing, institutional, special use and conditional, public and semi-public lands, wooded and undeveloped areas, and parks, recreation, and open space districts comprise the remainder of the project areas. Utility easements do not require rezoning of the easement or of the parcel in

which the easement occurs. The proposed areas for WTP sites, pump stations, booster pump stations, and an elevated water tank are in several zoning districts as well as areas that are not zoned. Rezoning may be required for implementation of the proposed project, regardless of which alternative is selected. As some areas in which project alternatives are located are not zoned, the acreage of the zoning within each alternative's footprint cannot be calculated. Direct impacts to zoning from the proposed alternatives will be minor. Minor indirect and cumulative impacts due to the anticipated growth and development in the service area are expected to occur regardless of the selected alternative.

5.3.1.2 No-Action Alternative

The No-Action Alternative will not involve the acquisition of easements or change to an existing tract of land. Compliance with existing zoning classifications and restrictions will not be altered by implementing the No-Action Alternative. Future development may result in an increased need for private wells to ensure access to drinking water, which may affect future compliance with zoning classifications and development intensities. Minor indirect and cumulative impacts due to the anticipated growth and development in the service area are expected to occur under the No-Action Alternative.

5.3.2 Land Use Plans

Land Use Plans or other similar planning documents have been developed and approved by municipalities and counties in which a portion of the project is located. Chatham, Harnett, Johnston, Lee, and Wake Counties along with the municipalities of Apex, Clayton, Fuquay-Varina, Garner, Holly Springs, Lillington, Princeton, Selma, and Wilson Mills have adopted a land use planning framework. Per the land use plans, growth in the project service area is expected to continue, and demand for water provision is anticipated to increase accordingly. The proposed project will support the growth and increased demand for water service detailed in the Supporting Infrastructure section of the land use plan for the Town of Fuquay-Varina (Fuquay-Varina 2022).

5.3.3 Existing Land Use

In the transmission line corridor areas where existing land cover is wooded, the corridor will be converted to an herbaceous cover type during construction. Where feasible, removal of large trees at the edges of construction areas will be avoided. A portion of the easements will be maintained as permanent easements to allow for unobstructed access for routine inspection and maintenance. The width of the maintained easement will be reduced to the extent feasible. The remainder of the easements (i.e., temporary construction areas) will be allowed to re-vegetate to a natural wooded community.

Cleared areas associated with the proposed WTP and WWTP sites, pump stations, booster pump stations, and intake and discharge structures will be minimized to the extent feasible. Removal of vegetation will be limited to the areas necessary to accommodate the construction of the proposed infrastructure. A cleared buffer around the proposed aboveground infrastructure will be maintained in perpetuity to allow for unobstructed access to the structures for routine inspection and maintenance. An unaltered buffer around the perimeter of the WTP and WWTP sites will be protected to provide a natural screen between the WTPs and WWTPs and existing residences, commercial properties, and adjacent agricultural lands.

Conversion of an existing quarry to a raw water storage facility will occur with Alternative 2. Alternatives 1 and 3 include creation of a Middle Creek Reservoir. Land use in Alternatives 1 and 3 consists of undeveloped land dominated by forested wetlands.

Tree Protection Area fences and/or signage will be placed along the clearing limits of the project areas to avoid accidental removal of trees. To improve habitat for wildlife, woody debris from corridor clearing will be used to establish brush piles, and downed logs will be placed adjacent to the maintained areas, where feasible. Impacts are not anticipated to be significant.

Existing land use on impacted private property will be allowed to continue to the greatest extent practicable. In agricultural areas, current land usage may be impeded for a brief period to accommodate installation of proposed transmission lines. Upon completion of construction within each area, previous agricultural activities may resume. Impacts to agricultural areas will be direct, temporary, adverse, and minor.

In areas that are developed for residential, commercial, institutional, or industrial purposes, minor temporary direct impacts are expected to occur during construction. The impacts are likely to involve driveway and entrance crossings and excavation of lawn areas. Use of the properties for the existing uses may be hindered temporarily during construction on the respective parcels.

5.3.3.1 Common Elements of All Alternatives

The project alternatives require the acquisition of easements from private owners, commercial entities, NCDOT, railroad, and other utility providers. Streams and roadways will be traversed by each alternative's transmission line corridor. The land area required for acquisition varies by alternative. The pump and booster pump station sites are principally located in previously disturbed or currently maintained areas. It is assumed that all areas in the transmission line corridors have the potential for disturbance. Maintained access corridor in permanent easements will be a reduced to the extent feasible.

All project alternatives will require clearing of wooded/undeveloped land. The wooded/undeveloped land consists of areas adjacent to infrequently maintained areas including roadways and existing utility easements as well as areas adjacent to more regularly maintained areas such as residential, commercial, and agricultural properties. Wooded/undeveloped areas in the proposed project footprints range from large tracts of mature forest to narrow strips of trees between farm fields or developed properties.

Siting of the transmission line corridors and aboveground infrastructure was conducted with preference given to existing maintained corridors for the alignments, including roadsides and existing utility easements, and to existing pump station sites or otherwise disturbed sites for the proposed pump stations, booster pump stations, elevated tank, intake and outfall sites, and WTPs. Using areas that are currently maintained reduces the land area that will be converted from wooded/undeveloped to herbaceous or scrub-shrub to accommodate the proposed infrastructure. Impacts to residential, commercial, institutional, and industrial land uses are expected to occur as a result of any of the alternatives. Developed areas will be affected by increased use of existing infrastructure and facilities as well as a rise in development pressures. It is expected that development pressures will also affect agricultural lands in the project areas.

Table 4-5 summarizes the land cover by alternative and project component type. Pipe corridors, except for Alternative 9B, are mainly within developed areas with minimal agricultural land and undeveloped, wooded land in the project areas. Temporary and permanent impacts to land use during and after construction of the project alternatives will be localized, adverse, and moderate. Minor, indirect, and cumulative impacts to existing land use will result from the increased volume of available drinking water within the service area, which will support future growth and development. Minor, indirect, and cumulative impacts to land use are also expected to occur in the form of further conversion of wooded/undeveloped and agricultural lands to residential, commercial, institutional, and industrial lands for all alternatives.

5.3.3.2 No-Action Alternative

The No-Action Alternative will not directly impact land use. Minor indirect and cumulative impacts due to the anticipated growth and development in the service area are expected to occur.

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

5.4.1 Common Elements of All Alternatives

All the transmission line corridors traverse public, recreational and natural areas including bike and walking trails, state and local parks, game lands, and schools. All alternatives, except for Alternative 6, traverse land designated as SNHA. All the alternatives have project corridors that cross streams.

Most of the project components associated with the alternatives are not in public, recreational, or state natural areas. The Middle Creek Reservoir associated with Alternative 3 is in Southeast County Park. The pump stations associated with the raw water intakes for Alternatives 6 and 7 are in game lands associated with Jordan Lake.

A permanent easement that allows unobstructed access to transmission lines for routine inspection and maintenance will be required in the corridors. Impacts associated with the permanent easement include conversion of forest to herbaceous and scrub-shrub land covers. Conversion may be visible to users of the public, natural, and recreational lands.

Moderate, temporary impacts to recreational boating and fishing within the streams traversed by the transmission line corridors associated with the alternatives will occur during construction of the proposed project. Moderate, temporary impacts will also occur to the visitors of the parks, other open space, and public lands in the proposed transmission line corridors associated with the alternatives during construction activities. Resources in transmission line corridors will be restored to their full pre-construction purposes upon completion of construction.

Negligible, permanent impacts will occur to the future use of or development in the transmission line corridors from development restrictions that will be imposed on the corridors such that routine inspection and maintenance of the corridor is not impeded. Permanent impacts to parks, open space, and public lands in the project areas or project vicinity are anticipated to be negligible. Moderate, permanent impacts to SNHAs, which vary slightly between the alternatives, will occur from pipeline construction in association with

all the alternatives, except Alternative 6. Following construction in pipe corridors, potential direct impacts to recreational use of the streams, parks, and bike routes will be limited to visual impacts due to the need to maintain a mowed permanent access corridor.

The pump stations, booster pump stations, elevated water tank, WTPs, and WTP and WWTP expansions associated with the project alternatives will not occur on public, recreational, or state natural areas. Construction of the pump stations and raw water intakes associated with Alternatives 6 and 7 will each have a minor, permanent, adverse impact to approximately 1.0 acre within the Jordan Lake game lands. Construction of raw water storage facilities, especially the Middle Creek Reservoirs, will provide scenic, recreational, and natural areas. Wells associated with Alternative 10 may be installed in or near public lands or scenic, recreational, or state natural areas. Quantification of public lands, scenic, recreational, and state natural areas within project areas and that are anticipated to be impacted if that alternative is chosen are provided in Table 4-7.

Minor indirect and cumulative impacts to public lands and scenic, recreational, and state natural areas are anticipated to occur from future growth in the service area. Growth is anticipated to occur in the service area regardless of implementation of the proposed project. Minor indirect and cumulative impacts to the previously mentioned resources associated with the project areas of all alternatives are anticipated to include an increase in public use of parks, greenways, and other public lands in the project area as the population grows.

5.4.2 No-Action Alternative

Direct impacts to public lands and scenic, recreational, or state natural areas will not occur from the No-Action Alternative. The No-Action Alternative will not include land disturbance on public lands or scenic, recreational, or state natural areas. No indirect or cumulative impacts to public lands or scenic, recreational, or state natural areas are anticipated to occur as a result to the No-Action Alternative. Growth is projected to occur in the areas presently served by the water system. The projected growth is anticipated to occur regardless of the selected alternative.

5.5 Prime or Unique Agricultural Lands

5.5.1 Common Elements to All Alternatives

Direct impacts to prime agricultural lands are likely to occur due to implementation of any of the alternatives. Minor, direct impacts will result from excavation, grading, and other construction activities necessary to install transmission lines, pump stations, booster pump stations, elevated water tank, well field, and WTPs, as well as expansion of WTPs and WWTPs. Impacts associated with transmission line installation will be temporary, and the impacts associated with construction of pump stations, booster pump stations, elevated water tank, raw water storage facilities, well field, WTPs, and WWTPs will be permanent.

Minor indirect and cumulative impacts of alternatives are anticipated due to the growth and development that will be supported by the increased water capacity. The growth and development may result in additional

direct and indirect impacts to prime agricultural lands. Details regarding the area of prime agricultural lands within the project areas of each alternative are summarized in Table 5-3.

Table 5-3: Prime Farmland Soils within Project Areas

Alternative	Pipe Corridor, acres [1]	Other Infrastructure, acres [2, 3]	Total Prime Farmland Soils, acres [4]
1	129	230 [5]	359
2	434	1	435
3	55	131 [6]	186
4	173	33 [7]	206
5	152	1	153
6	131	2	133
7	175	2	177
8A	200	----	200
8B	162	----	162
9A	137	1	138
9B	132	1	133
9C	337	1	338
9D	269	1	270
10	----	----	199,139 [8]

[1] *Temporary impacts to prime farmland soils.*

[2] *Permanent impacts to prime farmland soils.*

[3] *Impacts to prime farmland soils present within the WTP and WWTP sites and the well field cannot be quantified at this time since the layouts thereof have not yet been determined.*

[4] *WTP and WWTP sites and the well field are not included since the footprint of impact for the infrastructure will be significantly less than the study area.*

[5] *Approximately 224 and 6 acres are associated with the proposed Middle Creek reservoir and WTP site, with little in agricultural use.*

[6] *Approximately 130 acres of the 131 acres are associated with the proposed Middle Creek reservoir, most of which is not in agricultural use.*

[7] *Associated with the proposed raw water storage facility, which is not in use for agriculture.*

[8] *Alternative 10 includes prime agricultural land mapped in well field area and is not specific to areas that will be impacted if the alternative is selected and implemented.*

5.5.2 No-Action Alternative

The No-Action Alternative involves no disturbance of land regardless of the designation of prime agricultural lands. Therefore, the No-Action Alternative will not directly impact prime agricultural lands. Minor indirect and cumulative impacts due to future growth and development in the service area are expected to occur.

5.6 Areas of Archaeological or Historic Value

5.6.1 Archaeological Resources

5.6.1.1 Common Elements to Alternatives

Direct, adverse impacts to areas of archaeological value are not known at this time. Once a preferred alternative is chosen, coordination with the North Carolina Office of State Archaeology will occur to determine if potential areas of concern are present and whether an archaeological survey is required within the project areas. The final determination of potential impacts to archaeological resources as a result of the preferred alternative will be made upon completion of the archaeological survey, if necessary. Indirect impacts to archaeological resources are possible from the proposed project regardless of the selected alternative.

5.6.1.2 No-Action Alternative

No work is proposed under the No-Action Alternative. Growth within the service area will occur irrespective of the alternative selected for the project. Minor indirect and cumulative impacts are expected to occur to archaeological resources with the implementation of the No-Action Alternative.

5.6.2 Resources of Historic Value

5.6.2.1 Common Elements to Alternatives except Alternatives 2, 3, 9A, 9B, and 9D

At least one potential historic resource was found to be in proximity to the project areas, per Table 4-9. Of those, one listed site, Erwin Commercial Historic District, is traversed by the pipe corridor associated with Alternative 4. One site each in Alternatives 1, 5, 8A, 8B, and 9C, four sites each in Alternatives 6 and 7, and three sites each in 9D have been determined to be eligible for listing and either located in or are traversed by an alternative corridor. Other sites that have been determined eligible for listing or have been added to the study list are located near the proposed project alignments and infrastructure. No potential historic resources were determined to be within or abutting the proposed raw water storage areas. No direct or indirect, permanent or temporary impacts to historic structures or districts will occur from the project alternatives with the exception of temporary impacts to the Erwin Commercial Historic District from transmission line installation.

5.6.2.2 No-Action Alternative

No impacts to resources of historic value will result from the implementation of the No-Action Alternative. Growth within the service area will occur irrespective of the alternative selected for the project. Therefore, minor indirect and cumulative impacts are expected to occur with the implementation of the No-Action Alternative.

5.7 Air Quality

5.7.1 Common Elements to Alternatives

All alternatives except for the No-Action Alternative are expected to have a minor impact on air quality during the period of construction. An increase in airborne particulates from land clearing impacts to air quality are anticipated for all alternatives. Emergency onsite power generation is proposed to provide back-up power to the pump and booster pump stations and treatment plants in the event of an emergency. The proposed generators will require an air permit for standby emergency power generation. The proposed emergency generators present negligible impacts to local air quality. The negligible impacts due to the operation of emergency power generators are necessary in order to prevent the adverse impacts to public health and safety that would result from a disruption of power at a pump or booster pump station or treatment plant. Compliance with air quality standards will be required at both the state and local level. Minor indirect impacts to air quality are anticipated to occur from the proposed project regardless of which alternative is chosen.

5.7.2 No-Action Alternative

The No-Action Alternative proposes no construction or new sources of air pollutants. Growth in the service area will occur irrespective of the alternative selected for the project. Minor indirect and cumulative impacts, as described herein, are expected to occur to air quality with the implementation of the No-Action Alternative.

5.8 Noise Levels

5.8.1 No-Action Alternative

The No-Action Alternative proposes no construction or new sources of noise. Growth in the service area will occur irrespective of the alternative selected for the project. Negligible, indirect and cumulative impacts are expected to occur with the implementation of the No-Action Alternative.

5.8.2 Common Elements to Alternatives

All alternatives are expected to have a minor impact on environmental noise conditions. Construction of any alternative will result in short-term noise level increases due to operation of the construction equipment. To reduce disturbances to adjacent properties, temporary increases in noise levels will be limited to daylight hours in accordance with local noise ordinances. Construction will only occur during normal weekday working hours, may be suspended on holidays, and may be extended by the appropriate local jurisdiction at the request of the contractor.

Noise from the new conveyance system alternatives are expected to be negligible during operation. In emergency situations, a generator may be required to provide power to pump stations, booster pump stations, WWTPs, and WTPs. Generator operation will slightly increase the noise level in the project areas when power has been disrupted and an emergency power source is required.

Urban growth in the service area may affect long-term noise levels. Growth in the service area may create nuisance noise levels from traffic and construction in rural areas that are presently relatively quiet. Careful planning and zoning, preservation of buffers, and construction of noise barriers for stationary sources, such as highways and major commercial roads, will help in protecting residential areas from excessive noise. Minor, temporary and permanent, direct noise impacts for all the alternatives.

5.9 Floodways and 100-Year Floodplains

Direct impacts to the FEMA-designated floodways and 100-year floodplains in the pipe corridor areas are anticipated due to construction but are expected to be minor. No impacts to floodways will occur from pump stations, booster pump stations, the elevated water tank, WWTP expansions, or construction or expansion of WTPs. Minor, permanent impacts to floodways may occur in association with raw water intakes or discharge structures, and moderate, direct, permanent impacts from construction of the Middle Creek Reservoirs. Temporary and permanent, direct impacts for all the alternatives are provided in Table 5-4. Indirect and cumulative impacts are expected to be negligible for all alternatives if present.

5.9.1 Common Elements to All Alternatives

Portions of all but two Alternatives, 9A and 9B, have transmission line corridors in FEMA-designated floodways. Alternatives 1, 2, 3, 4, 5, 8A, 8B, and 9C have other infrastructure in floodways, including construction of new or modification of existing raw water intakes or discharge structures. The finished water lines associated with Alternatives 9A, 9B, 9C, and 9D cross the Cape Fear River in Lee County. Floodways have not been designated in Lee County; however, the Cape Fear River has designated floodways in Harnett County downstream of the project areas. If floodways were designated in Lee County, it is likely that the Cape Fear River in the project areas would be designated as a floodway.

All the alternatives have pipe corridors that traverse 100-year floodplains and all but four alternatives, Alternatives 5, 9A, 9B and 9D, have other infrastructure proposed in the 100-year floodplain. The well field is a concept level evaluation and since floodways are present in the well field area, temporary impacts to floodways and 100-year floodplains are expected to occur in association with Alternative 10 pipe corridors and potentially other infrastructure. Therefore, all the alternatives are anticipated to have temporary, direct impacts that will be adverse and minor due to excavation and grading activities in the floodway and floodplain that may occur as a result of the transmission line installation. Additionally, all the alternatives except Alternatives 9A and 9B will have infrastructure with permanent, direct impacts that will be adverse and minor due to construction of project components with small footprints in floodplains and/or floodways per Table 5-4.

Equipment and vehicles will be staged outside the floodway and 100-year floodplain to minimize potential impacts during construction. Upon completion of the installation of the proposed transmission line, the disturbed area will be graded to match the existing elevation and surface contours to the extent feasible, thereby eliminating a permanent modification of the floodway or 100-year floodplain.

No booster pump stations are in designated 100-year floodplain areas. Several proposed pump stations are in designated 100-year floodplain areas; however, no pump station is sited within a designated floodway.

Permanent, direct, minor impacts to the 100-year floodplain will occur due to the construction of proposed pump stations in the floodplain. Several raw water intakes and discharge locations, and Middle Creek Reservoir are located in the designated floodway. Pump station designs will follow applicable local floodplain regulations with respect to flood control measures.

Table 5-4: Temporary and Permanent Impacts to Floodway and 100-Year Floodplain

Resource	Alternative	Temporary Impact, acres [1]	Permanent Impact, acres [2]
Floodway	1	1.2	359.3 [3]
	2	13.7	0.1
	3	0.9	360.2 [3]
	4	1.5	0.5
	5	1.6	0.5
	6	0.4	----
	7	0.4	----
	8A	3.2	1.0
	8B	1.1	1.0
	9A	N/A [5]	---- [5]
	9B	N/A [5]	---- [5]
	9C	3.2	0.5
	9D	0.6	---- [2]
100-Year Floodplain	1	4.0	460.0 [3]
	2	23.7	21.0 [3]
	3	3.1	246.7 [4]
	4	1.2	0.5 [3]
	5	7.8	0.5
	6	1.7	0.5
	7	15.5	1.5
	8A	15.7	0.9
	8B	10.4	0.9
	9A	15.6	----
	9B	11.5	----
	9C	31.3	0.9
	9D	7.7	---- [2]

[1] Temporary impact areas include the transmission line corridor.

[2] Permanent impact areas include the raw water intakes, pump stations, booster pump stations, and/or treated effluent discharge, as applicable, that are affiliated with each alternative. WTP and WWTP sites and the well fields are not included as the layouts thereof have not yet been developed.

[3] Associated with a proposed raw water reservoir.

[4] 245.3 acres associated with the proposed Middle Creek Reservoir.

[5] The only potential floodway impacts are in Lee County. Detailed flood studies have not been conducted in Lee County.

No impacts to floodways will occur as a result of the construction of any of the proposed treatment facilities or existing facility expansions. Portions of the A.B. Uzzle WTP and Terrible Creek WWTP are in the 100-year floodplain. The layout of treatment plant infrastructure has not yet been developed, so impacts cannot be quantified. Efforts to avoid floodplain encroachment will be made during site design. Indirect or cumulative impacts, if any, are anticipated to be negligible for all alternatives since growth and development in the service area is anticipated to continue regardless of the project.

5.9.2 Common Elements Associated with Alternatives 1 and 3

Approximately 359.3 and 360.2 acres of floodway and 459.5 and 245.3 acres 100-year floodplain will be inundated by Alternatives 1 and 3 with construction of the Middle Creek Reservoir. However, new floodplain and potentially floodway will be established abutting the new extents of the normal pool. Analysis or modeling to determine the post-reservoir 100-year floodplain footprint has not been performed. Alternatives 1 and 3 will create an unknown amount of new floodplain and floodplain area. However, due to the large amount of floodway and floodplain impacted by implementation of Alternatives 1 and 3 per Table 5-4, direct and permanent impacts to floodplain and floodway in association with Alternatives 1 and 3 are considered moderate.

5.9.3 No-Action Alternative

The No-Action Alternative does not include any land disturbance or placement of new structures. Growth and development in the service area is anticipated to continue even if the No-Action Alternative is selected and implemented. Therefore, negligible indirect and cumulative impacts to the floodway or 100-year floodplain with the implementation of the No-Action Alternative are anticipated to occur.

5.10 Wetlands

The design and precise location of the proposed transmission line corridors and aboveground structures have not been adjusted to avoid wetlands at this time. Once a preferred alternative is selected, further investigation into the exact location of jurisdictional wetlands will be conducted, and the design will be adjusted as needed to avoid and minimize permanent impacts to wetlands. The acreage of NWI wetlands that may be impacted temporarily or permanently by the proposed project alternatives pipe corridors is summarized in Table 5-5.

Compliance with Sections 401 and 404 of the CWA will require authorizations from DWR and USACE, respectively, for proposed impacts to jurisdictional waters. Coordination with the aforementioned agencies will take place, as necessary, to ensure adherence to regulations associated with the CWA. Based on the NWI mapping of wetlands in the project area, permitting requirements are expected to be met with a Nationwide Permit (NWP) 58 and the corresponding Water Quality Certification (WQC) for all alternatives except Alternative 1 and 3, which are expected to require a Standard Permit from the USACE and DWR. The general conditions of the NWP or Standard Permit and the WQC will be followed during the design, construction, and post-construction phases of the project where jurisdictional waters occur.

Table 5-5: NWI Wetland Impacts in Pipe Corridors and Raw Water Storage Areas

Alternative	Temporary Impacts, acres [1]		Permanent Impacts, acres [1]	
	Forested	Non-forested	Forested	Non-forested
1	18.2	2.8	610	104
2	6.3	20.3	0.9	5.4
3	7.7	0.8	359	47.5
4	0.8	2.8	0.1	0.7
5	2.2	2.8	0.3	1.9
6	0.9	3.5	0.1	0.8
7	1.0	14.1	0.2	0.9
8A	16.9	2.7	2.5	14.4
8B	12.8	1.5	1.9	10.9
9A	1.8	3	0.3	1.5
9B	2.9	2.1	0.4	2.5
9C	18.7	5.7	2.8	15.9
9D	3.1	3.7	0.5	1.6

[1] *Impacts do not include the new WTPs, WTP or WWTP expansions, or the well field and its associated infrastructure as the layouts thereof have not yet been determined.*

5.10.1 Common Elements to All Alternatives

NWI mapping of wetlands along the pipe corridors associated with all alternatives indicates the potential presence of wetlands in the areas that may be impacted by construction. During construction, existing vegetation will be removed by mechanical clearing, and the excavated soil will be temporarily stockpiled adjacent to the trench. Temporary fill material will be placed to provide temporary construction access, as needed. Pre-construction contours in wetland areas will be restored in accordance with USACE and DWR permit requirements, as applicable. The cleared corridor will be reseeded with an appropriate, native seed mixture of annual and/or perennial groundcover that does not include fescue. The permanent maintained access corridor will be restricted to the minimum width feasible and in accordance with DWR General WQCs and will be maintained as an herbaceous or scrub-shrub area. The disturbed wetlands located outside the permanently maintained access corridor will be allowed to re-vegetate naturally, returning to its pre-construction vegetative composition over time. Wetland areas adjacent to the permanent access easement and in the temporary construction easement are anticipated to incur direct, adverse, minor, temporary impacts.

The wetland impacts associated with pipe corridors per alternative is provided in Table 5-5 with the forested wetlands corresponding to PFO1 and all other NWI designated wetland types within the project areas categorized as non-forested. Direct impacts are based only on NWI mapping and a 15-foot wide maintained area in the pipe corridor. Neither field verification of the NWI mapping nor wetland delineations independent of the NWI mapping have been performed for any alternative. Converted forested wetland areas associated with the permanent maintained pipe access easement will have minor, permanent, direct impacts.

The proposed pump stations, booster pump stations, and elevated water tank are not in areas denoted by NWI as wetlands. NWI wetlands are depicted in sites associated with the Terrible Creek WWTP, A.B. Uzzle WTP, Harnett County Regional WTP, and proposed WTPs associated with Alternatives 6, 7, 8A, 8B, and 9C. Since the layouts of the new WTPs, WTP and WWTP expansions, and the well field have not yet been determined, impacts associated with these project components cannot be quantified. During project design and construction of the chosen alternative, measures to avoid and minimize impacts to wetland areas will be implemented. Wetland impacts from WTP and WWTP construction activities are anticipated to be minor, permanent, and direct. Minor indirect and cumulative impacts to wetlands may occur due to growth and development in the service area.

5.10.2 Common Elements to Alternatives 1 and 3

Construction of the Middle Creek Reservoir for Alternatives 1 and 3 will convert 708.75 and 396.4 acres, respectively, of palustrine, forested, broad-leaved deciduous and scrub-shrub wetlands to an open water lake (L1UBHh). New wetland areas, including fringe and emergent wetland areas, will be formed along the perimeter of the new pool elevation. No modeling or analysis of the quantity or type of wetlands that will be created in association with the new pool elevation has occurred. The 7.7 and 6.6 acres of riverine wetlands depicted by NWI mapping in the Middle Creek Reservoir areas associated with Alternatives 1 and 3, respectively, will be converted to a lacustrine system. Impacts to jurisdictional areas associated with the Middle Creek Reservoir alternatives, Alternatives 1 and 3, will be direct, permanent, and major. It should be noted that construction of either of the Middle Creek Reservoirs will create fringe wetlands and the open water area of the reservoirs will provide for more open water habitat than the NWI-depicted wetland areas in the project footprints.

5.10.3 Alternative 10

A large number and area of wetlands are depicted on the NWI maps in the well field area. Wetland impacts from construction of the well field and associated infrastructure cannot be quantified at this time since the well field layout has not yet been developed. The area assessed for the well field contains more wetland areas than for the other alternatives. Jurisdictional areas will be avoided when possible, and impacts will be minimized to the extent practicable when avoidance is not possible. Direct, permanent impacts are expected to be minimized to the point of achieving an intensity level not to exceed minor. Direct, temporary impacts may range from negligible to major, depending on final design and construction methods.

5.10.4 No-Action Alternative

The No-Action Alternative does not include disturbance of or placement of fill material in jurisdictional wetlands. Minor indirect and cumulative impacts are anticipated to occur as a result of the growth and development anticipated in the service area regardless of the alternative chosen for the proposed project.

5.11 Shellfish or Fish and Their Habitats

5.11.1 Common Elements of Alternatives

The transmission line corridors associated with the project alternatives include open cut crossings of several rivers and streams that provide habitat for shellfish and fish, although the number of crossings and the streams crossed will vary by alternative (refer to Tables 5-6 and 4-16, respectively). Woody vegetation is anticipated to be removed from streamside areas to accommodate the pipe corridor, although the area of riparian disturbance will be reduced to the extent practicable. Construction activities associated with the raw water intakes will occur in the Cape Fear River (Alternatives 4, 5, 8A, and 8B), Neuse River (Alternative 2), Middle Creek (Alternatives 1 and 3), and Jordan Lake (Alternatives 6 and 7). Construction activities for effluent discharge structures will occur in the Cape Fear River for Alternatives 8A and 9C and in Kenneth Creek for Alternative 8B. Installation of the transmission pipes, raw water intakes, and effluent discharge pipes will require disturbance of stream banks and channel substrates. Currently, efforts are underway to upgrade the existing Sanford WTP and its associated raw water intake in the Cape Fear River. Alternatives 9A, 9B, 9C, and 9D will use infrastructure that will be existing at the time the proposed project moves forward. Therefore, no additional upgrades to the Sanford WTP or its associated raw water intake will occur for alternatives 9A, 9B, 9C, or 9D.

Proposed construction activities will involve land disturbance in the project footprints. Therefore, the potential for erosion and sedimentation may increase during construction. Erosion and sedimentation may carry soils, toxic compounds, trash, and other materials into the aquatic communities. Erosion control during construction will be important to minimize direct and indirect impacts to streams during construction. Quick re-vegetation of disturbed areas will reduce the impacts by supporting the underlying soils. An Erosion and Sediment Control Plan will be developed and implemented during construction associated with the proposed alternative. Implementation of BMPs and further precautionary measures during construction of the proposed project will minimize adverse impacts to fish and shellfish.

Transmission line installation is anticipated to have indirect and direct, minor, temporary impacts to fish species within and downstream of the project areas during construction activities for all alternatives. No permanent impacts to fish and shellfish within and downstream of the project areas are anticipated to occur relative to pipe installation. No temporary or permanent direct impacts to shellfish or their habitats will occur from construction or operation of the elevated water tank, pump stations, and booster pump stations. Impacts have not been quantified for WTP or WWTP sites since the location and footprint of the infrastructure is not known; however, the impacts are anticipated to be negligible.

Anadromous fish spawning areas (AFSA) are present in the project areas. The Cape Fear River from the Alternatives 8A and 8B raw water intake site, which is immediately downstream of the Harnett County Regional WTP and the withdrawal site associated with Alternative 5, to downstream of the A.B. Uzzle WTP is an AFSA. Therefore, the effluent discharge associated Alternatives 8A and 9C are in an AFSA. The raw water intake on the Neuse River associated with Alternative 2 is also in an AFSA. Instream work may be subject to construction moratoria associated with the presence of anadromous fish species in project streams. Permanent impacts to fish and shellfish within and downstream of the project areas are anticipated to be negligible from construction of the proposed project.

Permanent impacts to fish and shellfish may occur from the raw water intakes. Impingement of ichthyoplankton and entrainment of young-of-the-year fish are anticipated relative to raw water intakes. Direct, indirect, temporary, and permanent impacts to fish and shellfish are anticipated to be minor in proximity of the raw water intakes and the effluent discharge sites associated with Alternatives 8A, 8B, and 9C.

Construction of a reservoir on an existing stream will change the fish and shellfish habitats currently present in the footprint of the reservoir. Most of the Middle Creek reach in the reservoir areas associated with Alternatives 1 and 3 and one pipe crossing of Middle Creek associated with Alternative 2 is reported to support populations of several listed aquatic species. Tributaries to Middle Creek within the footprints of the Middle Creek reservoirs are also reported as supporting listed aquatic species. Several federally and state protected aquatic invertebrate and vertebrate species are listed for the counties in which project components are located. Information relative to the listed species and habitats in the project areas is provided in Section 5.13.

Occurrences of the state and federally listed mussel species are reported in streams crossed by pipe corridors, streams impounded for raw water storage, and streams in which intakes or discharges are proposed in association with the alternatives. Mussel surveys or surveys for other listed aquatic species have not been performed for the project. Impacts to aquatic species relative to the proposed alternatives are anticipated to be direct, permanent and temporary, and moderate. Implementation of BMPs and further precautionary measures during construction of the proposed project will minimize adverse impacts to fish and shellfish.

Indirect and cumulative impacts to aquatic habitats may occur from growth in the service area. The anticipated growth and associated development may cause increased erosion, sedimentation, and stormwater runoff. The inputs of sediment and runoff from development may result in loss, fragmentation, or degradation of aquatic species and their habitats. As a result, a decline in water quality, aquatic resources, fisheries, and wetlands in the service area may occur. Indirect or cumulative impacts are anticipated to be moderate.

5.11.2 No-Action Alternative

The No-Action Alternative will not directly impact shellfish or fish and their habitats. Regardless of the alternative selected for the project, growth in the project service area is anticipated and planned. Moderate indirect and cumulative impacts are expected to occur from development activities associated with anticipated and planned growth.

5.12 Forest Resources

5.12.1 Common Elements of Alternatives

Impacts to forest resources have the potential to occur as a result of vegetative clearing required during construction of each alternative. The forest resources of the project area are comprised of several community types. Mixed hardwood and pine species of varying age are present throughout the project

areas. Tracts of forested areas that contain varying ages of pine species planted and managed for timber production are also present. The temporary and permanent direct impacts to forest resources are summarized in Table 5-6. The acreages provided represent an estimate of forested areas based on data obtained from the North Carolina Division of Forest Resources Important Forest Lands mapping.

Trees will be removed to allow access for construction equipment and activities. The impact to forest resources varies among the project alternatives due to variations in the project corridor locations. The majority of the transmission line corridors associated with the individual alternatives are located along existing maintained roadway easements, which minimizes the clearing required for pipe installation.

Temporary and permanent impacts associated with the WTP sites, the WWTP sites, and the well sites are not known at this time as the location of required infrastructure has not been determined. However, it is anticipated that temporary impacts will be minor. Portions of the pump station and booster pump station sites contain forested areas. All the raw water storage sites contain forested areas, with the two reservoir sites on Middle Creek containing large, forested areas. Cleared areas associated with the treatment plant and pump station sites, and the elevated tank site will be minimized to the extent feasible such that removal of vegetation is limited to the area necessary to accommodate proposed infrastructure and the construction and installation. The indirect impacts and cumulative effect of direct impacts due to land clearing for construction and access in addition to the impacts due to future development are anticipated to be minor for the project alternatives.

Table 5-6: Important Forest Lands per Alternative

Alternative	Transmission Line Corridor, acres		Pump Station, acres		Other Infrastructure, acres [1]		Total per Alternative, acres	
	Temporary Impacts	Permanent Impacts	Temporary Impacts	Permanent Impacts	Temporary Impacts	Permanent Impacts	Temporary Impacts	Permanent Impacts
1	168	30	----	1	15	1,089	183	1,120
2	99	17	----	1	1	11	100	29
3	5	1	----	----	7	671	12	672
4	13	2	----	----	1	12	14	14
5	12	2	----	----	----	----	12	2
6	12	2	----	1	----	----	12	3
7	20	3	----	1	----	----	20	4
8A	31	5	----	1	----	----	31	6
8B	19	3	----	1	----	----	19	4
9A	92	16	----	----	----	----	92	16
9B	117	21	----	----	----	----	117	21
9C	122	22	----	----	----	----	122	22
9D	141	24	----	----	----	----	141	24

[1] *Impacts are not included for treatment plant or well sites as the footprint of the infrastructure is not known.*

5.12.2 No-Action Alternative

The No-Action Alternative will not directly impact forest resources. Regardless of the alternative selected for the project, growth in the project service area is anticipated and planned. Indirect and cumulative impacts are expected to occur from development activities associated with anticipated and planned growth.

5.13 Wildlife and Natural Vegetation

5.13.1 Wildlife Habitat and Resources

5.13.1.1 Common Elements of Alternatives

Each of the proposed alternatives includes installation of subsurface pipes. Most of the alternatives include construction of a raw water intake and pump station and/or booster pump station, and either a WTP, WTP expansion, or a WWTP expansion. Construction of transmission lines will have direct impacts on current terrestrial habitats during the construction period. Construction of pump stations and booster pump stations, WTPs, and the well field, and expansion of WTPs and WWTPs will have direct, permanent impacts on existing terrestrial habitats. The amount and type of impacted habitat for the alternatives varies based on the land cover community types associated with each project area. The two major land use community types in the project areas are disturbed lands and forested areas. Disturbed lands include roadway easements, existing utility easements, land used for agriculture or pastureland, and lands developed for residential, commercial, institutional, and industrial purposes. Forested communities are areas dominated by mature, undisturbed woody vegetation.

The land use community type associated with the location of the proposed alternatives may be used to compare each alternative's direct impact on wildlife habitat. Construction activities that take place on disturbed lands are anticipated to have less impact on wildlife habitat than construction in forested areas. The approximate percentage of forested land area affected by construction activities provides a basis to compare the estimated wildlife habitat impacts among the alternatives. Forested land associated with components of each alternative is summarized in Table 5-7. All the WTP and WWTP sites associated with the project alternatives contain areas that are forested.

Temporary, minor, direct impacts to wildlife and vegetation have the potential to occur as a result of all alternatives. Impacts to terrestrial habitats and resources will occur during construction activities associated with all the proposed project alternatives. Temporary fluctuations of terrestrial species are anticipated during construction activities. Slow moving, burrowing, and/or subterranean organisms will be directly impacted by construction activities, while mobile organisms will be displaced to adjacent communities. Negligible, direct, permanent impacts to terrestrial habitat or resources will occur from implementation of any of the alternatives from loss or change in habitat. Permanent impacts to protected species may also occur if present within the footprint of proposed structures and paved areas. The indirect impacts and cumulative effect of direct impacts to wildlife habitat and resources from construction and access in addition to the impacts due to future development are anticipated to be minor for the project alternatives.

5.13.1.2 Alternatives 1, 2, 3, and 4

Alternatives 1 and 3 include construction of a reservoir on Middle Creek. Construction of a reservoir on Middle Creek will permanently change the habitat in areas of inundation from riverine/herbaceous and forested wetlands/forested uplands to open water areas. Alternative 2 includes conversion of a quarry to a raw water reservoir and Alternative 4 includes conversion of undeveloped land dominated by maintained grass areas with some forested areas present to open water area. The conversion of non-open water habitat to open water habitat for Alternatives 1, 3, and 4 will permanently modify the types and quantities of habitat within and immediately abutting the areas of impoundment.

Direct, temporary, permanent, and minor impacts to terrestrial and aquatic habitat and resources will occur during construction activities associated with the raw water storage facilities. During inundation of the raw water storage facilities, except for Alternative 2 that already contains open water habitat, mobile terrestrial species will be displaced to adjacent communities, and slow moving, burrowing, and/or subterranean organisms will be directly impacted by inundation. Direct, permanent, and moderate impacts to wildlife habitat and resources will occur from conversion of existing upland, wetland, and aquatic forested and non-forested habitat to open water habitat fringed with forested and non-forested areas. However, the total area of available habitat will not change significantly. The open water areas will provide diverse habitats and resources for aquatic and avian species, and the shoreline and areas of temporary or semi-permanent inundation will provide diverse habitats and resources for terrestrial species.

5.13.1.3 No-Action Alternative

Direct, adverse impacts to wildlife habitat and resources will not occur from implementation of the No-Action Alternative. Indirect and cumulative impacts associated with the No-Action Alternative are anticipated to occur from development activities associated with anticipated and planned growth in the service area. Indirect and cumulative impacts to wildlife habitat and resources due to development in the service area will include temporary impacts during construction activities and permanent impacts from conversion of presently undisturbed, forested land.

5.13.2 Rare and Protected Species or Habitats

Ten federally listed species are documented by the NHP in a project site and within a two-mile radius of the project areas associated with the alternatives. The potential availability of suitable habitat for the federally listed species was assessed based on review of published data, including aerial photography, NRCS soils mapping, USGS topographic quadrangles, NWI maps, and FEMA flood insurance rate maps. Based on the review of the published data relative to the project areas associated with the alternatives, habitat for numerous federally listed species was determined to likely be available within the footprint of the various elements of the proposed alternatives.

A discussion of which federally listed species have or have the potential to be present in project areas or within a 2-mile radius from a project alternative and which alternative elements potentially contain habitat for listed species are discussed in the following sections. The potential effects on documented species

populations are discussed in the following sections. A summary of the species documented within each alternative and within a two-mile radius from each alternative is provided in Table 5-7.

If a population of a federally protected species is found to be present in a project area associated with the selected alternative, USFWS and NCWRC will be contacted to confirm the species identification and extent of the population. Avoidance of impacts to aquatic species is preferred, and the Town of Fuquay-Varina will initiate consultation with USFWS to identify measures to avoid impacting the species. If impacts to the species cannot be entirely avoided, then efforts to minimize the remaining impacts will be identified.

Impacts to species habitat are likely to occur during construction of the proposed project and are anticipated to be minor. Impacts to habitat may be adverse or beneficial due to clearing wooded areas and the creation of new forest edges and new herbaceous or scrub-shrub areas in the proposed utility easement. The changes may eliminate habitat for some species while creating or expanding habitat for other species. During construction activities, temporary fluctuations of protected species are possible. Slow moving, burrowing, and/or subterranean organisms may be directly impacted by construction while mobile organisms will be displaced to adjacent communities during construction. Future growth and development in the service area may result in indirect and cumulative impacts to federally protected species and their habitat. The indirect impacts and cumulative effect of direct impacts to rare and protected species or habitats for construction in addition to the impacts due to future development are anticipated to be minor for the project alternatives.

5.13.2.1 Alternative 1

Three federally listed aquatic species are documented in the Alternative 1 project area and two additional federally listed species are documented within a 2-mile radius of the project area. Dwarf wedgemussel is documented as a current occurrence in the portion of Swift Creek that is crossed by the pipe corridor and that abuts the Dempsey E. Benton WTP, in Middle Creek in the downstream-most portion of the proposed Middle Creek Reservoir area, and downstream of the reservoir. Current occurrences of Atlantic pigtoe and Neuse River waterdog are documented within the portion of Middle Creek that will be contained in the reservoir, as well as portions of Middle Creek upstream and downstream of the proposed reservoir area.

Along with the above listed species, yellow lance and bald eagle are documented within a 2-mile radius from the Alternative 1 project area. The bald eagle is documented in the southeastern portion of Lake Benson and yellow lance is documented in Swift Creek downstream of the project area. The other federally listed species documented within a 2-mile radius from the Alternative 1 project areas are present in the waterways upstream and downstream of the project area.

Habitat for three federally listed species is documented in the Alternative 1 project area. Habitat for these three species and two additional species is documented within a 2-mile radius of the project area. If Alternative 1 is selected, surveys may be required for proposed activities abutting or in areas in which federally protected aquatic species are documented or suitable habitat is present. Surveys for bald eagles may also be required if project areas are found to contain or are in proximity to suitable habitat.

5.13.2.2 Alternative 2

Six federally listed aquatic species are documented in the Alternative 2 project area. Atlantic pigtoe and Neuse River waterdog are documented in Middle Creek. Atlantic pigtoe and dwarf wedgemussel are documented in White Oak Creek and in Little Creek. Atlantic pigtoe, dwarf wedgemussel, and yellow lance are documented in Swift Creek. The documented occurrences of these federally listed aquatic species are reported as current occurrences. Neuse River waterdog, Carolina madtom, and Tar River spinymussel are documented in the Neuse River at the proposed intake site. The Carolina madtom and Tar River spinymussel at the Neuse River intake site are reported as historical occurrences.

The aforementioned federally listed species present in the Alternative 2 project area plus one additional federally listed species, RCW, are documented within a 2-mile radius of the Alternative 2 project area. The RCW is documented near US Highway 70 west of Princeton and is listed as a historical occurrence. The documented presence of listed species within a 2-mile radius from the project area are reported to be current and historical occurrences.

Habitat for six federally listed species is documented within the Alternative 2 project areas. Habitat for these six species and one additional species is documented within a 2-mile radius of the project area. If Alternative 2 is selected, surveys may be required for proposed activities abutting or in areas in which federally protected aquatic species are documented or suitable habitat is present. Surveys for RCW may also be required if project areas are found to contain or are in proximity to suitable habitat.

5.13.2.3 Alternative 3

Two federally listed aquatic species are documented in the Alternative 3 Middle Creek Reservoir project area and downstream of the reservoir. Atlantic pigtoe and Neuse River waterdog are documented in Middle Creek in the proposed reservoir footprint and downstream of the reservoir. The documented presence of Atlantic pigtoe and Neuse River waterdog in the Alternative 3 project area are reported as current occurrences.

The two federally listed species present in the Alternative 3 project area and one additional federally listed species, dwarf wedgemussel, are documented within a 2-mile radius of the project area. The three federally listed species within a 2-mile radius from the Alternative 3 project areas are within Middle Creek downstream of the project area. The documented presence of these species is reported as current occurrences.

Habitat for two federally listed species is documented in the Middle Creek Reservoir footprint for Alternative 3. Habitat for these six species and an additional species is documented in the 2-mile reach of Middle Creek downstream from the proposed Alternative 3 Middle Creek Reservoir. If Alternative 3 is selected, surveys may be required for proposed activities abutting or within the Middle Creek Reservoir in which suitable habitat is present.

5.13.2.4 Alternative 4

One federally listed species, Cape Fear shiner, is documented in the reach of the Cape Fear River in which the raw water intake is proposed. The documented presence of Cape Fear shiner in the Alternative 4 project area is reported as a current occurrence. The Cape Fear shiner is the only federally listed species documented in the Alternative 4 project area.

The Cape Fear shiner is documented in a 1.3-mile segment of the Cape Fear River downstream of the raw water intake site and RCW is documented east of the Alternative 4 pipe corridor in the vicinity of NC 27. The documented presence of the Cape Fear shiner downstream of the raw water intake site is reported as a current occurrence. The documented presence of RCW is reported as a historical occurrence.

Habitat for the Cape Fear shiner is documented in the Cape Fear River at and downstream of the raw water intake site. If Alternative 4 is selected, surveys may be required for proposed activities abutting or within the Cape Fear River. If Alternative 4 is selected and habitat for RCW is found in the project area, surveys may be required.

5.13.2.5 Alternative 5

Two historical occurrences of federally listed species are present in the Alternative 5 project area. The Cape Fear shiner was historically documented in Neills Creek from its confluence with the Cape Fear River upstream to its confluence with Kenneth Creek and was historically documented in Kenneth Creek. The Atlantic pigtoe was historically documented in the Cape Fear River from a point approximately 0.25-mile upstream of the proposed pipe crossing of the Cape Fear River and extends downstream for approximately 1.3 miles.

Habitat for the Cape Fear shiner was historically documented in a long reach of Neills Creek that includes and extends upstream and downstream of the Alternative 5 pipe crossing. Habitat for the Atlantic pigtoe was historically documented in the Cape Fear River at, upstream, and downstream of the raw water intake site. If Alternative 5 is chosen, surveys may be required for proposed activities abutting or within streams that contain appropriate habitat for federally listed aquatic species.

5.13.2.6 Alternative 6

No federally listed species are documented within Alternative 6 project area and one federally listed species, bald eagle, is documented within a 2-mile radius of the project area. Several eagle nests are documented approximately one mile from the pipe corridor along the edge of Jordan Lake. The raw water intake and pump station are located along the shoreline of Jordan Lake. At present, no documented eagle nests are in proximity to the intake and pump station site. If Alternative 6 is chosen, surveys for bald eagles are anticipated to be required in project areas that contain or are in proximity to suitable habitat.

5.13.2.7 Alternative 7

No federally listed species are documented in the Alternative 7 project area and two federally listed species are documented within a 2-mile radius of the project area. An eagle nest is documented approximately 100 feet from the pipe corridor, 1,000 feet from the raw water intake, and 2,000 feet from the pump station site. No bald eagle nests are within a 2-mile radius of the WTP site. A second eagle nest is documented approximately 0.5 mile from the pipe corridor. Numerous current listings of eagle nests are documented along the edge of Jordan Lake within a 2-mile radius from the project areas. A historical occurrence of Cape Fear shiner is documented in Robeson Creek from 1963 to 1968. Robeson Creek is currently part of Jordan Lake. If Alternative 7 is selected, surveys for bald eagles are anticipated to be required. Time of year restrictions relative to construction may occur if an active eagle nest is within 660 feet of project areas.

5.13.2.8 Alternatives 8A and 8B

Two federally listed aquatic species were historically documented within Alternatives 8A and 8B. Atlantic pigtoe was historically documented in Neills Creek, which is traversed by the Alternatives 8A and 8B pipes and in the Cape Fear River adjacent to the proposed raw water intake and pump station for Alternative 8A. Cape Fear shiner was historically documented in the Cape Fear River at the intake site for both Alternatives 8A and 8B but not at the effluent discharge site downstream of the intake site. Within a 2-mile radius of the Alternative 8A and 8B project area, the only federally listed species documented are historical occurrences of Atlantic pigtoe in the Cape Fear River, Neills Creek, and Kenneth Creek, which is tributary to Neills Creek, and the Cape Fear shiner in a reach of the Cape Fear River that extends from approximately 0.7 mile upstream of the raw water intake site to approximately 0.5 mile downstream of the intake site. If either Alternative 8A or 8B are chosen, surveys for federally protected aquatic species for which suitable habitat is present may be required.

5.13.2.9 Alternatives 9A and 9B

No federally listed species are documented in the Alternative 9A and 9B project area. Two federally listed species, bald eagle and Cape Fear shiner, are documented within a 2-mile radius of the project area. Several historical eagle nests approximately 1.2 and 2.3 miles downstream of the pipe crossings of the Cape Fear River are documented. The current occurrence of Cape Fear shiner is located approximately 0.7 mile and 1.8 miles from the Alternative 9A and 9B pipe crossings of the Cape Fear River. If Alternatives 9A or 9B is chosen, surveys for bald eagles and Cape Fear shiner are anticipated to be required in project areas that contain or are in proximity to suitable habitat.

5.13.2.10 Alternative 9C

One federally listed aquatic species is documented within the Alternative 9C project areas. Atlantic pigtoe was historically documented in Neills Creek, which is traversed by the Alternatives 9C effluent discharge pipe. Within a 2-mile radius of the Alternative 9C project area, a current occurrence of the Cape Fear shiner is documented approximately 1.8 miles downstream of the finished water main crossing of the Cape Fear River and a historical occurrence of the Cape Fear shiner is documented in a segment of the Cape Fear River upstream of the effluent discharge site. Several historical eagle nests are documented approximately

2.3 miles downstream of the finished water main crossing of the Cape Fear River. If Alternative 9C is chosen, surveys for bald eagles and Cape Fear shiner are anticipated to be required in project areas that contain or are in proximity to suitable habitat.

5.13.2.11 Alternative 9D

No federally listed species are documented in the Alternative 9D project area. One federally listed aquatic species, one avian species, and one vascular plant species are reported within a 2-mile radius from the project area associated with Alternative 9D. The RCW was historically documented approximately 0.3 mile north and 0.8 mile southwest of the western portion of Alternative 9D. A current occurrence of Atlantic pigtoe was observed in headwaters associated with Middle Creek, upstream of Bell's Lake Road, approximately 1.9 miles north of Terrible Creek. A current occurrence of Michaux's sumac was observed within a longleaf pine restoration area in Harris Research Tract. Additional species include those discussed for Alternative 9A. If Alternative 9D is chosen, surveys for federally listed species are anticipated in project areas containing suitable habitat.

5.13.2.12 Alternative 10

Five federally listed aquatic species, two avian species, and one vascular plant species are reported in the Alternative 10 well field area. Some of the species have more than one documented occurrence. Of these eight species, four species occurrences are reported as historical, which include Cape Fear shiner, Atlantic pigtoe, Neuse River waterdog, and RCW. Species reported as current occurrences include dwarf wedgemussel, Neuse River waterdog, Atlantic pigtoe, yellow lance, and bald eagle. The federally listed species documented in the Alternative 10 project area are the same species documented within a 2-mile radius of the well field except for an occurrence of Michaux's Sumac being documented within a 2-mile radius of the well field. If Alternative 10 is selected, surveys for federally species are anticipated to be required in project areas that contain suitable habitat.

5.13.2.13 No-Action Alternative

The No-Action Alternative will not disturb any lands and therefore will not result in direct impacts to federally protected species. Indirect and cumulative impacts due to the anticipated growth and development in the service area are expected to affect federally protected species and their habitat.

Table 5-7: Federally Listed Species In and Within Proximity to Project Areas

Scientific Name	Common Name	Federal Status	Alternative	Habitat Present	Population Reported in Project Area	Population Reported in 2-mile Radius of Project Area
Alasmidonta heterodon	Dwarf wedgemussel	E	1	Y	Y	Y
			2	Y	Y	Y
			3	Y	N	Y
			10	Y	Y	Y
Elliptio lanceolata	Yellow lance	T	1	Y	N	Y
			2	Y	Y	Y
			10	Y	Y	Y
Elliptio steinstansana	Tar River spineymussel	E	2	Y	Y	Y
Fusconaia masoni	Atlantic pigtoe	PT	1	Y	Y	Y
			2	Y	Y	Y
			3	Y	Y	Y
			5	Y	Y	Y
			8A	Y	Y	Y
			8B	Y	Y	Y
			9C	Y	Y	Y
			9D	Y	N	Y
			10	Y	Y	Y
Haliaeetus leucocephalus	Bald eagle	BGPA	1	Y	N	Y
			6	Y	N	Y
			7	Y	N	Y
			9A	Y	N	Y
			9B	Y	N	Y
			9C	Y	N	Y
			10	Y	Y	Y
Necturus lewisi	Neuse River dog	PT	1	Y	Y	Y
			2	Y	Y	Y
			3	Y	Y	Y
			10	Y	Y	Y
Notropis mekistocholas	Cape Fear shiner	E	4	Y	Y	Y
			5	Y	Y	Y
			7	Y	N	Y
			8A	Y	Y	Y

Table 5-7: Federally Listed Species In and Within Proximity to Project Areas

Scientific Name	Common Name	Federal Status	Alternative	Habitat Present	Population Reported in Project Area	Population Reported in 2-mile Radius of Project Area
			8B	Y	Y	Y
			9A	Y	N	Y
			9B	Y	N	Y
			9C	Y	N	Y
			10	Y	Y	Y
Noturus furiosus	Carolina madtom	PE	2	Y	Y	Y
Picoides borealis	Red-cockaded woodpecker	E	2	Y	N	Y
			4	Y	N	Y
			9D	Y	N	Y
			10	Y	Y	Y
Rhus michauxii	Michaux's sumac	E	9D	Y	N	Y
			10	Y	N	Y

E – Endangered. A taxon "in danger of extinction throughout all or a significant portion of its range."

T – Threatened. A taxon likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

P – Proposed for listing.

BGPA – Bald and Golden Eagle Protection Act. The bald eagle was de-listed from the Federal List of Threatened and Endangered wildlife, and the primary law protecting the bald eagle became the BGPA.

5.14 Water Resources (Surface Water Quantity)

The primary potential impact of an IBT is typically the water quantity being moved out of the source basin resulting from the transfer of surface water. The primary tool used to evaluate water resource impacts in the affected basins resulting from the proposed IBT was the CFNCRB model. The CFNCRB model was developed under the provisions of General Statute § 143-355(o), which compels DWR to develop hydrologic models for each of the 17 major river basins in North Carolina with approval and modification responsibilities granted to the EMC. The models must include surface water uses in the basin and any other withdrawal, ecological flow, instream flow requirements, future withdrawal projections, and LWSP data. DWR is the steward of these hydrologic models.

Hydrologic basin models typically use an OASIS hydrologic model platform. OASIS is a computer program designed to simulate surface water flows through a river basin considering watershed inflows, withdrawals, discharges, and water management protocols. DWR uses these hydrologic models for many of the State's river basins for long-term water supply planning, management, and regulatory decision-making, particularly during drought conditions. For this EIS, the CFNCRB model was used for the evaluation of alternatives.

The original Cape Fear and Neuse River Basin hydrologic models were developed initially in 2004 and 2008 for separate use in the Cape Fear and Neuse River basins. A single combined OASIS model of the Cape Fear and Neuse River basins was developed in 2011 for the purpose of water supply planning, drought management in the Cape Fear and Neuse River basins, and to evaluate the significant interbasin movement of water in the urbanized upper reaches of the basins, particularly in the Research Triangle area (DWR, 2016a). The combined OASIS model, the CFNCRB model, extends geographically from the headwaters of the Deep and Haw Rivers to the mouth of the Cape Fear River and from the headwaters of the Eno, Flat, and Little Rivers to the mouth of the Neuse River. The CFNCRB model has been used to evaluate Jordan Lake water supply allocation requests and the Towns of Cary and Apex interbasin transfer request in 2014.

The CFNCRB model was updated for this EIS to evaluate the impact of the Town of Fuquay-Varina's proposed interbasin transfer. A Technical Memorandum (Appendix F) provides a detailed explanation of the model development, assumptions, and results of the CFNCRB model used to evaluate the water supply alternatives covered in this EIS. The CFNCRB model results were compared from the array model runs that were executed for this EIS alternatives analysis. The CFNCRB model simulated the hydrologic outcome of a specific alternative, alternative with a climate scenario, or a target year demand (i.e., baseline of 2025 versus 2055 planning horizon) to compare with other model runs. The following sections provide a summary level analysis of the CFNCRB model development and results.

5.14.1 Model Development

The CFNCRB model was used as a foundation for the existing water supply and demands in the Cape Fear and the Neuse River basins. The model was updated with municipal demands based on approved 2022 LWSPs. Any exceptions are noted in Appendix F. All known, proposed, and approved developments to the water supply to be completed by 2055 (i.e., the planning period for this EIS) were added as new information to the model in the form of nodes, junctions, and/or reservoirs.

The CFNCRB model uses a hydrologic and climatic dataset developed from a 90-year historical period. The period of record starts on January 1, 1930 and extends through September 30, 2020. The dataset was developed using historical stream gage records; however, the purpose of the CFNCRB model is to simulate present day or potential future water management operations and assess impacts to streamflow, reservoir storage, water supply reliability, and other metrics of interest. The data set developed for the model used a comprehensive approach, as follows:

1. The CFNCRB model uses data from over 60 USGS streamflow gages in the Cape Fear and Neuse River basins. The CFNCRB model also uses historical weather station data to develop information on precipitation and evaporation that is applied to reservoirs in the model.
2. The CFNCRB model accounts for direct human-caused flow alterations, or impairments, from reservoir regulation and net water consumption. The CFNCRB model corrects these influences so that current or future conditions may be simulated using the adjusted historical hydrologic information.
3. Statistical techniques were used to complete missing hydrologic records for the streamflow gages.

For this EIS, the CFNCRB model was significantly updated since the last update by DWR in 2014 for the Cary/Apex IBT. The updates include changes to the Falls Lake Conservation Pool Reallocation, Jordan Lake Round 4 allocation, and water supply project updates for several utilities (e.g., Johnston County, WIP, Durham, Greensboro, etc.), and updated WSRPs. Minor changes were also made to the CFNCRB model to correct and update annual withdrawal and discharge patterns, inter-utility wholesale purchase agreements, and water shortage response protocols.

5.14.2 Climate Variability

The potential impact of climate change on the hydrologic status of the Cape Fear and Neuse River basins as a result of the proposed transfer were evaluated in this EIS. The technical evaluation of climate change requires an assessment of how natural hydrologic inputs to both basins may change over time. The impact of climate change was applied to Alternatives 1 to 9 for the planning year 2055. Hazen subcontracted with Tetra Tech for a climate variability screening and to produce synthetic hydrology for three selected climate variability scenarios (Appendix F). Two of the three scenarios employed a near worst-case assumption with regard to greenhouse gas emissions and warming through the end of the 21st century. Tetra Tech's work involved taking outputs from global climate models (GCMs) and running the relevant outputs through a rainfall-runoff model to arrive at basin hydrology that could then be incorporated into the CFNCRB model.

The climate assessment covers a scientifically supported range of future climate variability per the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2013). As a measure of conservatism, the climate assessment scenarios skew toward a more severe change (e.g., higher temperatures). Future climate projections remain uncertain, in particular for precipitation (refer to Appendix F Section 4). There is less uncertainty regarding future temperature changes. Future climate projections are best used to describe a probability envelope of future conditions to which adaptation may be needed. To select a set of scenarios

that bound the likely range of potential climate futures with respect to water supply, the relative change in mean annual temperature and mean annual precipitation was assessed across a range climate models (over 30 models) paired with two of the more severe but commonly studied greenhouse gas emissions trajectories.

The greenhouse emissions trajectories are standardized and referred to as representative concentration pathways (RCPs) (van Vuuren, 2011). The two RCPs used in this study are RCP 4.5 and RCP 8.5. The number following the RCP (4.5 or 8.5) refers to the climate forcing condition of the RCP in watts per meter squared (W/m^2) for the year 2100 relative to the pre-industrial year of 1750. The higher the number, the greater the degree of warming expected. A paper published after the scenario screening analysis was conducted suggests that, at present, the most likely warming scenarios are similar to RCP 3.4 (Pielke, 2021), which would be somewhat less severe than RCP 4.5 and significantly less so than RCP 8.5.

The climate scenarios selected came from the Multivariate Adaptive Constructed Analogue CMIP5 climate dataset. The full set of scenarios show a wide range in potential change with regard to temperature and precipitation (refer to Figure 3 in Attachment A of Appendix F). While both temperature and precipitation changes play a role in future water supply, the changes in precipitation patterns and quantity are likely to have a greater impact. Three GCM models were selected to develop a quantitative climate assessment that covers a scientifically supported range of future climate variability. The three selected scenarios are listed as follows with model name first followed by the RCP and the purpose for selecting the scenario. More information on these models and scenarios is available in Appendix F.

- CNRM-CM5, RCP 4.5 (higher runoff potential)
- MIROC-EMS-CHEM, RCP 8.5 (lower runoff potential)
- GFDL-ESM2M, RCP 8.5 (approximates ensemble mean)

Timeseries output were then downloaded from the archive for the three selected scenarios. A watershed runoff model, the National Hydrologic Model (NHM) with the Precipitation-Runoff Modeling System (PRMS), was then used to convert GCM output (temperature and precipitation in particular) to a hydrologic runoff timeseries and evaporation timeseries for use in the CFNCRB model. A detailed explanation of the selection and processing of the climate scenario data is included in Appendix F.

Hydrologic timeseries associated with each climate future scenario are compared to a historical “hindcast” model run covering 1950 to 2005. Hindcasting is conducted using the GCM with historical forcing conditions (i.e., past atmospheric greenhouse gas concentrations) to simulate the 1950 to 2005 period and evaluate the GCM accuracy in reproducing historical climate conditions. When coupled with a future climate forecast, hindcasting provides an apples-to-apples indication of relative change in any number of climatic factors. The relative change is used to adjust the inputs to the CFNCRB model using a bias-adjustment technique. The bias adjustment accounts for systematic differences that may be present between the PRMS model and historically observed flows. The target future year of 2055 is based upon the assumption of a 30-year IBT certificate issued around 2025. Since a 30-year period is typically used to evaluate statistical climate normal (NOAA, 2021), the climate variability scenarios used outputs from the GCM from 2040 to 2070, the mid-

point of which is 2055. The 30-year timeseries for each of the three climate variability scenarios was then inserted into the CFNCRB model for evaluation.

5.14.3 Analysis of CFNCRB Model Simulation Results

The modeling results are summarized with the no-action baseline alternative in 2025 and 2055 in comparison with Alternatives 1 through 9 in the planning year 2055. The modeling results for the historic hydrologic record are presented along with the three selected climate variability scenarios for each alternative, including the no-action alternative. Many of the metrics presented are consistent with the metrics presented in the 2014 Cary-Apex IBT analysis in the Cape Fear. The CFNCRB model results were evaluated using three broad classes of model output, as follows:

1. Municipal water supply reliability.
2. Performance of Jordan Lake and Falls Lake in Meeting Flow Targets and Recreational Criteria.
3. Low-flow discharge in the Cape Fear River and Neuse River:
    a. Potential climate change impact to hydrology.
    b. Cumulative impact related to Cape Fear River basin development (i.e., water demand increase between 2025 and 2055).
    c. Project-related impacts to 7Q10.
    d. USGS gage accuracy and CFNCRB model precision.

5.14.3.1 Municipal Water Supply Reliability

The ability of municipal purveyors to meet water supply needs is a key consideration for long-term planning. This section describes model results related to the ability to achieve this goal. The frequency, in percent of days, for meeting nominal (i.e., unrestricted) water demand for each alternative and climate scenario is summarized in Table 5-8. The nominal demand does not include reductions produced by conservation measures (i.e., when a water shortage response stage is triggered). For example, a frequency of 100 percent indicates that all of the water demand is met over the entire simulation period and no conservation was triggered for that utility. Frequency values less than 100 percent indicate the nominal demand is not always met. This phenomenon occurs for two reasons: 1) water conservation has been invoked, and/or 2) not enough water is available to meet the demand. For those systems whose triggers can be modeled, water demand is reduced according to the utility's WSRP proscribed conservation schedule when appropriate (i.e., a 10 percent reduction in water use in Stage 1 conservation).

An example is the Towns of Cary-Apex, which meets the conditions for triggering its WSRP at various points in all 2055 scenarios. Simulations using the historic inflow record show 100 percent delivery for Cary-Apex in year 2025 for the No-Action alternative and then decreasing to 93.5 percent in 2055. In 2055, the increased water demand on Jordan Lake prompts activation of Cary-Apex's drought plan on approximately 6.5 percent of the days in the model record (1930 to 2020 hydrology representing 33,000 days). Therefore,

delivery of water supply in 2055 would meet Cary-Apex's unrestricted demand on 93.5 percent of days. For the other 6.5 percent of days, the model indicates the reduced demand (i.e., triggering the Cary-Apex's WSRP) would be met 100 percent of the time.

Many of the water systems summarized in Table 5-8 do not have drought (i.e., WSRP) triggers that are quantifiable in the CFNCRB model. For these systems, water demand is not reduced under water shortage conditions. These systems all follow the statutory requirements for water shortage response; however, the triggers for entering the mandatory stages of the water shortage response are not specific enough to model. A failure to meet the unrestricted demands is due to a shortage of water (i.e., insufficient water on some days in the model to meet the full demand). This unrestricted demand scenario includes the Town of Fuquay-Varina. The model indicated that the Town of Fuquay-Varina would have a 0 percent supply reliability in 2055 in the No-Action alternative, as additional supply is not considered to meet the Town's projected 2055 needs.

Shortages due to absolute insufficiency of supply occur for only two other demand nodes in the model (at a single withdrawal point) and are limited to two of the three climate change scenarios. These shortages due to climate change occur for the Cape Fear Public Utility Authority (CFPUA) and Lower Cape Fear Water and Sewer Authority (LCFWSA) raw water intakes at the downstream end of the Cape Fear River basin. Using historical inflows, the 2055 demands are always met for CFPUA and LCFWSA across every modeled alternative. The frequency of shortages under the two more adverse climate change scenarios is extremely small. The period of record for the climate change runs (2040 to 2070) is 11,000 days. Therefore, a 0.01 percent result equals approximately 1 day of water supply shortage. These rare instances are highlighted as blue cells. All of the modeled shortages for CFPUA and LCFWSA were short, intermittent, infrequent, and did not include mitigation from a WSRP with quantifiable demand reductions by WSRP stage. Additionally, the shortages occurred during significant additional demand-side water stress. The municipal surface water demands for Fayetteville Public Works Commission (PWC), CFPUA and LCFWSA are projected to increase by over 57 mgd between 2025 and 2055 per the respective LWSPs submitted by these utilities, which is a 90 percent increase in water demand at these locations over the 30-year planning horizon.

For systems that do have quantifiable WSRP triggers, additional information on the nature of WSRP performance is provided in Table 5-9 and Table 5-10. There are four water utilities (Cary-Apex, Raleigh Water, City of Dunn, and Town of Benson) whose WSRPs were activated in the CFNCRB model. In July 2023, PWC adopted changes to their WSRP that included quantifiable shortage response triggers based on water elevation in the Cape Fear River at the PWC raw water intake. The PWC WSRP was adopted after the updates to the CFNCRB model. Drought response operations for PWC were modeled similarly to the operation for the City of Dunn. The City of Dunn's drought response rules are based off Cape Fear River discharges. The PWC WRSP elevation triggers were mapped to the flow output from the CFNCRB simulations using historical stage-discharge data at the Fayetteville NC USGS gage and the state HEC-RAS model for this section of the Cape Fear River. Tables 5-9 and 5-10 provide the percent of years in which the WSRP is activated, the median length of time the WSFPs are active once activated (i.e., the length of water use restrictions), the worst case event length, and the highest (i.e., most restrictive) WSRP stage reached during the entire model run.

When evaluating the results in Table 5-9 and Table 5-10, it should be noted that the historical hydrologic record is approximately three times as long as each climate change scenario. When comparing the results for any of these utilities by water supply alternative, there is very little difference between the alternatives. There are differences between the climate scenarios, but the most significant difference is simply due to the cumulative change between 2025 and 2055. Both Raleigh Water and Cary-Apex have WSRP activation frequencies of less than 1 in 3 years for all alternatives and climate outcomes. Using historical hydrology, the median restriction periods extend approximately 2 months for Raleigh Water and about 3.5 months for Cary-Apex. In the most severe historical drought, Cary/Apex spends just over 3 months in Stage 2 of their WSRP and Raleigh Water spends 6 months in Stage 3 of their WSRP. For Dunn and Benson, the activation frequencies are less than once in ten years and the median restrictions have a one week duration. In the worst case these extend to just under three weeks. For Fayetteville PWC, there is little to no change between the 2025 and 2055 conditions under historical hydrology and the median and maximum event lengths remain the same plus or minus a day across all scenarios within the respective hydrology.

Table 5-8: Summary of Frequency of Achieving Nominal (Unrestricted) Demand (% of Days)

Water Supply Alternative	Year	Inflows	Cape Fear River Basin Model Nodes						Neuse River Basin Model Nodes						
			Cary-Apex	Sanford [1]	Harnett County [1]	Dunn	Fayetteville	CFPUA / LCFWSA [1]	Raleigh	Johnston County [1]	Smithfield [1]	Fuquay-Varina [1]	Benson	Goldsboro [1]	Neuse-WASA [1]
No action (baseline)	2025	Historic	100.00%	100.00%	100.00%	99.15%	98.92%	100.00%	100.00%	100.00%	100.00%	100.00%	99.15%	100.00%	100.00%
	2055	Historic	93.53%	100.00%	100.00%	99.83%	98.84%	100.00%	97.72%	100.00%	100.00%	0.00%	99.83%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.55%	100.00%	96.68%	100.00%	100.00%	0.00%	99.57%	100.00%	100.00%
		GFDL	92.41%	100.00%	100.00%	99.98%	99.69%	100.00%	100.00%	100.00%	100.00%	0.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.35%	96.17%	99.98%	96.90%	100.00%	100.00%	0.00%	99.35%	100.00%	100.00%
Alternative 1	2055	Historic	93.46%	100.00%	100.00%	99.83%	98.88%	100.00%	97.73%	100.00%	100.00%	100.00%	99.83%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.55%	99.98%	96.72%	100.00%	100.00%	100.00%	99.57%	100.00%	100.00%
		GFDL	92.41%	100.00%	100.00%	99.98%	99.69%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.35%	96.23%	100.00%	96.91%	100.00%	100.00%	100.00%	99.35%	100.00%	100.00%
Alternative 2	2055	Historic	93.56%	100.00%	100.00%	99.83%	98.88%	100.00%	97.72%	100.00%	100.00%	100.00%	99.83%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.55%	99.90%	96.68%	100.00%	100.00%	100.00%	99.57%	100.00%	100.00%
		GFDL	92.41%	100.00%	100.00%	99.98%	99.69%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.37%	96.23%	99.86%	96.90%	100.00%	100.00%	100.00%	99.37%	100.00%	100.00%
Alternative 3	2055	Historic	93.46%	100.00%	100.00%	99.83%	98.88%	100.00%	97.72%	100.00%	100.00%	100.00%	99.83%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.55%	100.00%	96.68%	100.00%	100.00%	100.00%	99.57%	100.00%	100.00%
		GFDL	92.41%	100.00%	100.00%	99.98%	99.69%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.35%	96.23%	100.00%	96.90%	100.00%	100.00%	100.00%	99.35%	100.00%	100.00%

Table 5-8: Summary of Frequency of Achieving Nominal (Unrestricted) Demand (% of Days)

Water Supply Alternative	Year	Inflows	Cape Fear River Basin Model Nodes						Neuse River Basin Model Nodes						
			Cary-Apex	Sanford [1]	Harnett County [1]	Dunn	Fayetteville	CFPUA / LCFWSA [1]	Raleigh	Johnston County [1]	Smithfield [1]	Fuquay-Varina [1]	Benson	Goldsboro [1]	Neuse-WASA [1]
Alternative 4	2055	Historic	93.48%	100.00%	100.00%	99.83%	98.74%	100.00%	97.72%	100.00%	100.00%	100.00%	99.83%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.33%	99.96%	96.68%	100.00%	100.00%	100.00%	99.57%	100.00%	100.00%
		GFDL	92.41%	100.00%	100.00%	99.98%	99.60%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.35%	95.98%	99.97%	96.90%	100.00%	100.00%	100.00%	99.35%	100.00%	100.00%
Alternative 5	2055	Historic	93.44%	100.00%	100.00%	99.77%	98.74%	100.00%	97.72%	100.00%	100.00%	100.00%	99.77%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.41%	98.46%	99.89%	96.68%	100.00%	100.00%	100.00%	99.41%	100.00%	100.00%
		GFDL	92.37%	100.00%	100.00%	99.98%	99.66%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.13%	96.23%	99.91%	96.90%	100.00%	100.00%	100.00%	99.13%	100.00%	100.00%
Alternative 6	2055	Historic													
		CNRM	Identical to Alternative 7 (withdrawal from Jordan Lake)												
		GFDL													
		MIROC													
Alternative 7	2055	Historic	93.46%	100.00%	100.00%	99.83%	98.87%	100.00%	97.72%	100.00%	100.00%	100.00%	99.83%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.55%	100.00%	96.68%	100.00%	100.00%	100.00%	99.57%	100.00%	100.00%
		GFDL	92.38%	100.00%	100.00%	99.98%	99.81%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.76%	100.00%	100.00%	99.37%	96.23%	99.94%	96.90%	100.00%	100.00%	100.00%	99.37%	100.00%	100.00%
Alternative 8A	2055	Historic	93.44%	100.00%	100.00%	99.77%	98.92%	100.00%	97.72%	100.00%	100.00%	100.00%	99.77%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.41%	98.54%	99.97%	96.68%	100.00%	100.00%	100.00%	99.41%	100.00%	100.00%
		GFDL	92.37%	100.00%	100.00%	99.98%	99.69%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.13%	96.28%	99.87%	96.90%	100.00%	100.00%	100.00%	99.13%	100.00%	100.00%

Table 5-8: Summary of Frequency of Achieving Nominal (Unrestricted) Demand (% of Days)

Water Supply Alternative	Year	Inflows	Cape Fear River Basin Model Nodes						Neuse River Basin Model Nodes						
			Cary-Apex	Sanford [1]	Harnett County [1]	Dunn	Fayetteville	CFPUA / LCFWSA [1]	Raleigh	Johnston County [1]	Smithfield [1]	Fuquay-Varina [1]	Benson	Goldsboro [1]	Neuse-WASA [1]
Alternative 8B	2055	Historic	93.46%	100.00%	100.00%	99.78%	98.87%	100.00%	97.72%	100.00%	100.00%	100.00%	99.78%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.55%	99.90%	96.68%	100.00%	100.00%	100.00%	99.57%	100.00%	100.00%
		GFDL	92.41%	100.00%	100.00%	99.98%	99.66%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.23%	96.23%	99.94%	96.90%	100.00%	100.00%	100.00%	99.23%	100.00%	100.00%
Alternative 9A/B	2055	Historic	93.44%	100.00%	100.00%	99.77%	98.74%	100.00%	97.72%	100.00%	100.00%	100.00%	99.77%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.41%	98.46%	99.89%	96.68%	100.00%	100.00%	100.00%	99.41%	100.00%	100.00%
		GFDL	92.37%	100.00%	100.00%	99.98%	99.66%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.13%	96.23%	99.91%	96.90%	100.00%	100.00%	100.00%	99.13%	100.00%	100.00%
Alternative 9C	2055	Historic	93.46%	100.00%	100.00%	99.77%	98.91%	100.00%	97.72%	100.00%	100.00%	100.00%	99.77%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.41%	98.54%	99.98%	96.68%	100.00%	100.00%	100.00%	99.41%	100.00%	100.00%
		GFDL	92.37%	100.00%	100.00%	99.98%	99.69%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.11%	96.31%	99.92%	96.90%	100.00%	100.00%	100.00%	99.11%	100.00%	100.00%
Alternative 9D	2055	Historic	93.44%	100.00%	100.00%	99.78%	98.87%	100.00%	97.72%	100.00%	100.00%	100.00%	99.78%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.52%	99.89%	96.68%	100.00%	100.00%	100.00%	99.57%	100.00%	100.00%
		GFDL	92.41%	100.00%	100.00%	99.98%	99.66%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.23%	96.23%	99.93%	96.90%	100.00%	100.00%	100.00%	99.23%	100.00%	100.00%

[1] *These systems do not have quantifiable drought triggers that can be modeled in OASIS, so only the unrestricted demand is considered for these systems. Instances when unrestricted demand for these systems cannot be met are highlighted in blue. The only systems subject to this condition, other than Fuquay-Varina in the No-Action alternative, are CFPUA and LCFWSA.*

Table 5-9: Detailed Water Shortage Response Plan Statistics for Cary-Apex, City of Dunn, and Fayetteville PWC

Water Supply Alternative	Year	Inflows [1]	Cape Fear River Basin Model Nodes for Cary-Apex						Cape Fear River Basin Model Nodes for Dunn						Cape Fear River Basin Model Nodes for Fayetteville					
			% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)
No action (baseline)	2025	Historic	0	0	0	0	0	0	0	0	0	0	0	0	15.4	13	33	2	1.1	26
	2055	Historic	25.3	102.5	236	2	1.1	96	3.3	7.5	19	2	1.1	19	16.5	13	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	12.9	9.5	22	2	3.2	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	6.5	8	13	1	6.5	13	32.3	16	37	2	16.1	35
Alternative 1	2055	Historic	25.3	106	236	2	1.1	96	3.3	7.5	19	2	1.1	19	16.5	13	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	12.9	9.5	22	1	12.9	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	6.5	8	13	1	6.5	13	32.3	16	36	2	12.9	31
Alternative 2	2055	Historic	25.3	106	236	2	1.1	96	3.3	7.5	19	2	1.1	19	16.5	13	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	12.9	9.5	22	1	12.9	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	6.5	8	13	1	6.5	13	32.3	16	36	2	12.9	31
Alternative 3	2055	Historic	25.3	106	236	2	1.1	96	3.3	7.5	19	2	1.1	19	16.5	13	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	12.9	9.5	22	1	12.9	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	6.5	8	13	1	6.5	13	32.3	16	36	2	12.9	31

Table 5-9: Detailed Water Shortage Response Plan Statistics for Cary-Apex, City of Dunn, and Fayetteville PWC

Water Supply Alternative	Year	Inflows [1]	Cape Fear River Basin Model Nodes for Cary-Apex						Cape Fear River Basin Model Nodes for Dunn						Cape Fear River Basin Model Nodes for Fayetteville					
			% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)
Alternative 4	2055	Historic	25.3	104.5	236	2	1.1	96	3.3	7.5	19	2	1.1	19	17.6	13	34	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	19.4	9	22	2	3.2	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	17.5	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	6.5	8	13	1	6.5	13	32.3	17	37	2	16.1	35
Alternative 5	2055	Historic	25.3	106	236	2	1.1	96	5.5	9	20	2	1.1	19	18.7	13	34	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	9.7	10	13	1	9.7	13	12.9	9.5	22	2	6.5	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	9.7	8.5	13	1	9.7	13	32.3	16	36	2	19.4	35
Alternative 6	2055	Historic																		
		CNRM	Identical to Alternative 7 (Jordan Lake Withdrawal)																	
		GFDL																		
		MIROC																		
Alternative 7	2055	Historic	25.3	106	236	2	1.1	96	3.3	7.5	19	2	1.1	19	16.5	13	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	12.9	9.5	22	1	12.9	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	3.2	9	9	1	3.2	9
		MIROC	32.3	144	249	2	19.4	131	6.5	8	13	1	6.5	13	32.3	16	36	2	12.9	31

Table 5-9: Detailed Water Shortage Response Plan Statistics for Cary-Apex, City of Dunn, and Fayetteville PWC

Water Supply Alternative	Year	Inflows [1]	Cape Fear River Basin Model Nodes for Cary-Apex						Cape Fear River Basin Model Nodes for Dunn						Cape Fear River Basin Model Nodes for Fayetteville					
			% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)
Alternative 8A	2055	Historic	25.3	106	236	2	1.1	96	5.5	9	20	2	1.1	19	14.3	14.5	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	9.7	10	13	1	9.7	13	12.9	9	22	2	6.5	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	9.7	8.5	13	1	9.7	13	32.3	16	36	2	19.4	35
Alternative 8B	2055	Historic	25.3	106	236	2	1.1	96	5.5	8.5	20	2	1.1	19	16.5	13	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	12.9	9.5	22	2	3.2	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	6.5	8.5	13	1	6.5	13	32.3	16	36	2	16.1	35
Alternative 9A/B	2055	Historic	25.3	106	236	2	1.1	96	5.5	9	20	2	1.1	19	18.7	13	34	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	9.7	10	13	1	9.7	13	12.9	9.5	22	2	6.5	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	9.7	8.5	13	1	9.7	13	32.3	16	36	2	19.4	35
Alternative 9C	2055	Historic	25.3	106	236	2	1.1	96	5.5	9	20	2	1.1	19	14.3	14.5	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	9.7	10	13	1	9.7	13	12.9	9	22	2	6.5	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	9.7	8.5	13	1	9.7	13	32.3	16	36	2	19.4	35

Table 5-9: Detailed Water Shortage Response Plan Statistics for Cary-Apex, City of Dunn, and Fayetteville PWC

Water Supply Alternative	Year	Inflows [1]	Cape Fear River Basin Model Nodes for Cary-Apex						Cape Fear River Basin Model Nodes for Dunn						Cape Fear River Basin Model Nodes for Fayetteville					
			% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)
Alternative 9D	2055	Historic	25.3	106	236	2	1.1	96	5.5	8.5	20	2	1.1	19	16.5	13	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	12.9	9.5	22	2	3.2	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	6.5	8.5	13	1	6.5	13	32.3	16	36	2	16.1	35

[1] *Note that the historical hydrologic record in OASIS spans 91 years whereas the length of record for each of the CNRM-CM5, GFDL-ESM2M, and MIROC-EMS-CHEM hydrologic scenarios is 31 years.*

Table 5-10: Detailed Water Shortage Response Plan Statistics for Raleigh Water and Town of Benson

Water Supply Alternative	Year	Inflows [1]	Neuse River Basin Model Nodes for Raleigh Water						Neuse River Basin Model Nodes for Benson					
			% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)
No action (baseline)	2025	Historic	0	0	0	0	0	0	0	0	0	0	0	0
	2055	Historic	20.9	67	211	3	2.2	181	3.3	7.5	19	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8	13	1	6.5	13
Alternative 1	2055	Historic	20.9	67	211	3	2.2	181	3.3	7.5	19	2	1.1	19
		CNRM [2]	6.5	385	385	3	3.2	150	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8	13	1	6.5	13
Alternative 2	2055	Historic	20.9	67	211	3	2.2	181	3.3	7.5	19	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8	13	1	6.5	13
Alternative 3	2055	Historic	20.9	67	211	3	2.2	181	3.3	7.5	19	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8	13	1	6.5	13
Alternative 4	2055	Historic	20.9	67	211	3	2.2	181	3.3	7.5	19	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8	13	1	6.5	13

Table 5-10: Detailed Water Shortage Response Plan Statistics for Raleigh Water and Town of Benson

Water Supply Alternative	Year	Inflows [1]	Neuse River Basin Model Nodes for Raleigh Water						Neuse River Basin Model Nodes for Benson					
			% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)
Alternative 5	2055	Historic	20.9	67	211	3	2.2	181	5.5	9	20	2	1.1	19
		CNRM	6.5	386	386	3	6.5	174	9.7	10	13	1	9.7	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	9.7	8.5	13	1	9.7	13
Alternative 6	2055	Historic												
		CNRM [2]	Identical to Alternative 7 (withdrawal from Jordan Lake)											
		GFDL												
		MIROC												
Alternative 7	2055	Historic	20.9	67	211	3	2.2	181	3.3	7.5	19	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8	13	1	6.5	13
Alternative 8A	2055	Historic	20.9	67	211	3	2.2	181	5.5	9	20	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	9.7	10	13	1	9.7	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	9.7	8.5	13	1	9.7	13
Alternative 8B	2055	Historic	20.9	67	211	3	2.2	181	5.5	8.5	20	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8.5	13	1	6.5	13

Table 5-10: Detailed Water Shortage Response Plan Statistics for Raleigh Water and Town of Benson

Water Supply Alternative	Year	Inflows [1]	Neuse River Basin Model Nodes for Raleigh Water						Neuse River Basin Model Nodes for Benson					
			% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)
Alternative 9A/B	2055	Historic	20.9	67	211	3	2.2	181	5.5	9	20	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	9.7	10	13	1	9.7	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	9.7	8.5	13	1	9.7	13
Alternative 9C	2055	Historic	20.9	67	211	3	2.2	181	5.5	9	20	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	9.7	10	13	1	9.7	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	9.7	8.5	13	1	9.7	13
Alternative 9D	2055	Historic	20.9	67	211	3	2.2	181	5.5	8.5	20	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8.5	13	1	6.5	13

[1] Note that the historical hydrologic record in OASIS spans 91 years whereas the length of record for each of the CNRM-CM5, GFDL-ESM2M, and MIROC-EMS-CHEM hydrologic scenarios is 31 years.

[2] For each alternative using CNRM-CM5 inflows, Raleigh Water experiences a singular water shortage event that spans two years reaching up to shortage response Stage 3 for 150 to 174 days, thus the mean and median event length are equal.

5.14.3.2 Performance of Jordan Lake and Falls Lake in Meeting Flow Targets and Recreational Criteria

The second class of modeling results described in this report pertain to the frequency (in percent of days) that an alternative does not meet storage, lake elevation, or flow metrics at specific locations, as summarized in Table 5-11. These results generally pertain to the ability of Falls Lake and Jordan Lake to meet their authorized purposes. These metrics are consistent with the metrics presented in the 2014 Cary/Apex IBT analysis in the Cape Fear River. Similar metrics were developed for Falls Lake. The specific metrics used in the analysis include the following:

- Jordan Lake < 210 feet
- Jordan Lake < 210 feet Memorial to Labor Day
- Jordan Lake water quality storage < 80%, < 60%, < 40%, and < 20%
- Jordan Lake water supply storage < 50%
- Lillington gage flow < 550 cfs
- Fayetteville intake flow < 600 cfs
- Falls Lake < 242.5 feet
- Falls Lake < 242.5 feet Memorial to Labor Day
- Jordan Lake water quality storage < 80%, < 60%, < 40%, and < 20%
- Jordan Lake water supply storage < 50%
- Falls Lake gage flow < seasonal target at Falls Lake (April to October at 100 cfs; 60 cfs otherwise).
- Clayton gage flow < seasonal target at Clayton gage (April to October at 254 cfs; 184 cfs otherwise).

The 210 feet pool elevation in Jordan Lake and the 242.5 feet pool elevation in Falls Lake (USACE, 2018) represent lake levels at which boat access (i.e., the recreation purpose authorized for both federal projects) are anticipated to be adversely impacted. The normal pool for Jordan Lake is 216 feet. The normal pool elevation for Falls Lake is 251.5 feet. The following is a summary of the key conclusions:

- Jordan Lake drops to less than 210 feet less than 0.8 percent of the time for nearly all alternatives and climate change scenarios and 0.2 percent or less in the key summer recreational period. The singular exception is for the MIROC climate scenario for Alternatives 6 and 7 where the numbers are 1.2 percent and 0.4 percent, respectively.
- Jordan Lake water quality storage never drops less than 20 percent (i.e., equivalent to the Stage 4 trigger) in any alternative using either historic or climate change inflows. The water quality storage declines to less than 40 percent infrequently (i.e., less than 2.4 percent of the time) for all 2055 scenarios.
- The amount of time the Jordan Lake Water Quality Pool contains less than 80 percent storage (i.e., the Stage 1 drought trigger) ranges from approximately 9 percent of days up

to 20 percent of days. The results for the historical hydrology generally indicate approximately 15 percent of days in 2055, which is notably a 40 percent reduction in the amount of time at or below 80 percent storage as compared to the baseline results for 2025 (i.e., 25 percent in 2025 versus 15 percent in 2055). This owes to the contribution that treated wastewater makes toward meeting the flow target in Lillington in 2055 as compared to projections in 2025.

- The results for Jordan Lake Drought Stage 1 are highly correlated to the amount of time that the full flow target at Lillington (550 cfs) is not met. The discharge at Lillington is less than 550 cfs approximately 14.5 percent of the time for the alternatives using the historical inflow record. The discharge at Lillington is less than 550 cfs approximately 9.3 to 18.8 percent across all the climate change scenarios. The variation across the modeled alternatives is very low with the greatest difference between any two alternatives (and the same hydrology) of only 0.5 percent. The 14.5 percent in 2055 compares to 19.5 percent under 2025 conditions, so there is a relative reduction of over 25 percent of days spent in a Stage 1 event or worse.
- The model demonstrates that approximately 5.5 percent of the days the flow at Fayetteville of 600 cfs would not be met using historical inflows, which is a 50 percent reduction in days with discharge upstream of the PWC intake under 600 cfs as compared to the 2025 baseline. The variation under the climate change inflows is modest except for the MIROC (MIROC-EMS-CHEM) scenario, which produces low runoff periods that increase the percentage from 12 to 12.6 percent. Nevertheless, like the other metrics, the variance across alternatives under this climate scenario is small.
- Falls Lake drops to less than 242.5 feet less than 0.4 percent of the time for all alternatives and climate change scenarios and never does in the key summer recreational period.
- The Falls Lake water quality storage declines to less than 40 percent infrequently (i.e., less than 2.5 percent of the time and 1.5 percent of the time using historical hydrology). Falls Lake storage almost never declines to less than 20 percent. The lowest modeled storage reached 16.9 percent during one event in the historical hydrology (i.e., in late 2007) and never under the climate change scenarios.
- The Falls Lake minimum release and Clayton gage seasonal flow targets are never impacted.

Table 5-11: Frequency (% of Days) Alternatives Do Not Meet Storage and Flow Metrics at Select Locations in Cape Fear and Neuse River Basins

Alternative	Year	Inflows	Jordan Lake < 210 feet	Jordan Lake < 210 feet Memorial to Labor Day	Jordan Lake Water Quality Storage < 80%	Jordan Lake Water Quality Storage < 60%	Jordan Lake Water Quality Storage < 40%	Jordan Lake Water Quality Storage < 20%	Jordan Lake Water Supply Storage < 50%	Lillington Gage Flow < 550 cfs	Fayetteville Intake Flow< 600 cfs	Falls Lake < 242.5 feet	Falls Lake < 242.5 feet Memorial to Labor Day	Falls Lake Water Quality Storage < 80%	Falls Lake Water Quality Storage < 60%	Falls Lake Water Quality Storage < 40%	Falls Lake Water Quality Storage < 20%	Falls Lake Water Supply Storage < 50%	Falls Lake Release < Seasonal target [1]	Clayton Flow < Seasonal target [2]
No action (baseline)	2025	Historic	0.0%	0.0%	25.2%	17.0%	5.7%	0.0%	0.0%	19.0%	11.2%	0.0%	0.0%	13.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2055	Historic	0.1%	0.0%	15.0%	5.7%	0.6%	0.0%	0.0%	14.2%	5.6%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.4%	5.5%	1.2%	0.0%	0.0%	12.2%	7.1%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.3%	1.6%	0.0%	0.0%	0.0%	9.3%	2.9%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.7%	0.1%	19.4%	8.5%	1.9%	0.0%	0.0%	18.5%	12.2%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%
1	2055	Historic	0.1%	0.0%	15.0%	5.7%	0.6%	0.0%	0.0%	14.2%	5.5%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.4%	5.5%	1.2%	0.0%	0.0%	12.2%	7.0%	0.2%	0.0%	14.5%	6.4%	1.5%	0.0%	3.4%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.2%	1.6%	0.0%	0.0%	0.0%	9.3%	2.9%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.7%	0.1%	19.3%	8.5%	1.8%	0.0%	0.0%	18.5%	12.0%	0.0%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%
2	2055	Historic	0.1%	0.0%	15.0%	5.7%	0.6%	0.0%	0.0%	14.2%	5.5%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.4%	5.5%	1.2%	0.0%	0.0%	12.3%	7.0%	0.4%	0.0%	14.6%	6.4%	1.7%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.1%	1.6%	0.0%	0.0%	0.0%	9.3%	2.9%	0.0%	0.0%	11.8%	1.1%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.7%	0.1%	19.4%	8.6%	1.9%	0.0%	0.0%	18.5%	12.0%	0.1%	0.0%	23.9%	10.3%	2.5%	0.0%	6.3%	0.0%	0.0%

Table 5-11: Frequency (% of Days) Alternatives Do Not Meet Storage and Flow Metrics at Select Locations in Cape Fear and Neuse River Basins

Alternative	Year	Inflows	Jordan Lake < 210 feet	Jordan Lake < 210 feet Memorial to Labor Day	Jordan Lake Water Quality Storage < 80%	Jordan Lake Water Quality Storage < 60%	Jordan Lake Water Quality Storage < 40%	Jordan Lake Water Quality Storage < 20%	Jordan Lake Water Supply Storage < 50%	Lillington Gage Flow < 550 cfs	Fayetteville Intake Flow< 600 cfs	Falls Lake < 242.5 feet	Falls Lake < 242.5 feet Memorial to Labor Day	Falls Lake Water Quality Storage < 80%	Falls Lake Water Quality Storage < 60%	Falls Lake Water Quality Storage < 40%	Falls Lake Water Quality Storage < 20%	Falls Lake Water Supply Storage < 50%	Falls Lake Release < Seasonal target [1]	Clayton Flow < Seasonal target [2]
3	2055	Historic	0.1%	0.0%	15.0%	5.7%	0.6%	0.0%	0.0%	14.2%	5.5%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.4%	5.5%	1.2%	0.0%	0.0%	12.2%	7.0%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.1%	1.6%	0.0%	0.0%	0.0%	9.3%	2.9%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.7%	0.1%	19.4%	8.6%	2.0%	0.0%	0.0%	18.5%	12.0%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%
4	2055	Historic	0.1%	0.0%	15.0%	5.7%	0.6%	0.0%	0.0%	14.2%	5.9%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.4%	5.5%	1.2%	0.0%	0.0%	12.3%	7.3%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.3%	1.6%	0.0%	0.0%	0.0%	9.3%	3.2%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.7%	0.1%	19.4%	8.5%	1.9%	0.0%	0.0%	18.5%	12.6%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%
5	2055	Historic	0.1%	0.0%	15.7%	6.2%	0.8%	0.0%	0.0%	14.6%	5.7%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.8%	5.7%	1.4%	0.0%	0.0%	12.7%	7.3%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.7%	1.7%	0.0%	0.0%	0.0%	9.8%	3.2%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.8%	0.2%	20.0%	9.1%	2.4%	0.0%	0.0%	18.8%	12.2%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%

Table 5-11: Frequency (% of Days) Alternatives Do Not Meet Storage and Flow Metrics at Select Locations in Cape Fear and Neuse River Basins

Alternative	Year	Inflows	Jordan Lake < 210 feet	Jordan Lake < 210 feet Memorial to Labor Day	Jordan Lake Water Quality Storage < 80%	Jordan Lake Water Quality Storage < 60%	Jordan Lake Water Quality Storage < 40%	Jordan Lake Water Quality Storage < 20%	Jordan Lake Water Supply Storage < 50%	Lillington Gage Flow < 550 cfs	Fayetteville Intake Flow< 600 cfs	Falls Lake < 242.5 feet	Falls Lake < 242.5 feet Memorial to Labor Day	Falls Lake Water Quality Storage < 80%	Falls Lake Water Quality Storage < 60%	Falls Lake Water Quality Storage < 40%	Falls Lake Water Quality Storage < 20%	Falls Lake Water Supply Storage < 50%	Falls Lake Release < Seasonal target [1]	Clayton Flow < Seasonal target [2]
6	2055	Historic																		
		CNRM	Identical to Alternative 7 (withdrawal from Jordan Lake)																	
		GFDL																		
		MIROC																		
7	2055	Historic	0.2%	0.0%	15.0%	5.8%	0.6%	0.0%	0.0%	14.4%	5.5%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.4%	0.0%	12.4%	5.5%	1.2%	0.0%	0.0%	12.4%	7.0%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.1%	1.4%	0.0%	0.0%	0.0%	9.8%	2.9%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	1.2%	0.4%	19.4%	8.5%	1.9%	0.0%	0.0%	18.7%	12.0%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%
8A	2055	Historic	0.1%	0.0%	15.7%	6.2%	0.8%	0.0%	0.0%	14.7%	5.4%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.9%	5.8%	1.4%	0.0%	0.0%	12.7%	7.0%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.7%	1.7%	0.0%	0.0%	0.0%	9.8%	3.0%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.8%	0.2%	19.9%	9.1%	2.4%	0.0%	0.0%	18.8%	12.0%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%

Table 5-11: Frequency (% of Days) Alternatives Do Not Meet Storage and Flow Metrics at Select Locations in Cape Fear and Neuse River Basins

Alternative	Year	Inflows	Jordan Lake < 210 feet	Jordan Lake < 210 feet Memorial to Labor Day	Jordan Lake Water Quality Storage < 80%	Jordan Lake Water Quality Storage < 60%	Jordan Lake Water Quality Storage < 40%	Jordan Lake Water Quality Storage < 20%	Jordan Lake Water Supply Storage < 50%	Lillington Gage Flow < 550 cfs	Fayetteville Intake Flow< 600 cfs	Falls Lake < 242.5 feet	Falls Lake < 242.5 feet Memorial to Labor Day	Falls Lake Water Quality Storage < 80%	Falls Lake Water Quality Storage < 60%	Falls Lake Water Quality Storage < 40%	Falls Lake Water Quality Storage < 20%	Falls Lake Water Supply Storage < 50%	Falls Lake Release < Seasonal target [1]	Clayton Flow < Seasonal target [2]
8B	2055	Historic	0.1%	0.0%	15.2%	5.9%	0.7%	0.0%	0.0%	14.3%	5.6%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.6%	5.5%	1.3%	0.0%	0.0%	12.4%	7.1%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.4%	1.5%	0.0%	0.0%	0.0%	9.6%	3.1%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.7%	0.1%	19.5%	8.8%	2.0%	0.0%	0.0%	18.6%	12.0%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%
9A/B	2055	Historic	0.1%	0.0%	15.7%	6.2%	0.8%	0.0%	0.0%	14.6%	5.7%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.8%	5.7%	1.4%	0.0%	0.0%	12.7%	7.3%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.7%	1.7%	0.0%	0.0%	0.0%	9.8%	3.2%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.8%	0.2%	20.0%	9.1%	2.4%	0.0%	0.0%	18.8%	12.2%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%
9C	2055	Historic	0.1%	0.0%	15.7%	6.2%	0.8%	0.0%	0.0%	14.6%	5.4%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.8%	5.7%	1.4%	0.0%	0.0%	12.7%	7.0%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.7%	1.7%	0.0%	0.0%	0.0%	9.8%	3.0%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.8%	0.2%	20.0%	9.1%	2.4%	0.0%	0.0%	18.8%	12.0%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%

Table 5-11: Frequency (% of Days) Alternatives Do Not Meet Storage and Flow Metrics at Select Locations in Cape Fear and Neuse River Basins

Alternative	Year	Inflows	Jordan Lake < 210 feet	Jordan Lake < 210 feet Memorial to Labor Day	Jordan Lake Water Quality Storage < 80%	Jordan Lake Water Quality Storage < 60%	Jordan Lake Water Quality Storage < 40%	Jordan Lake Water Quality Storage < 20%	Jordan Lake Water Supply Storage < 50%	Lillington Gage Flow < 550 cfs	Fayetteville Intake Flow< 600 cfs	Falls Lake < 242.5 feet	Falls Lake < 242.5 feet Memorial to Labor Day	Falls Lake Water Quality Storage < 80%	Falls Lake Water Quality Storage < 60%	Falls Lake Water Quality Storage < 40%	Falls Lake Water Quality Storage < 20%	Falls Lake Water Supply Storage < 50%	Falls Lake Release < Seasonal target [1]	Clayton Flow < Seasonal target [2]
9D	2055	Historic	0.1%	0.0%	15.2%	5.9%	0.7%	0.0%	0.0%	14.3%	5.6%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.5%	5.5%	1.3%	0.0%	0.0%	12.3%	7.1%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.4%	1.5%	0.0%	0.0%	0.0%	9.6%	3.1%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.7%	0.1%	19.5%	8.8%	2.0%	0.0%	0.0%	18.6%	12.0%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%

[1] *Falls Lake flow target: April to October, 100 cfs; 60 cfs otherwise.*

[2] *Clayton flow target: April to October, 254 cfs; 184 cfs otherwise.*

5.14.3.3 Low-Flow Discharge in the Cape Fear River and Neuse River

The third class of output metrics pertains to low flow conditions at various key locations along the Cape Fear and Neuse Rivers. A statistical summary of streamflow impacts was developed to assess and evaluate the alternatives in the Neuse and Cape Fear River basins, focusing on the 7Q10, which is the lowest 7-day flow that occurs on average once every 10 years.

Table 5-12 summarizes the 7Q10 flow statistics at various nodes in the CFNCRB model. The evaluated 7Q10 locations are illustrated in Appendix F. The locations where the 7Q10 is reported include the Lillington gage, upstream of PWC's raw water intake in the Cape Fear basin, upstream of the CFPUA/LCFWSA raw water intake in the Cape Fear basin, at the Cayton Gage in the Neuse River basin, the confluence of the Neuse and Little Rivers in the Neuse River basins, and upstream of Neuse Regional Water and Sewer Authority's (NRWASA) raw water intake in the Neuse River basin. Alternative 9A/B is the Town of Fuquay-Varina partnering with the City of Sanford for finished water supply. Alternatives 9C and 9D are similar but also include a return of treated wastewater to the Cape Fear River.

The CFNCRB model provided results for four categories of change that could influence future low flow conditions to include the following:

1. Potential climate change impact to hydrology.
2. Cumulative impact related to Cape Fear River basin development (i.e., water demand increase between 2025 and 2055).
3. Project-related impacts to 7Q10.
4. Gage accuracy and model precision.

These impacts can be distinguished by comparing the low flows that result from the array of 45 different model runs and observing how an alternative, climate scenario, or target year demand (2025 vs 2055) affects the 7Q10 compared to other model runs. The magnitude of impacts to low flows were compared across the three aforementioned categories. The model suggests that the impact due to climate change would potentially incur the largest impact followed by cumulative impacts from increased water demand in the basin unrelated to a specific alternative. The selection of a water supply alternative for the Town of Fuquay-Varina resulted in minimal impact.

Figures 5-1 and 5-2 illustrate the model run comparisons. The chart for each location begins at the 2025 No Action baseline and progresses to indicate the relative impact of development through 2055, then the range of impacts across all the water supply alternatives (removing the baseline No Action climate effect) and finally shows the cumulative range of impacts due to the three climate scenarios evaluated. Where there is a range shown (water supply alternatives and climate scenarios), the green bar represents the median of the dataset and the whiskers at the top and bottom of the bar represent the entire range for that location.

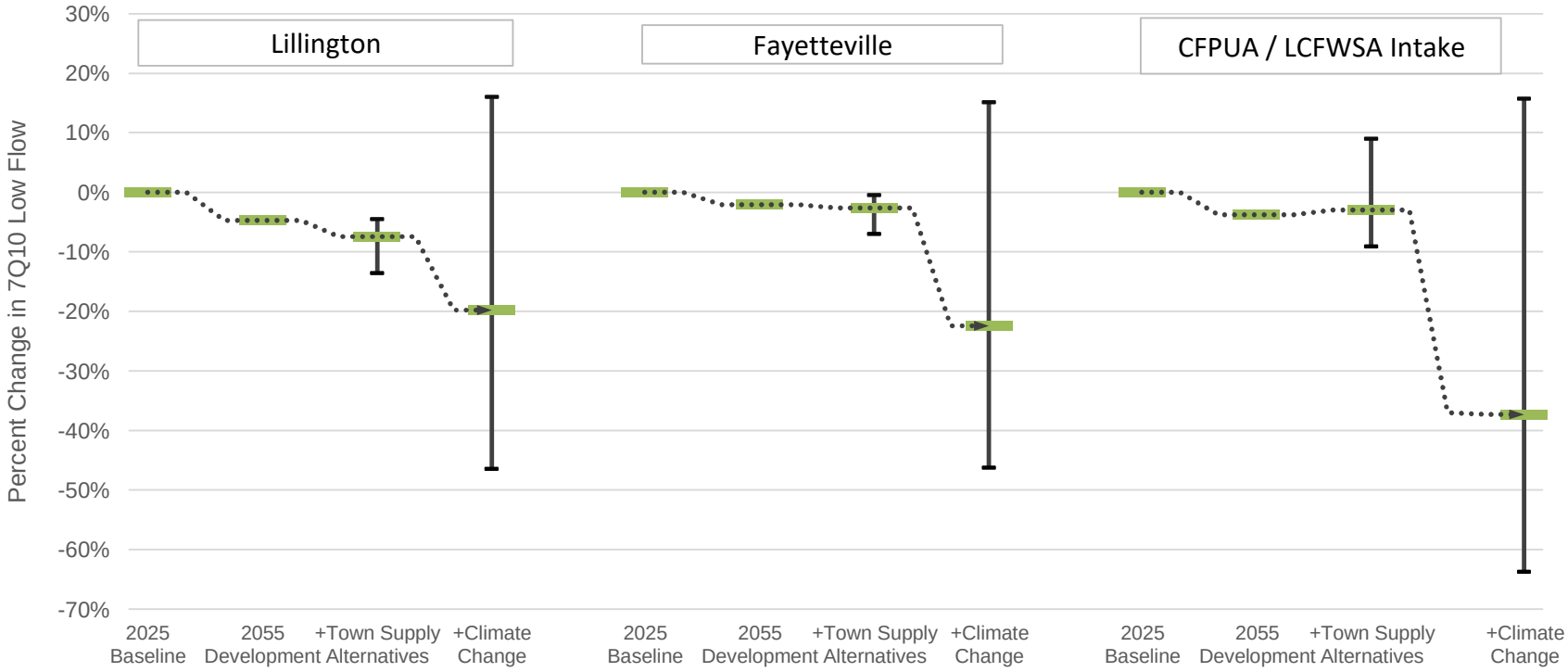


Figure 5-1: Comparison of Low Flow Impacts at Select Points in the Cape Fear River

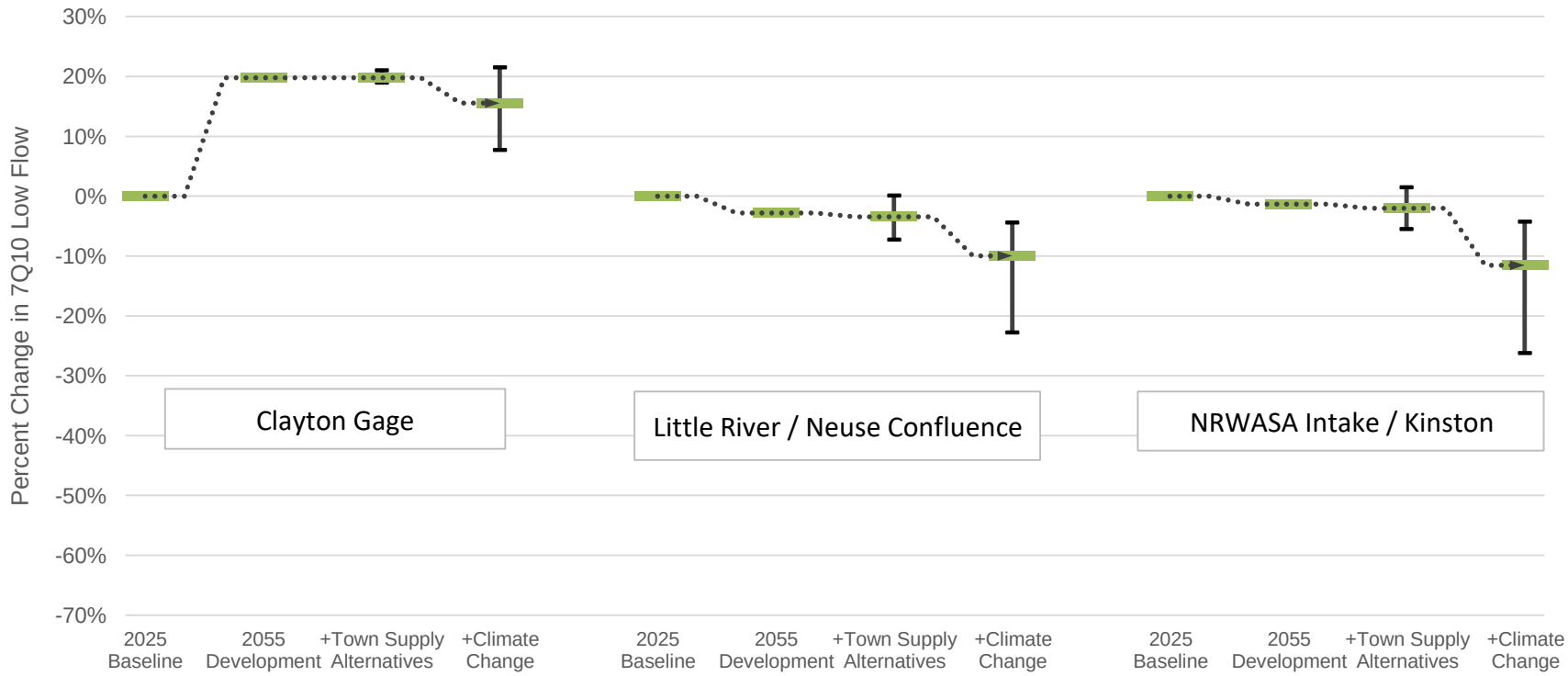


Figure 5-2: Comparison of Low Flow Impacts at Select Points in the Neuse River

5.14.3.3.1 Potential Climate Change Impact to Hydrology

The climate models selected for use in this EIS are not consistent with respect to the direction of change (increasing or decreasing) to future low flow conditions in central North Carolina. However, the magnitude of the forecasted changes from the climate models are significant. The low flow magnitude of change is 5 to 20 times greater than the change predicted from increased water demand through 2055 or the preferred alternative 9A/B. In the following summaries, the percent value describes the change between the historical hydrology runoff and the indicated climate change scenario for an alternative. Ranges are provided at a fixed location as the magnitude of the impact varies depending on the alternative. For example, the GFDL model suggests the Lillington gage 7Q10 would increase by 23.5 percent in the No-Action alternative but only increase by 18.7 percent for Alternative 9C. Therefore, the range in this scenario is between 19 and 24 percent.

In the Cape Fear River basin, the CNRM and MIROC climate models suggest a decrease in the 7Q10. Both models also suggest the changes are more severe further downstream. This may be a function of more severe hydrologic impacts further south and east in the basin, but it is also a function of how Jordan Lake is managed (refer to Section 4). Compared to the historical hydrology and 2055 water demand, the CFNCRB model 7Q10 results for 2055 are 12 to 20 percent less at Lillington, reduced by 20 percent upstream of PWC's intake, and reduced by 32 to 36 percent at the CFPUA/LCFWSA intake. For the MIROC model the comparative changes are a 35 to 40 percent reduction at Lillington, slightly over a 40 percent reduction at PWC's intake, and a reduction of 60 percent at the CFPUA/LCFWSA intake. The GFDL-ESM2M, RCP 8.5 model suggests the 7Q10 results in the Cape Fear will increase 19 to 24 percent at Lillington, 15 to 18 percent at PWC's intake, and 17 to 19 percent at the CFPUA intake. Ranges are provided as an attempt to characterize the climate impacts broadly across all 12 alternatives.

In the Neuse Reiver basin, all three climate models suggest a decline in the 7Q10. The exception is the GFDL-ESM2M, RCP 8.5 model result at the Clayton gage (+1.5 percent). The MIROC-EMS-CHEM model is the most conservative and resulted in a reduction of 12 percent at Clayton, 19 to 22 percent at the confluence of the Little River and Neuse River, and 24 to 27 percent at the NRWASA intake. The CNRM-CM5, RCP 4.5 model suggests a reduction of 4 percent at Clayton, 1 to 4 percent at the Neuse-Little River confluence, and 2 to 5 percent at the NRWASA intake in Kinston. The GFDL-ESM2M, RCP 8.5 model resulted in a 1.4 percent increase at Clayton, a 5 to 8 percent reduction at the Neuse-Little River confluence, and an 8 to 12 percent reduction at the NRWASA intake. The low flow reductions in the Neuse are more modest than the predicted reductions in in the Cape Fear in part due to the consistency of the flow target at Clayton regardless of the hydrologic scenario.

5.14.3.3.2 Cumulative Impact Related to Cape Fear River Basin Development

The cumulative impacts from the increase in water demand between 2025 and 2055 in the Cape Fear basin (excluding the Town of Fuquay-Varina) is forecast to reduce the 7Q10 at the Lillington gage, upstream of PWC's raw water intake, and upstream of the CFPUA/LCFWSA raw water intake by 4.7 percent, 2.1 percent, and 3.8 percent, respectively. The impact at the Lillington gage is larger and potentially misleading. The Lillington 7Q10 result is reported at the gage location, which is downstream of Harnett County's Regional WTP withdrawal and upstream of the effluent discharge from the North Harnett Regional

WWTP. Since Harnett County and partners plan for significant growth between 2025 and 2055, the impact is greater in the one-mile stretch between the County's raw water intake and the effluent discharge than elsewhere along this stretch of the Cape Fear River.

The cumulative impacts due to growth in water demand between 2025 and 2055 in the Neuse River basin are mixed depending on location. At the Clayton gage, the 7Q10 is forecast to rise by nearly 20 percent due to increased use and discharge at Raleigh Water's Neuse Regional Resource Recovery Facility (NRRRF) and the Town of Clayton's Sam's Branch WRF. Further downstream at the confluence of the Neuse and Little River in Goldsboro, the models predict a reduction of 2.8 percent in the future 7Q10 and 1.3 percent at NRWASA's raw water intake. The confluence of the Neuse and Little Rivers is downstream of Goldsboro's raw water intake and upstream of the City of Goldsboro's wastewater discharge, so approximately one-half of the impact at this location (between no change and -2.8 percent) is due to the increase in the City of Goldsboro's water demand over the planning horizon.

The CFNCRB model suggests the upstream increase in 7Q10 at Clayton may be counteracted further downstream by growth in Johnston County combined with conservative model assumptions about Johnston County's wastewater return to water demand ratio. The wastewater return to water demand ratio for Johnston County will increase with urbanization similar to other urbanizing areas across the state. The wastewater return to water demand ratio is increasing in urban areas but has not been subject to extensive research and therefore is difficult to forecast. The CFNCRB model reflects the present-day wastewater to water demand ratio in the 2055 demand scenario.

5.14.3.3.3 Project-related Impacts to 7Q10

The following comparative 7Q10 statistics apply to the historical basin runoff (i.e., hydrology) using the 2055 water demand scenario:

- The difference between the No-Action alternative in 2055 and Alternative 9A/B (no return of wastewater to the Cape Fear River basin) is a reduction of 4.6 cfs (-1.1 percent) for Alternative 9A/B at the PWC raw water intake and 3.1 cfs (-0.8 percent) at the CFPUA raw water intake. In the No-Action alternative, the majority of the Town of Fuquay-Varina's demand is unmet as additional supply options are not considered. In Alternative 9A/B, the Town of Fuquay-Varina's water demand is met with a withdrawal from the Cape Fear River near Sanford, which results in an approximate 1 percent reduction in the 7Q10 downstream of Sanford's intake.
- The difference between the 2055 No-Action alternative and Alternative 9C (return of water to Cape Fear) is an increase of 3.4 cfs (+0.8 percent) at PWC's raw water intake and 4.6 cfs (+1.2 percent) at the CFPUA raw water intake. The difference between the No-Action alternative and Alternative 9D (i.e., Western Wake WRF) is an increase of 0.8 cfs and 0.5 cfs at the same respective downstream locations. The smaller change with Alternative 9D is due to the fact the wastewater is returned upstream of the Lillington gage and the releases from Jordan Lake are adjusted accordingly in the model.

- The difference between Alternatives 9A/B (i.e., no return of water) and 9C (i.e., return of water) is an increase of 8 cfs (+2 percent) at PWC's raw water intake and 7.9 cfs (+2 percent) at the CFPUA raw water intake.
- The difference between Alternatives 9A/B and 9D is an increase of 5.4 cfs (+1.3 percent) at PWC's raw water intake and an increase of 3.9 cfs (+1 percent) at the CFPUA raw water intake.
- The model predicts small differences in 7Q10 downstream of the confluence of Middle Creek and the Neuse River depending on the source of the Town of Fuquay-Varina's future water supply and the location of the Town's discharged wastewater (i.e., Terrible Creek in the Neuse River basin or returned to the Cape Fear River). The impact to the 7Q10 reported at the confluence of the Neuse and Little Rivers and at the NRWASA raw water intake can be reduced by approximately 7 cfs for Alternative 1 for the 2055 No Action alternative or supplemented by up to nearly 6 cfs for Alternatives 4, 5, 6, 7, and 9A/B. For either Alternatives 9C or 9D, the impact at both locations is a very small reduction of 1.6 cfs compared to the 2055 No Action Alternative.

5.14.3.3.4 USGS Gage Accuracy and CFNCRB Model Precision

Models allow a high precision comparison of scenario outputs and relative changes as a result of modifying model variables. Modifying a model variable allows a relational cause and effect to be identified. The CFNCRB model has produced accurate and precise output results for the comparison of alternatives in this EIS. However, the ability to discern marginal changes in the field is a separate issue. The USGS gages used to measure streamflow are not nearly as precise in consistency and reproducibility as results from a mathematical model.

The USGS provides ratings for all installed stream gages. An assessment of gage accuracy is found in the "Remarks" Section in the station description (USGS, 2023). A gage station with an "Excellent" rating indicates that approximately 95 percent of the daily flow records are within 5 percent of the true value. A "Good" rating indicates that flow records are within 10 percent of the true flow value and a "Fair" rating indicates that the daily flow record is within 15 percent of the daily flow value. Stations with a "Poor" rating have daily discharge records of less than "Fair" accuracy. Per USGS, the gage station at Lillington has a "Good" rating, the gage station at Fayetteville has a "Poor" rating, and the gage station at Cape Fear Lock 1 NR Kelly has a "Good" rating. At the Lillington gage, a "Good" rating in the low-flow range of 250 to 600 cfs translates to a margin of error of +/- 25 to 60 cfs.

The modeled 7Q10 differences between any two alternatives using historical hydrology are less than 10 cfs at Lillington and at the other gage sites. The difference in the 7Q10 flow values between the evaluated water supply alternatives are substantially less than the station margin of error (i.e., accuracy) for daily discharge for all three gaging stations in the Cape Fear River. Since a 7Q10 event is statistically an event that lasts seven days, it is possible that the gage margins of error are reduced over this longer time period versus an instantaneous flow event. However, even with the potential for a lower margin of error, the CFNCRB model results predict differences in streamflow that will most likely not be captured at the USGS gage stations.

Table 5-12: Summary of 7Q10 Flow Statistics at Select Nodes in the Neuse and Cape Fear River Basins

Water Supply Alternative	Demand Year	Inflows	Lillington Flow, cfs	Fayetteville Intake, cfs	Cape Fear PUA Intake, cfs	Clayton Flow, cfs	Neuse River / Little River Confluence, cfs	Neuse River WASA Intake, cfs
No-Action (baseline)	2025	Historic	278.9	415.2	407.2	198.8	224.7	244.9
	2055	Historic	265.8	406.5	391.9	238.1	218.4	241.6
		CNRM	233.8	326.7	248.6	228	216.1	236.1
		GFDL	328.2	477.5	462.8	241.4	204.2	218.6
		MIROC	170.7	238.1	164.4	209.8	176.8	183.6
Alternative 1	2055	Historic	266.3	410.3	395.8	238.1	211.2	234.3
		CNRM	233.8	330.5	272.1	230.8	207.3	226.5
		GFDL	319.2	475	466.4	241.4	195.1	209.5
		MIROC	170.9	241.8	169.7	209.8	172.4	181.5
Alternative 2	2055	Historic	266	410.3	396	236.6	217.4	240.7
		CNRM	233.8	330.5	260.7	226.6	215.1	235.1
		GFDL	319.2	474.9	466.2	240.6	205.5	220.5
		MIROC	170.7	241.7	165.4	208	176.3	183.6
Alternative 3	2055	Historic	266.3	410.4	395.8	238.1	212.3	235.3
		CNRM	233.9	330.6	280.2	228	209.5	228.5
		GFDL	319.2	475	466.4	241.4	195.6	210
		MIROC	170.9	241.8	167.8	209.8	173.2	180.1
Alternative 4	2055	Historic	265.8	399.2	384.1	238.1	224.3	247.5
		CNRM	233.8	318.1	273.3	228	220.2	240.7
		GFDL	328.2	470.1	455	241.4	210.1	224.6
		MIROC	170.7	230.8	160.8	209.8	181.5	188.8

Table 5-12: Summary of 7Q10 Flow Statistics at Select Nodes in the Neuse and Cape Fear River Basins

Water Supply Alternative	Demand Year	Inflows	Lillington Flow, cfs	Fayetteville Intake, cfs	Cape Fear PUA Intake, cfs	Clayton Flow, cfs	Neuse River / Little River Confluence, cfs	Neuse River WASA Intake, cfs
Alternative 5	2055	Historic	258	401.9	388.7	238.1	224.3	247.5
		CNRM	213	313.7	251.2	228	220.8	241.2
		GFDL	315.7	469	461.4	241.4	210.1	224.6
		MIROC	157.3	226.4	158.4	209.8	181.5	188.8
Alternative 6/7	2055	Historic	265.9	409.6	395	238.1	224.3	247.5
		CNRM	233.9	330.6	255	228	220.2	240.7
		GFDL	328.2	481.2	466.4	241.4	210.1	224.6
		MIROC	170.9	241.9	167	209.8	181.5	188.8
Alternative 8A	2055	Historic	258	412.3	399.9	238.1	216.8	240
		CNRM	213	322	269.8	228	214.7	234.5
		GFDL	315.7	476.6	468.8	241.4	202.6	217.1
		MIROC	157.2	234	158	209.8	175	181.9
Alternative 8B	2055	Historic	263.9	407.5	392.9	238.1	216.8	240
		CNRM	230.9	326.7	257.1	228	214.7	234.5
		GFDL	316.6	470.7	463	241.4	202.6	217.1
		MIROC	163.7	234.1	163.4	209.8	175	181.9
Alternative 9A/B	2055	Historic	258	401.9	388.7	238.1	224.3	247.5
		CNRM	213	313.7	251.2	228	220.8	241.2
		GFDL	315.7	469	461.4	241.4	210.1	224.6
		MIROC	157.3	226.4	158.4	209.8	181.5	188.8

Table 5-12: Summary of 7Q10 Flow Statistics at Select Nodes in the Neuse and Cape Fear River Basins

Water Supply Alternative	Demand Year	Inflows	Lillington Flow, cfs	Fayetteville Intake, cfs	Cape Fear PUA Intake, cfs	Clayton Flow, cfs	Neuse River / Little River Confluence, cfs	Neuse River WASA Intake, cfs
Alternative 9C	2055	Historic	258	409.9	396.6	238.1	216.8	240
		CNRM	213	322	267.9	228	214.7	234.5
		GFDL	315.7	476.6	468.8	241.4	202.6	217.1
		MIROC	157.3	234	155.6	209.8	175	181.9
Alternative 9D	2055	Historic	263.9	407.3	392.6	238.1	216.8	240
		CNRM	230.9	326.7	257.1	228	214.7	234.5
		GFDL	316.5	470.7	463	241.4	202.6	217.1
		MIROC	163.8	234.2	165.1	209.8	174.8	181.8

5.14.4 Interpretation of Future Climate Simulation Results

The climate variability scenarios results need to be interpreted with caution. Climate models are typically run for hundreds of years to collect statistics on the frequency and intensity of weather events. One variable is changed and the model simulations are re-run to assess the global change in the statistics (Lerner, 2022). When climate models are used to predict the average future surface temperature for a given greenhouse gas emissions scenario, the majority of the models tend to agree (i.e., the models converge). The climate models do not converge as well for precipitation scenarios and struggle particularly with predicting the magnitude and frequency of extreme weather events.

Climate models have improved over several generations but also demonstrate weaker capability to reproduce precipitation patterns (Flato, 2013). The models used in this evaluation come from the CMIP5 archive. The improvement in skill of CMIP5 models over prior iterations is illustrated in Appendix F, Section 4. The lesser ability of these models to predict precipitation magnitude and timing will have implications for the hydrologic conditions assumed for these scenarios. Preparing for future climate variability is widely recognized as an important planning consideration for water supply infrastructure and therefore merits attention in this EIS despite continued uncertainty in the timing, magnitude, and patterns.

Shifts in the overall hydrologic productivity and timing of runoff for the three climate scenarios were evaluated with respect to the future water supply reliability in the Cape Fear and Neuse River basins. Table 5-13 summarizes the median unit runoff for four broad geographic areas in the Cape Fear and Neuse River basins. The median unit runoff provides additional quantitative context on the overall impact to the region's hydrology. The four geographical areas are as follows:

1. Neuse basin upstream of Falls Lake Dam
2. Neuse basin downstream of Falls Lake Dam
3. Cape Fear basin upstream of Jordan Lake Dam
4. Cape Fear basin downstream of Jordan Lake Dam (includes Rocky/Deep River watersheds)

Unit runoff results are presented for both 2010 to 2040 and 2040 to 2070 for the three climate variability scenarios even though the former period was not modeled in the CFNCRB model. The unit runoff results between 2010 and 2040 provide context for how the climate scenarios unfold over the next decades. Both historical observations and climate variability scenarios demonstrate greater unit runoff for the downstream portions of each basin as compared to the upstream portions. Runoff originating in the upper portions of the basins flowing into the lower basins was not included in the runoff statistics for the lower basins. The unit runoff in the Cape Fear basin is marginally higher than for the Neuse River basin. It is also notable that the unit runoff for the MIROC-ESM-CHEM model between 2040 and 2070 indicates a marked reduction compared to the historical runoff and runoff from the other two climate scenarios. The suitability of any of these scenarios is difficult to assess; however, one indication that there are challenges in plausibility of the MIROC-ESM-CHEM model is that the model has a known warm temperature bias at mid-latitudes, including the southeastern United States (Watanabe, 2011). Nevertheless, the MIROC-ESM-CHEM model was selected as a worst-case bounding condition despite this model flaw.

Table 5-13: Median Unit Runoff by Inflow Scenario in the Neuse and Cape Fear Upstream and Downstream of Major Basin Reservoir Nodes

Time Period	Climate Change Scenario	Neuse Upstream Falls Lake, cfs/mi^2	Neuse Downstream Falls Lake, cfs/mi^2	Cape Fear Upstream Jordan Lake, cfs/mi^2	Cape Fear Downstream Jordan Lake, cfs/mi^2
Historic (1930 to 2020)	N/A	0.35	0.63	0.47	0.69
2010 to 2040	MIROC-ESM-CHEM	0.36	0.63	0.48	0.70
	GFDL-ESM2M	0.34	0.61	0.45	0.78
	CNRM-CM5	0.40	0.74	0.51	0.80
2040 to 2070	MIROC-ESM-CHEM	0.24	0.44	0.35	0.48
	GFDL-ESM2M	0.30	0.57	0.40	0.66
	CNRM-CM5	0.34	0.64	0.44	0.74

The hydrologic changes modeled in MIROC-ESM-CHEM and CNRM-CM5 produce rare shortages for a single major municipal water supply withdrawal, CFPUA and LCFWSA, at the last freshwater withdrawal point on the Cape Fear River. Per the aforementioned discussion, climate models have difficulty reproducing precipitation patterns under historical conditions, so similar challenges should be anticipated for future predictions. There are six events in the MIROC scenario and three events in the CNRM scenario that produce supply shortages at the CFPUA/LCFWSA intake over a 30-year hydrologic period. These events are typically a single day in length; however, the longest duration event is 11 days.

Table 5-14 summarizes key system conditions during the months of water supply shortages for CFPUA and LCWSA. In each case, there are several factors or opportunities that would either naturally mitigate these events or could be leveraged to prevent the water supply shortages from occurring. The following are factors and opportunities that will mitigate these shortages:

<u>The monthly average discharge at the intake is well in excess of the raw water need.</u>

The average monthly discharge in the Cape Fear River at the point of withdrawal, even in a severe drought, is well in excess of the magnitude of the water supply withdrawal needed to satisfy CFPUA and LCFWSA demands. This result is demonstrated by comparing the column “Monthly Mean River Discharge at Intake” with the adjacent column, “Monthly Mean Water Withdrawal” in Table 5-14**.** The data suggests that the river discharge may not decline to the low daily discharges observed in the CFNCRB model to cause the observed shortages. In reality the runoff (and consequently flow) in the Lower Cape Fear may be more stable than the daily fluctuations in these climate scenarios suggest.

<u>The storage behind Lock and Dam #1 is not part of the OASIS model.</u>

The CFNRBM model assumes the CFPUA/LCFWSA intake points are “run-of-river” and that there is no storage capacity in the Cape Fear River. However, backwater from Lock & Dam 1 runs upstream to Lock and Dam 2 (Palmer, 2024), a distance of 32 miles. Combined with an average river width between 200 and 300 feet and a navigation channel of 8 feet deep, over a billion gallons is stored in this reach of the Cape

Fear River. Each inch of backwater storage is equivalent to 20 to 30 million gallons. This storage may be sufficient to mitigate the longest modeled shortage time frame of 11 days. This storage could be a mitigating factor for an actual sustained shortage, should a shortage occur, particularly when combined with other management factors to help alleviate and buffer low flow events.

CFPUA/LCFWSA do not have target demand reductions in WSRPs or a quantifiable source water trigger condition.

Neither CFPUA nor LCFWSA have WSRPs with quantifiable triggers and target demand reductions in the CFNCRB model. Demand curtailment would undoubtedly accompany the response to drought events of this magnitude. However, the CFNCRB model assumes no water demand reduction for CFPUA or LCFWSA during droughts because the conditions for enacting in their DWR approved WSRPs are not quantifiable.

Modified management of Jordan Lake.

Modified or improved management of Jordan Lake could eliminate the rare shortages observed at the CFPUA/LCFWSA intake with or without consideration of the three aforementioned mentioned mitigation opportunities. The management of Jordan Lake under the current Drought Contingency Plan (DCP) in the CFNCRB model plays a role in causing these rare shortages. There is sufficient storage in Jordan Lake to mitigate downstream shortages with releases from the Water Quality Pool.

Jordan Lake operations are not explicitly managed to meet needs downstream of Lillington. The release protocol for Jordan Lake was established to help meet downstream water quality needs while maintaining water supply storage in the reservoir. The drought plans for Jordan Lake allow for reductions in this minimum flow target at Lillington. In the Stage 3 and Stage 4 drought protocol, there is no flow target at Lillington but there is a specified maximum release from Jordan Lake. The CFNCRB model uses these operating conditions by limiting the maximum Jordan Lake release to 200 cfs. For example, when a Jordan Lake Stage 3 drought is invoked, there is far less protection remaining for downstream uses. It is only under Stage 3 conditions (Stage 4 is never reached in any scenario) when the CFPUA/LCFWSA shortages occur. Historically, the runoff downstream of Jordan Lake has been sufficient to meet water demands and have not required flow augmentation from Jordan Lake during low-flow periods. However, if water demand growth in the lower portions of the Cape Fear River basin is achieved as forecasted by LWSPs and climate change is severe, there will be a need to change the Jordan Lake operational approach.

Using the Jordan Lake Water Quality Pool to consider water supply needs in the Cape Fear River downstream of Lillington appears to be a viable means of ensuring water supply reliability per the CFNCRB model results. For reference, Jordan Lake drought Stages 1 through 4 are triggered when the Water Quality Pool storage drops below 80 percent, 60 percent, 40 percent, and 20 percent, respectively. The USACE operates Jordan Lake to meet the following flow targets:

- Drought level 0: Flow target at Lillington remains at 600 +/- 50 cfs
- Drought level 1: Flow target at Lillington ranges from 450 to 600 +/- 50 cfs
- Drought level 2: Flow target at Lillington ranges from 300 to 450 +/- 50 cfs

- Drought level 3: No flow target set at Lillington. A maximum release rate of 200 cfs from Jordan Lake, plus any required water supply releases downstream to Lillington.
- Drought level 4: No flow target set at Lillington. A maximum release rate of 100 to 200 cfs from Jordan Lake plus any required water supply releases downstream to Lillington.

The 2008 Jordan Lake DCP indicates the USACE may engage in a range of flow targets at Lillington during drought Stages 1 and 2. The target flow in Stages 1 and 2 is establish via collaboration and coordination on a variety of parameters such as stakeholder input, short and long-term weather outlook, gate status, influences on stream flows downstream, and local inflows to both Jordan Lake and reaches downstream of the dam. When Jordan Lake is in drought Stages 3 and 4, the Jordan Lake DCP does not specify how far downstream water supply needs should be fulfilled. Flexibility in adjusting dam releases has some limits under the Jordan Lake DCP. When Jordan Lake contains water in the conservation pool (as has always been the case), Jordan Lake will be operated to meet water supply requirements and water quality low flow releases. Utilities using Jordan Lake as a water supply will be unaffected by this change in DCP operating protocol.

The few shortages for the CFPUA/LCFWSA, which only occur in two of the climate variability scenarios, are due to extremely low inflows projected for this downstream portion of the Cape Fear River. The aggregate water supply need for utilities downstream of Lillington are not satisfied by the modest release from Jordan Lake because the shortages occur under significant additional water demand stress. The municipal surface water demands for PWC, CFPUA and LCFWSA are projected to increase by over 57 mgd between 2025 and 2055 per the respective LWSPs submitted by these systems, which is approximately a 90 percent increase in water demand at these locations over the 30-year planning period. The water supply shortages for CFPUA/LCFWSA disappear when the climate models are rerun with a modification to the Jordan Lake Stage 3 minimum release to mimic a Stage 2 release. Adjusting the Jordan Lake releases from the water quality pool to consider downstream water supply needs will require coordination between the State and USACE as specified in the Jordan Lake DCP. The authority to modify releases appears to be vested in the State in the current Jordan Lake DCP as described on pages 6-9 of the DCP.

Given the various mitigation options, it seems reasonable to conclude that if climate impacts of the magnitude suggested by the CNRM and MIROC scenarios occur, there are available options to mitigate the emergency. Per the discussion in Section 3, it is clear that the selection of a water supply alternative for the Town of Fuquay-Varina does not significantly exacerbate the water supply shortages in the Cape Fear River basin nor does the Town's preferred water supply alternative prevent mitigation strategies from being implemented.

Table 5-14: Key System Conditions During Months with Shortages for CFPUA and LCWSA

Alternative	Climate Scenario	Month and Year	Jordan Lake		CFPUA / LCFWSA			
			Minimum Water Quality Storage, MG (%)	Average Release (mgd)	Monthly Mean River Discharge at Intake (mgd)	Monthly Mean Water Withdrawal (mgd)	Days with Shortage [1]	Average Shortage (mgd) [1]
No Action	MIROC-ESM-CHEM	August, 2043	12,036 (39%)	129	304	68.5	----	----
		September, 2043	9,804 (32%)	119	347	61.3	----	----
		October, 2050	10,631 (34%)	92	352	54.0	1	16.4
		August, 2051	12,056 (39%)	195	218	66.9	----	----
		September, 2056	10,051 (33%)	140	153	60.5	1	30.2
		September, 2063	10,620 (34%)	143	269	58.7	4	16.2
	CNRM-CM5	September, 2057	8,930 (29%)	124	121	61.3	----	----
		August, 2058	10,671 (35%)	141	306	59.7	9	34.3
		September, 2058	11,676 (38%)	136	1,862	61.3	1	7.5
9A/B	MIROC-ESM-CHEM	August, 2043	12,034 (39%)	129	304	62.7	1	0.4
		September, 2043	9,741 (32%)	119	348	60.3	----	----
		October, 2050	10,631 (34%)	92	357	54.6	2	12.6
		August, 2051	12,055 (39%)	195	224	67.6	1	51.2
		September, 2056	10,053 (33%)	140	158	61.1	1	26.2
		September, 2063	10,620 (34%)	143	270	57.2	4	19.8
	CNRM-CM5	September, 2057	8,930 (29%)	124	124	59.8	----	----
		August, 2058	10,671 (35%)	141	317	67.7	11	24.8
		September, 2058	11,676 (38%)	136	1,866	60.4	----	----

Table 5-14: Key System Conditions During Months with Shortages for CFPUA and LCWSA

Alternative	Climate Scenario	Month and Year	Jordan Lake		CFPUA / LCFWSA			
			Minimum Water Quality Storage, MG (%)	Average Release (mgd)	Monthly Mean River Discharge at Intake (mgd)	Monthly Mean Water Withdrawal (mgd)	Days with Shortage [1]	Average Shortage (mgd) [1]
9C	MIROC-ESM-CHEM	August, 2043	12,312 (40%)	130	310	68.5	7	26
		September, 2043	10,023 (33%)	119	349	61.3	5	6.5
		October, 2050	10,808 (35%)	92	357	54.6	1	4.9
		August, 2051	12,238 (40%)	196	224	66.7	1	27.7
		September, 2056	10,225 (33%)	141	159	61.1	1	5.8
		September, 2063	11,070 (36%)	147	272	57.1	5	24.7
	CNRM-CM5	September, 2057	9,088 (29%)	124	123	59.8	1	44.9
		August, 2058	10,907 (35%)	147	316	61.7	2	13.4
		September, 2058	11,918 (39%)	133	1,863	60.5	1	29.1
9D	MIROC-ESM-CHEM	August, 2043	12,443 (40%)	152	321	68.5	1	0.4
		September, 2043	9,400 (30%)	122	355	61.3	----	----
		October, 2050	10,973 (36%)	92	356	54.3	1	4.9
		August, 2051	12,325 (40%)	205	230	68.5	2	29.1
		September, 2056	10,196 (33%)	145	162	60.3	1	8.2
		September, 2063	11,254 (37%)	146	272	59.2	5	25.2
	CNRM-CM5	September, 2057	9,280 (30%)	124	125	61.3	1	45.4
		August, 2058	11,010 (36%)	145	312	58.6	9	23.6
		September, 2058	11,981 (39%)	131	1,862	61.1	1	26.2

[1] The number of days and average shortage quantities are for both CFPUA and LCFWSA as they share a common intake location in the model.

[2] One of the two shortage days averaged was 26.3 mgd for CFPUA, the demand for this node on this day was 33.0 mgd.

5.15 Water Resources (Water Quality)

5.15.1 Common Elements of Alternatives 1, 2, and 3

Alternatives 1, 2, and 3 do not include require an interbasin transfer. The produced wastewater in the Cape Fear and Neuse River basins as a result of the proposed project will result in the use of existing NPDES discharge permits. Direct and indirect permanent and temporary impacts as a result of the discharge of treated effluent will be negligible, as these impacts are addressed in an existing CWA permit.

The water quality impacts of a proposed reservoir for Alternatives 1 and 3 may incur major direct and indirect impacts. Based on prior experience with the development of the proposed Little River reservoir for Raleigh Water, state and federal agencies requested a water quality model to ensure that water quality standard violations will not occur in the reservoir or downstream of the proposed reservoir. The minimum release from the proposed dam must also be sufficient to provide aquatic species with the necessary ecological flow for habitat and quality. The water quality model will assist in determining the extent of the impacts, if any, in the proposed reservoir and downstream of the proposed reservoir.

5.15.2 Alternatives 4, 5, 6, 7, 9A, and 9B

Alternatives 4, 5, 6, 7, 9A, and 9B do not include infrastructure to minimize the return of water (i.e., interbasin transfer) from the Neuse River to the Cape Fear River basin. The produced wastewater in the Cape Fear and Neuse River basins as a result of the proposed project will result in the use of existing NPDES discharge permits. The Town of Fuquay-Varina's Terrible Creek WWTP may not need to expand to a capacity greater than 6 mgd until after 2045.

The water quality comments during the SEPA scoping phase from the public and other utilities referenced potential impacts on water quality due to emerging contaminants, specifically PFAS and 1,4-dioxane (1,4-D). Comments indicated that PFAS and 1,4-D could potentially be returned to the Cape Fear River basin via the Harnett County North Regional WWTP or the Neuse River Basin through the Town of Fuquay-Varina's Terrible Creek WWTP with these alternatives. PFAS is present in domestic (e.g., residential and commercial) wastewater contribution across the U.S. The presence of 1,4-D appears to be more prevalent in wastewater discharges in the upper Cape Fear River basin than the Neuse River basin.

There are several challenges associated with assessing the water quality impact of PFAS and 1,4-D. Water quality standards have not been promulgated by the EPA or DEQ for PFAS or 1,4-D. Additionally, a certified analytical method for PFAS in a wastewater and surface matrix has not yet been promulgated per 40 CFR 136. Additionally, peer-reviewed water quality models are not available to address emerging contaminants in ambient waters. In the event water quality standards for PFAS or 1,4-D are promulgated and incorporated into NPDES permits, wastewater dischargers must comply with NPDES effluent limit discharge requirements, including the Town of Fuquay-Varina.

DWR did not provide comments in the SEPA scoping phase that water quality modeling was required of the applicant. Additionally, DWR conveyed to the applicant during a scoping meeting that water quality modeling was not necessary for the evaluation of the impacts of the interbasin transfer. Therefore, water quality

modeling was not conducted for the proposed interbasin transfer. In lieu of modeling, an analysis of the low flow statistics from the CFNCRB model was used as a proxy to qualify potential water quality impacts. Per Section 5.14, the difference between water supply alternatives without a return of water to the Cape Fear River is negligible. Four categories of relevant discussion are included in Section 5.14.3.3 of the EIS: potential climate change impact to hydrology, cumulative impact related to Cape Fear River basin development, project-related impacts to 7Q10, and USGS gage accuracy and CFNCRB model precision. Key points regarding the modeled low flow impacts are as follows:

- Using historical inflows, the difference between No-Action and Alternative 9A/B (without return of water) is a reduction of 4.6 cfs (-1.1 percent) at the Fayetteville raw water intake and 3.1 cfs (-0.8 percent) at the CFPUA/LCFWSA raw water intake.
- Using historical inflows, the difference between No-Action and Alternative 9C (return of water to Cape Fear) is an increase of 3.4 cfs (+0.8 percent) at the Fayetteville raw water intake and 4.6 cfs (+1.2 percent) at the CFPUA raw water intake for Alternative 9C.
- The difference between the No-Action alternative and Alternative 9D is an increase of 0.8 cfs (+0.2 percent) and 0.5 cfs (+0.1 percent) at the same respective downstream locations. The smaller change with Alternative 9D is due to the fact the wastewater in Alternative 9D is returned upstream of the Lillington gage and the releases from Jordan Lake were adjusted accordingly. The recorded discharge at the Lillington gage changes to a lesser degree with the wastewater return location for Alternative 9D.

Per Section 5.14, the modeled 7Q10 differences between any two alternatives using historical hydrology are less than 10 cfs at Lillington and at the other gage sites. The difference in the 7Q10 flow values between the evaluated water supply alternatives are substantially less than the station margin of error (i.e., accuracy) for daily discharge for all three gaging stations in the Cape Fear River. For example, the Lillington gage was assigned a “Good” rating in the low-flow range of 250 to 600 cfs, which translates to a margin of error of +/- 25 to 60 cfs. Since a 7Q10 event is statistically an event that lasts seven days, it is possible that the gage margins of error are reduced over this longer time period versus an instantaneous flow event. However, even with the potential for a lower margin of error, the CFNCRB model predicts differences in streamflow that will most likely not be captured at the USGS gage stations.

5.15.3 Alternatives 8A, 8B, 9C, and 9D

Alternatives 8A, 8B, and 9C include a return of water to the Cape Fear River basin to minimize the amount of the interbasin transfer. Per Section 5.14, the difference between water supply alternatives with a return of water to the Cape Fear River is negligible. Key points regarding the modeled low flow impacts are as follows:

- Using historical inflows, the difference between No-Action and Alternative 9C (return of water to Cape Fear) is an increase of 3.4 cfs (+0.8 percent) at the Fayetteville raw water intake and 4.6 cfs (+1.2 percent) at the CFPUA raw water intake for Alternative 9C.
- The difference between the No-Action alternative and Alternative 9D is an increase of 0.8 cfs (+0.2 percent) and 0.5 cfs (+0.1 percent) at the same respective downstream

locations. The smaller change with Alternative 9D is due to the fact the wastewater in Alternative 9D is returned upstream of the Lillington gage and the releases from Jordan Lake are adjusted accordingly. The recorded discharge at the Lillington gage changes to a lesser degree with the wastewater return location for Alternative 9D.

Similar to 5.15.2.2, the modeled 7Q10 differences between any two alternatives using the historical hydrology are less than 10 cfs at Lillington and at the other gage sites. The difference in the 7Q10 flow values between the evaluated water supply alternatives are substantially less than the station margin of error (i.e., accuracy) for daily discharge for all three gaging stations in the Cape Fear River.

DWR published a Regional Water and Wastewater Concept Plan for the U.S. 421 Corridor in May 2024 (DWR, 2024). The 421 Corridor Study assumes that the Cape Fear River basin will be subject to nutrient removal criteria by 2050 due to nutrient impaired waters. Existing wastewater dischargers that require a wastewater facility expansion in the Cape Fear would be required to hold oxygen, sediment, and nutrient loads constant (i.e., effluent load does not increase with increasing flow). It is unlikely that DWR will issue new NPDES permits in the Cape Fear River basin until the EPA modeling and Middle Cape Fear numeric nutrient criteria pilot are completed.

5.16 Water Resources (Streams and Riparian Buffers)

Direct impacts to perennial and intermittent streams in the project area are anticipated to result from construction of each of the proposed alternatives. Table 5-15 summarizes the number of perennial and intermittent streams crossings for each alternative and the length of temporary and permanent stream impacts that will occur for each alternative. For all stream crossings except the Cape Fear River, stream crossings will be performed by excavating an open trench, installing the transmission line, and backfilling the trench. Instream work will be performed in dry stream conditions, using a pump-around system or diversion, as necessary. Open cut pipe installation within streams will not result in permanent stream impacts since the areas of disturbance will be returned to original grade following construction activities. Transmission line crossings of the Cape Fear River and streams in which federally protected species or designated critical habitats are known to be present, if applicable, will be installed using trenchless technologies.

The stream lengths of temporary impacts assume that the entire width of the transmission line corridor will impact the streams, which involves a 100-foot wide area for all alternatives except 8A and 8B, which have 120-foot wide corridor where two pipes run parallel to each other. Actual impacts are expected to be less than stated for the transmission line corridors as minimization measures will be incorporated into final design. It is assumed that permanent impacts will not occur in association to pipe crossings of intermittent and perennial stream as all project elements will be below the stream bed and the stream will be returned to original condition. Permanent impacts to jurisdictional streams include the length of stream in the footprint of the proposed instream structures that include the effluent discharge associated with Alternatives 8A, 8B, and 9C, and the raw water intake structures for Alternatives 1 through 8B. As the aboveground structures have not been designed to the level at which impacts can be precisely calculated, the permanent impacts are stated as the maximum length of stream which may reasonably be expected to be impacted by the proposed infrastructure.

Direct impacts are not provided for the WTP and WWTP facilities or the well field as these layouts have not yet been developed. It is currently unknown if the WTP and WWTP facilities will impact jurisdictional streams or protected riparian buffers. Impacts to these resources will be determined once WTP and WWTP facility layouts are developed. Efforts will be made during the design of the WTP and WWTP facilities to avoid impacts to jurisdictional streams and protected riparian buffers to the extent feasible.

Use classifications of the streams that will be crossed by the proposed project alternatives will not be affected by the project. The proposed construction of a new raw water intake may require a reclassification of the water body into which the intake is proposed to be placed. For Alternatives 1 and 3 a reclassification of the respective river reaches will be necessary as the stream will then function as a water supply source. All alternatives except the No-Action Alternative will have a short-term, minor, adverse impact on the streams' ability to fully support its designated uses.

Fifty-foot riparian buffers are protected via the Neuse Buffer Rule for streams in the Neuse River basin that are depicted on USGS topographic map or NRCS published soils maps (15A NCAC 02B .0233). The Neuse River Buffer rule is applicable in project areas in the Neuse River basin. Portions of all alternatives except Alternatives 9A, 9B, and 9D are in the Neuse River or Jordan Lake basin. A small portion of Alternative 4 is in the Neuse River basin and no streams are located in the Neuse River basin portion of Alternative 4. Per the Neuse Buffer Rule, utility line crossings of buffered streams are exempt, allowable, or allowable with mitigation, depending on the angle of the crossing and the width of the construction area and permanent maintenance corridor. Authorization from DWR and obtaining mitigation may be required depending on the footprint of the proposed disturbances in the protected riparian buffer areas. Areas of disturbance in riparian areas in both the Neuse River and Cape Fear River basins will be avoided and minimized to the extent feasible during design and construction of project components regardless of which alternative is chosen. River basin boundaries are illustrated in Figure 4-7.

The Jordan Lake Buffer Rules apply to intermittent and perennial streams and perennial waterbodies (ponds) in-line with a stream or a natural drainage way in the Jordan Lake watershed. The raw water intakes and portions of the transmission lines associated with Alternatives 6 and 7 are in the Jordan Lake watershed. Project activities within the Jordan Lake watershed stream buffers will require authorization of the impacts. Areas of disturbance within riparian areas in both the Neuse River and Cape Fear River basins will be avoided and minimized to the extent feasible during design and construction of project components regardless of which alternative is chosen.

Table 5-15: Stream Crossings and Length of Stream Impacts

Alternative	Perennial Streams			Intermittent Streams		
	Number of Crossings	Temporary Impacts, feet	Permanent Impacts, feet	Number of Crossings	Temporary Impacts, feet	Permanent Impacts, feet
1 [1]	5	500	50	3	300	----
2	15	1,500	100	32	3,200	----
3 [1]	1	100	50	0	----	----
4	3	300	50	12	1,200	----
5 [2]	2	200	50	10	1,000	----
6	3	300	50	16	1,600	----
7	6	600	50	20	2,000	----
8A	5	560	100	21	2,300	----
8B	2	220	100	19	2,100	----
9A [2]	3	300	----	13	1,300	----
9B [2]	4	400	----	18	1,800	----
9C [2]	8	800	50	34	3,400	----
9D [2]	8	800	----	13	1,300	----

[1] Stream quantification does not include Middle Creek Reservoir stream areas.

[2] The Cape Fear River will be crossed in Alternatives 5, 9A, 9B, and 9C via trenchless construction methods; therefore, stream impacts to the Cape Fear River are not included.

5.16.1 Common Elements of All Alternatives

The proposed water main corridors for all alternatives will cross perennial and intermittent streams. All the stream crossings, except crossings of the Cape Fear River (Alternatives 5, 9A, 9B, 9C, and 9D), will be performed via open cut installation techniques. Open cut installation will not result in permanent stream impacts due to the temporary nature of the work allowing the disturbed areas to be returned to the original grade. Temporary stream impacts from opencut pipe crossings will be direct, minor, and adverse.

Permanent stream impacts are associated with raw water intake and effluent discharge structures, raw water storage facilities, and proposed reservoirs. No permanent impacts to intermittent streams will occur from any of the alternatives. Permanent, direct, minor, adverse impacts to perennial streams will occur for all alternatives except Alternatives 9A, 9B, and 9D. Alternatives 9A, 9B, and 9D will not require construction of a new raw water intake. These three alternatives will use infrastructure that will exist prior to this project moving forward.

Temporary impacts to the waterbodies' support of their respective uses will occur for all alternatives. Except for the Cape Fear River, the streams that are proposed to be crossed by pipe corridor will be open cut to accommodate installation of the pipe and dewatering will occur during construction. Most of the classified streams crossed by the alternatives are classified as recreation or water supply. The uses of the waterbodies, including fishing, boating, and aquatic life support for most classified streams in the project

corridors will be unsupported in the construction area and partially supported immediately upstream and downstream of the construction area during construction.

All alternatives except Alternatives 9A, 9B, 9C, 9D, and 10 include a raw water intake that may require review of the current best use classification and a determination as to whether a reclassification is necessary to accommodate the new intake and water withdrawals. Alternatives 1 and 3 include construction of new in-line reservoirs and Alternative 2 includes construction of a new raw water intake that are anticipated to require reclassification. Additionally, Alternatives 8A, 8B, and 9C include an effluent discharge.

Riparian buffers are protected along corridors of all alternatives except Alternatives 9A, 9B, and 9D which lie wholly in the Cape Fear River basin and downstream of the Jordan Lake dam. Temporary construction impacts to riparian buffers will be direct, minor, and temporary. Permanent impacts to riparian areas due to maintained access corridors are expected to be minor and direct.

5.16.2 Common Elements of Alternatives 1 and 3

The length of stream reaches in the Middle Creek Reservoir footprints associated with Alternatives 1 and 3 is 5.0 and 4.8 miles, respectively. A change of best use classification is anticipated to be required for Alternatives 1 and 3 relative to the creation of raw water storage facilities. Permanent, direct, major, adverse impacts to Middle Creek and its tributaries will occur from creation of new raw water storage facilities on Middle Creek.

5.16.3 Common Elements of Alternatives 5, 9A, 9B, 9C, and 9D

Alternatives 5, 9A, 9B, 9C, and 9D include installation of a pipe under the Cape Fear River. All Cape Fear River pipe crossings will be performed using trenchless construction techniques. Design factors taken into consideration for trenchless pipe installation will include anti-frac out measures to ensure inadvertent water quality issues do not arise during pipe installation under the river. Anti-frac out measures may include but are not limited to preconstruction geotechnical evaluation, pipe installation at the required minimum depth below stream bed elevation, and inclusion of a frac out plan in the design specifications for the contractor. No direct impacts will occur to the Cape Fear River from pipe crossings associated with Alternatives 5, 9A, 9B, 9C, and 9D; therefore, no permitting will be required.

5.16.4 Alternative 10

Numerous perennial and intermittent streams are within the well field area. The well field layout has not yet been developed. Stream crossings for Alternative 10 will be avoided to the extent feasible and minimized where avoidance is not feasible. The perennial and intermittent stream crossings will result in direct, temporary, adverse, minor impacts at the crossing locations. No direct, permanent impacts are expected to occur due to Alternative 10.

Temporary impacts to the waterbodies' support of their respective uses will occur for Alternative 10. The streams proposed to be crossed by the water main will be open cut to accommodate installation of the water

main and will be dewatered during construction. The uses of the waterbodies, including fishing, boating, aquatic life support, primary recreation, and water supply, will be unsupported in the construction area and partially supported immediately upstream and downstream of the construction area during construction. No change of best use classification is needed for the alternative.

Over half of the well field area is in the Neuse River basin and subject to the Neuse Buffer Rule. Riparian buffer protections apply to a 50-foot wide area adjacent to perennial and intermittent streams that are depicted on USGS topographical maps or NRCS published soil surveys. Portions of the well field are subject to the riparian buffer restrictions. The wells require spacing of 1,000 feet from another well. In order to avoid impacting the water level in the streams, the well field was selected based on an assumed need of a 500-foot wide offset from streams to individual wells. Temporary stream impacts and temporary and permanent riparian buffer impacts within the well field are expected to be direct and minor.

5.16.5 No-Action Alternative

The No-Action Alternative will not directly impact streams or protected riparian buffers as no construction or other activities are involved in the No-Action Alternative. Minor, indirect and cumulative impacts are anticipated to occur as a result of the growth and development expected in the service area regardless of the alternative chosen for the proposed project.

5.17 Environmental Justice

Populations that are covered by the Executive Order regarding environmental justice are discussed relative to three categories: minority populations, low-income populations, and potentially underserved populations. Minority and low-income populations are identified where the percentage exceeds the state average to document any disparity in the location and provision of water treatment and transmission facilities between the general population and the minority and/or low-income populations. A disproportionate impact to a minority or low-income population may occur where such populations comprise more than 50 percent of the total population. Potentially underserved populations are identified in accordance with the Charter of the DEQ Secretary's Environmental Justice and Equity Advisory Board (2022b).

5.17.1 Minority Populations

5.17.1.1 Alternative 1

The water main corridor associated with Alternative 1 traverses three census tracts that have minority populations greater than the North Carolina state average of 31.3 percent. Additionally, the proposed WTP expansion at Dempsey E. Benton WTP is located within a census tract with a minority population greater than the North Carolina state average. The water main corridor is routed along existing roadways through the census tracts. Therefore, temporary impacts to residents of the census tracts along the pipe corridor, regardless of minority status, are expected to be short-term and minor. The proposed WTP expansion will occur entirely within the existing WTP parcel and will result in short-term, temporary, minor impacts. As the minority populations of the census tracts traversed by the alternative are each below the analysis threshold of equal to or greater than 10 percent higher than the population percentage of the state or county in which

the census tract is located none of the anticipated impacts of the alternative will represent a disproportionate impact to minorities.

5.17.1.2 Alternative 2

The water main corridor associated with Alternative 2 follows the boundary of three census tracts with a minority population greater than 10 percent higher than the Johnston County average of 22.8 percent, specifically census tracts 403.01 (44.4 percent), 403.02 (43.0 percent), and 407 (33.7 percent). The water main corridor is routed along existing roadways through the three census tracts. No above ground infrastructure is proposed within the three census tracts. Therefore, temporary impacts to residents of the census tracts along the pipe corridor, regardless of minority status, are expected to be short-term and minor. None of the anticipated impacts of the alternative will represent a disproportionate impact to minorities.

5.17.1.3 Alternative 3

The census tracts in which the reservoir, WTP, pump station, and water main corridor associated with Alternative 3 are proposed to be sited have minority populations that are less than the state average and below the analysis threshold. No disparity in the location of water treatment and transmission facilities or in the provision of drinking water will result from implementation of Alternative 3. None of the proposed infrastructure will have a disproportionate direct, indirect, or cumulative impact on a minority population.

5.17.1.4 Alternative 4

Similar to Alternative 1, the water main corridor associated with Alternative 4 follows the boundary of one census tract with a minority population greater than the North Carolina state average of 31.3 percent, specifically census tract 709.04 (41.1 percent). The percentage of the population of census tract 709.04 is below the analysis threshold. The water main corridor is routed along existing roadways through the census tract. Therefore, temporary impacts to residents of the census tract along the pipe corridor, regardless of minority status, are expected to be short-term and minor. As the minority populations of the census tract traversed by the alternative are each below the 50-percent threshold, none of the anticipated impacts of the alternative will represent a disproportionate impact to minorities.

5.17.1.5 Alternative 5

The WTP expansion and water main corridor associated with Alternative 5 encroach on one census tract that has a greater minority population than the state average. The water main corridor enters and the WTP expansion is located within census tract 707 (45.2 percent), of which the minority population percentage exceeds the analysis threshold. The WTP expansion is expected to occur within the existing WTP parcel and adjacent to the existing facilities, and the segment of water main corridor within census tract 707 will be located within the WTP property. The parcels adjacent to the WTP are mostly buffered by existing trees, which will reduce the impact to residents on abutting parcels. Therefore, temporary impacts to residents of the block group, regardless of minority status, are expected to be short-term and minor. Permanent impacts are expected to be negligible to minor and consistent with the existing baseline conditions. Due to the

nature, extent, and duration of the anticipated impacts, the alternative will not represent a disproportionate impact to minorities.

5.17.1.6 Alternatives 6 and 7

The infrastructure associated with Alternatives 6 and 7 crosses three census tracts with minority populations greater than the state average. The minority populations of the three census tracts are below the analysis threshold. The water main corridor associated with this alternative is routed through or along the edge of these three census tracts, and the proposed WTP is located within one of the three census tracts. The percent minority populations in these three census tracts range from 31.7 to 37.3 percent. The water main corridor is routed along existing roadways through the census tracts, and the proposed WTP is sited in a forested area adjacent to an agricultural field. Therefore, direct impacts to the residents of these block groups are expected to be short-term and minor. No disproportionate direct, indirect, or cumulative impact to minority populations will occur under Alternative 6 or 7.

5.17.1.7 Common Elements of Alternatives 8A, 8B, 9A, 9B, 9C, and 9D

The census tracts in which the WTP, WWTP expansion, raw water intake, effluent discharge, and pipe corridor associated with Alternatives 8A and 8B are proposed to be sited have minority populations that are less than the state average and below the analysis threshold. The census tracts in which the booster pump station and pipe corridors associated with Alternatives 9A, 9B, 9C, and 9D and the effluent discharges associated with Alternatives 9C and 9D are proposed to be sited also have minority populations that are less than the state average and below the analysis threshold. No disparity in the location of water treatment and transmission facilities or in the provision of drinking water will result from implementation of Alternative 8A, 8B, 9A, 9B, 9C, or 9D. None of the proposed infrastructure will have a disproportionate direct, indirect, or cumulative impact on a minority population.

5.17.1.8 Alternative 10

Eleven census tracts within the well field have minority populations in excess of the state average. Census tracts 707 and 709.04 in Harnett County and census tracts 528.01, 528.02, 528.08, 530.08, 530.09, 532.04, 532.06, 532.07, and 534.20 in Wake County have minority populations that range from 31.7 to 45.2 percent. One census tract in the well field has a minority population percentage above the analysis threshold for consideration of possible disproportionate impacts to a minority population, specifically census tract 707. Census tract 707 is located along the edge of the well field area and is not expected to be impacted directly. Potential temporary impacts to the residents of the census tract include minor transportation effects due to road or lane closures on roads to the north during construction of the well field and associated piping.

The placement of permanent groundwater wells in these areas has the potential for moderate permanent impacts to the populations of these block groups, dependent upon the final siting and proximity to homes and residential areas. The potential impacts range from short-term to long-term and may be beneficial or adverse. The property owners may experience a short-term financial benefit from the sale of land to the Town of Fuquay-Varina to provide a location for a cluster of wells. The short-term benefit may be followed by a long-term, adverse impact due to the financial loss resulting from the lack of income from farming or

timbering the sold land. Farm workers who currently work the fields of farms in the well field area may experience a short-term financial loss if the farm(s) are sold to the Town of Fuquay-Varina. As the well field requirement is approximately 8,500 acres, the impacts will affect a large number of property owners, farm workers, and their families. The impact to individual families will vary in intensity, likely ranging from minor to major based on a number of variables.

The water mains associated with transport of the raw groundwater from the individual wells to the proposed WTP will be sited as the individual well locations are selected and secured. The water mains will be laid out within the well field area. As such, additional minor, temporary impacts during installation of the water mains are expected across the well field area.

The WTP associated with Alternative 10 is located in census tract 529.04, which has a minority population percentage of 25.2 percent. The WTP is located in an area the is predominantly rural residential and agricultural. Impacts to the population due to the WTP are anticipated to be negligible. The block group's minority population percentage is below the threshold of disproportionate impacts. The Alternative 10 transmission lines and WTP will not have a disproportionate direct, indirect, or cumulative impact on a minority population.

5.17.1.9 No-Action Alternative

The No-Action Alternative carries the risk of the Town of Fuquay-Varina losing its water supply if a current provider of drinking water does not renew the existing temporary contract to sell water to the Town or if the Town's water demand exceeds the total capacity available to the Town from their current water providers. One census tract within the SDSA contains a minority population percentage that is higher than the state average but below the analysis threshold. The No-Action Alternative will not have a disproportionate direct, indirect, or cumulative impact on the minority population.

5.17.1.10 Service Demographic Study Area

All alternatives provide drinking water to the same service area. The SDSA includes one census tract with a minority population percentage that is greater than the state average but less than the analysis threshold. Water service provided to the minority population is and will continue to be the same as the water service to areas without a predominantly minority population. Provision of water service under the proposed alternatives does not present a disparity between minority and non-minority populations.

5.17.1.11 Watershed Demographic Service Area

Analysis of the WDSA is focused on the effect of the proposed project on the availability of raw water supply volume for water utility customers that rely on the Cape Fear River downstream of project alternatives. The environmental justice analysis is performed with respect to Alternatives 4, 5, 6, 7, 9A, and 9B in comparison to Alternative 13 (No Action). Hydrologic modeling of downstream water quantity was conducted and is summarized in Appendix F. The modeling demonstrates that the difference in flow in the Cape Fear River at the raw water intake for the Town of Lillington and at the analysis location in Fayetteville is approximately 2 percent for each of the evaluated alternatives in comparison to the No-Action Alternative. The difference is

negligible and does not present a threat of inadequate water availability for downstream users, regardless of minority status. Therefore, no direct, indirect, or cumulative impact that is disproportionate to minority populations that rely on the Cape Fear River downstream of the proposed alternatives will occur as a result of the construction of Alternatives 4, 5, 6, 7, 9A, or 9B.

5.17.2 Low-Income Populations

5.17.2.1 Common Elements of Alternatives 1, 3, 6, 7, 9A, 9B, and 9D

Infrastructure associated with Alternatives 1, 3, 6, 7, 9A, 9B, and 9D is not proposed to be located within any census tract with a low-income population greater than the state average. No disparity in the location of water treatment and transmission facilities or in the provision of drinking water will result from the implementation of these alternatives. Therefore, no direct, indirect, or cumulative impact that is disproportionate to low-income populations will occur as a result of the construction of Alternatives 1, 3, 6, 7, 9A, 9B, or 9D.

5.17.2.2 Alternative 2

Alternative 2 raw water mains traverse one census tract (405) and is sited along the edge of three census tracts (403.01, 403.02, and 407) that have a low-income population percentage greater than the state average. The proposed raw water intake on the Neuse River and the raw water storage facility are located in census tracts (405 and 413) with a low-income population percentage greater than the state average. The noted census tracts have low-income population percentages that range from 16.2 to 36.1 percent. Census tracts 403.01 and 413 have low-income population percentages equal to or greater than the analysis threshold. The raw water storage facility will constitute re-purpose of an existing quarry and will therefore reduce the operational effects on the surrounding residents, regardless of income status. The raw water intake is located adjacent to the census tract 413 boundary and at an existing roadway bridge over the river with undeveloped forest in the vicinity. No disparity in the location of water treatment and transmission facilities will result from the implementation of Alternative 2. Therefore, no direct, indirect, or cumulative impact that is disproportionate to low-income populations will occur as a result of the construction of Alternative 2.

5.17.2.3 Alternative 4

Alternative 4 pipe corridor follows the edge of census tracts 704.02, 708.01, and 709.04 and passes through census tracts 704.01 and 705, which have low-income populations higher than the state low-income population percentage average. The noted census tracts have low-income population percentages that range from 15.5 to 21.9 percent, which are all less than the analysis threshold. The pipe corridor is routed along existing roadways within the low-income census tracts. Impacts to the residents of the census tracts are expected to be short-term and minor.

The proposed raw water intake, raw water storage facility, associated pump stations, and WTP expansion are located in census tract 705 near the boundary with census tract 704.01. The WTP, raw water intake and storage facility, and pump stations associated with this alternative are located in and abutting the existing

WTP property within this census tract. Minor impacts to the private property owner of the parcel on which the raw water storage facility is proposed due to the initial income associated with the purchase of the property (beneficial effect) and due to loss of future income from the reduction in acreage of farmland (adverse effect). Negligible impacts to the remaining residents of the census tract are anticipated as a result of the expanded WTP construction and operation.

None of the census tracts in which Alternative 4 infrastructure is proposed has a low-income population percentage equal to or greater than the analysis threshold. As the low-income population of the aforementioned census tracts is below the threshold for a disproportionate impact, Alternative 4 is not anticipated to disproportionately directly, indirectly, or cumulatively impact a low-income population.

5.17.2.4 Alternative 5

The Alternative 5 pipe corridor passes through census tract 708.01, which has a low-income population higher than the state low-income population percentage average of 14.7 percent. Approximately 20.5 percent of the population of the census tract is low-income. The water main corridor is routed along existing roadways through the census tract. Therefore, impacts to the residents of the census tract are expected to be short-term and minor as a result of installation of the water main.

The new raw water intake and WTP expansion associated with this alternative are located in a non-residential area within census tract 707, which has a low-income population of 16.9 percent. These project components are anticipated to be constructed within the existing WTP property. Impacts to the population due to these elements are anticipated to be negligible. As the low-income population of the aforementioned census tract is below the analysis threshold for a disproportionate impact, Alternative 5 is not anticipated to disproportionately directly, indirectly, or cumulatively impact a low-income population.

5.17.2.5 Common Elements of Alternatives 8A, 8B, and 9C

Alternatives 8A, 8B, and 9C pipes pass through or along the border of two census tracts with low-income populations greater than the state average of 14.7 percent. The two census tracts noted are 708.01 and 708.02, which have low-income populations of 20.5 and 29.3 percent, respectively. Census tract 708.02 has a low-income population percentage that exceeds the analysis threshold. The water main corridor is routed along existing roadways near the southwestern boundary of census tract 708.02. Therefore, impacts to the residents of the census tract due to the water main are anticipated to be short-term and minor.

The wastewater allocation expansion under Alternative 8A is associated with the effluent discharge volume permitted from the existing North Harnett WWTP. The North Harnett WWTP is located within census tract 707, which has a low-income population of 16.9 percent. No increase in wastewater treated at the North Harnett WWTP is proposed under Alternative 8A, as the wastewater is proposed to be treated to effluent standards at the Terrible Creek WWTP, located in a census tract with a lower percentage of low-income residents than the state average. The expansion of the wastewater allocation is proposed to be located in a nonresidential area. The state's standards for water quality of treated effluent being discharged into surface waters will apply to the effluent discharge under Alternative 8A. Therefore, impacts to the population due to these elements are anticipated to be negligible.

The alternative options are sited within three census tracts with low-income population percentages that are greater than the state average. For alternatives 8A and 8B, the raw water intake is proposed to be located in the Neuse River adjacent to a wooded area. The intake and a short length of raw water main traverse a small portion of a census tract with a low-income population of concern. The pipeline associated with alternative 9C also traverses a small portion of census tract 708.02. The pipeline is situated in the median of an existing roadway and then traverses timberland and agricultural fields. Temporary impacts during construction are anticipated to affect traffic and agricultural activities within the census tract. Alternatives 8A, 8B, and 9C will not disproportionately directly, indirectly, or cumulatively impact a low-income population.

5.17.2.6 Alternative 10

The well field associated with Alternative 10 includes all or a portion of eleven census tracts with low-income populations greater than the state average of 14.7 percent. The eleven census tracts are 412.01, 414, 528.02, 528.09, 704.01, 704.02, 707, 708.01, 708.02, 709.04, and 711.01. The low-income populations of these eleven census tracts range from 15.7 to 29.3 percent. Census tracts 414 and 708.02 exceed the analysis threshold for a disproportionate impact. The northwestern most portion of census tract 414, which is in the well field area, consists of stream valleys, agricultural lands, and two small pockets of residential use. The portion of census tract 708.02 that is located in the well field area consists of stream valleys, agricultural lands, solar farms, a portion of the Campbell University campus, rural residential, and high-density residential.

The placement of permanent groundwater wells in these areas will permanently impact the populations of these census tracts. The extent of the impact is dependent on the final siting and proximity to homes and residential areas. The potential impacts range from short-term to long-term and may be beneficial or adverse. The property owners may experience a short-term financial benefit from the sale of land to the Town of Fuquay-Varina to provide a location for a cluster of wells. The short-term benefit may be followed by a long-term, adverse impact due to the financial loss resulting from the lack of income from farming or timbering the sold land. Workers who currently work the fields of farms in the well field area may experience a short-term financial loss if the farm(s) are sold to the Town of Fuquay-Varina. As the well field requirement is approximately 8,500 acres, the impacts will affect a large number of property owners, farm workers, and their families. The direct, indirect, and cumulative impact to individual families will vary in intensity, likely ranging from minor to major based on a number of variables.

The WTP associated with Alternative 10 is located in census tract 529.04, which has a low-income population of 8.8 percent. The water main corridor is expected to be routed along existing roadways within the well field and will be located entirely within the well field. Impacts to the residents of the census tracts due to the water main corridor are expected to be short-term and minor. The low-income population of each of the well field census tracts is below the threshold of disproportionate impacts. Therefore, no direct, indirect, or cumulative impact that is disproportionate to low-income populations will occur as a result of the construction of the transmission line corridor and transmission line associated with Alternative 10.

5.17.2.7 Watershed Demographic Study Area

Within the WDSA, seven census tracts have a low-income population percentage that exceeds the 50-percent threshold for analysis of disproportionate effects, ranging from 50.6 to 75.2 percent. The effect of the proposed withdrawal of water from the Cape Fear River basin on the water volume available to downstream communities that rely on the Cape Fear River as their source of water is negligible. Compared to the baseline condition effect on water quantity at the raw water intakes for the Town of Lillington and the City of Fayetteville for the year 2055, the proposed alternatives that constitute a net IBT from the Cape Fear River Basin to the Neuse River Basin will reduce the water quantity at the aforementioned intakes by less than 2 percent of the river volume in 2055 (Appendix F). The impact will be negligible regardless of the demographic profile of the respective service areas. The IBT alternatives are not anticipated to disproportionately directly, indirectly, or cumulatively impact a low-income population.

5.17.2.8 No-Action Alternative

The No-Action Alternative will not affect the existing low-income populations in the project area. The No Action Alternative will not alter the availability of drinking water available to persons who are currently served by the Town of Fuquay-Varina. However, population in the Town of Fuquay-Varina who do not currently have drinking water supplied by the Town will likely not be added to the Town's service area.

5.18 Introduction of Toxic Substances

5.18.1 Groundwater

5.18.1.1 Common Elements to Alternatives

Temporary direct impacts to groundwater may occur as a result of construction of any of the alternatives. Excavation of the trench and pit for the installation of the proposed transmission line, pump station and booster pump station elements; WTPs and WTP and WWTP expansions; and reservoir construction may result in groundwater being encountered and therefore impacted during construction. These temporary direct impacts to groundwater are anticipated to be negligible and adverse. Negligible indirect and cumulative impacts to groundwater due to growth and development are anticipated to occur.

5.18.1.2 Alternatives 1, 2, 3, and 4

Alternatives 1 through 4 include raw water storage facilities in the Neuse River basin. Alternatives 1 and 3 include creating a reservoir along portions of Middle Creek. Alternative 2 includes using a rock quarry as a storage facility, and Alternative 4 includes construction of a raw water storage facility in proximity to the A.B. Uzzle WTP and new raw water intake on the Cape Fear River. Hydraulic and hydrologic modeling to assess the localized increased groundwater recharge in the raw water storage areas has not been performed. The impacts are expected to be permanent, direct, minor, and positive.

5.18.1.3 Alternative 10

Alternative 10 includes the development of a groundwater extraction well field. Approximately 8,500 acres of land would be required to yield the required volume of water. The well field encompasses portions of four counties, Wake, Chatham, Harnett and Johnston Counties, and most of the well field area does not currently have water and sewer service. Therefore, the residents and businesses in the proposed well field area rely on private and community groundwater wells, which will be adversely affected by the development and operation of the proposed well field. Additionally, operation of the proposed well field is expected to result in a significant reduction in the availability of groundwater for non-extraction related uses, including groundwater discharge into streams and wetlands. Although the precise calculation of impacts due to the implementation of Alternative 10 would require hydraulic and hydrologic modeling, the impacts of the alternative are anticipated to be permanent, adverse, major, and direct. Indirect and cumulative impacts to groundwater due to growth and development are anticipated to be permanent, adverse, and major.

5.18.1.4 No-Action Alternative

The No-Action Alternative involves no excavation or withdrawal of groundwater. Therefore, existing groundwater resources will not be affected by the implementation of the No-Action Alternative. Growth and development in the service area is expected to occur, even with implementation of the No-Action Alternative. Without a build alternative, future growth and development will likely rely on private and/or community groundwater wells. Additional use of groundwater will occur, and minor indirect and cumulative impacts to groundwater due to growth and development are anticipated to occur.

5.18.2 Common Elements to All Alternatives

Impacts from construction activities associated with the proposed alternatives are anticipated to be direct, minor, adverse, and temporary. A short-term cumulative increase in storage and use of hazardous and toxic materials, and generation and disposal of hazardous waste will occur during construction activities associated with all the project alternatives. Potential sources of toxic substances during construction may include exhaust emissions, oil, fuel, and other vehicle fluids. Escape of these substances will be minimized by proper vehicle maintenance, collection, and disposal of fluid containers. Contractors will be instructed to take precautions to ensure that uncured concrete is not allowed to contact surface waters.

Long-term operation of treatment facilities, well fields, pump stations, and transmission mains will have a negligible, long-term, direct and cumulative impact on the use, generation, and disposal of hazardous and toxic materials and substances. The hazardous and toxic materials will be handled, stored, used, and disposed of in accordance with applicable state and federal requirements during construction activities, and during operation of treatment facilities, well field, pump stations, and transmission lines.

Development will increase the amount of traffic and urban uses in the service area, which will increase stormwater runoff. Urban stormwater runoff contains pollutants, sediment and silt, nitrogen and phosphorus from lawn fertilizers, oils and greases, road salts, and pesticides and herbicides. Long-term impact of an increase in urban stormwater runoff could lead to declines in water quality if proper protective measures are not in place.

Permanent impacts are expected to be direct, minor, and adverse. Minor indirect and cumulative impacts to soils from anticipated growth and development in the service area are expected to occur.

5.18.3 No-Action Alternative

The No-Action Alternative does not include construction activities or operation of treatment facilities, a well field, transmission mains, or pump stations. Therefore, the use and storage of hazardous or toxic materials, or generation and disposal of hazardous waste will not occur. Minor indirect impacts are anticipated to occur as a result of the growth and development in the service area regardless of the alternative chosen for the proposed project.

6. Mitigative Measures to Address Direct and Indirect Impacts

Direct, indirect, and cumulative environmental impacts have the potential to occur as the result of implementation of a project alternative. Direct impacts are defined as impacts that are caused by an action at the same time and place. Secondary impacts are defined as the impacts that are reasonably foreseeable from growth and development induced or supported by an infrastructure project. Cumulative impacts are environmental impacts resulting from the incremental effects of an activity when added to other past, present, and reasonably foreseeable future activities.

No communities are anticipated to be served outside of the Town of Fuquay-Varina. Existing local, state, and federal programs and ordinances will mitigate the potential for direct and indirect impacts from the proposed action. An alphanumeric EIS key was assigned to each mitigation reference based upon the corresponding jurisdictional authority. The EIS keys are summarized in Table 6-1.

A detailed summary of programs is provided in Table 6-2. Stormwater, floodplain, riparian buffer, erosion and sedimentation control, wetland protection, open space and parks, water use, land use, historic preservation, tree preservation, endangered species protection, and regional transportation planning measures are discussed. An ordinance or reference is provided for each program, plan, ordinance, or rule. A description of the mitigative aspects of each ordinance or reference is also provided.

Table 6-1: EIS Key Identifiers by Jurisdictional Authority

Jurisdictional Authority	EIS Key Identifier
Town of Fuquay-Varina	A
Wake County	B
State of North Carolina	S
United States	U

Table 6-3 provides a summary of the anticipated direct and indirect environmental impacts associated with the project alternatives by environmental resource. Relevant local, state, and federal ordinances that mitigate the potential environmental impact are referenced by the assigned EIS key. The evaluated environmental resources include topography and floodplains, soils, land use, wetlands, prime or unique farmland, public lands, areas of archaeological or historic value, air quality, noise levels, surface water resources, groundwater resources, forest resources, shellfish or fish and habitats, wildlife and natural vegetation, and the introduction of toxic substances. The Town of Fuquay-Varina's current programs, policies, and ordinances meet the intent of General Statute § 143-215.22L.

As described and defined in Section 5 of this EIS, environmental resource impacts were evaluated as either temporary or permanent and then rated into one of four categories: negligible, minor, moderate, or major. Table 6-3 summarizes the most conservative potential impacts for each environmental resource as a result

of implementing one or more project alternatives. Per the discussion provided in Section 5, the following definitions were used in evaluating the impacts from each alternative:

- Temporary impact: A temporary impact is an impact that is not expected to persist more than one year following completion of construction.
- Permanent impact: An impact that is expected to last longer than one year after completion of construction.
- Negligible impacts: Negligible impacts are not detectable or are slight.
- Minor impacts: Minor impacts are measurable but are clearly not significant.
- Moderate impacts: Moderate impacts are those whose effects may require additional care, employment of BMPs, application of precautionary measures to minimize adverse impacts, or have some uncertainty inherent in whether the effects forecast by a predictive model would occur.
- Major impacts: Major impacts are clearly noticeable and severely adverse or exceptionally beneficial.

Table 6-2: Summary of Federal, Local, and State Programs and Ordinances for Town of Fuquay-Varina

Topic	EIS Key	Ordinance or Reference	Description
Stormwater	A.1	LDO § 9-1405	• NPDES MS4 and Urbanizing Areas Stormwater Requirements.
	A.2	Final Stormwater Management Plan – Town of Fuquay Varina (NCS000504)	• MS4 Information provided. • Stormwater management program administration. • Public education and outreach programs and public involvement and participation. • In accordance with 15A NCAC O2H .0153, the Town of Fuquay-Varina relies upon the North Carolina Sedimentation Pollution Control Act (SPCA) of 1973 and the NCG010000 permit for construction activities as qualifying alternative programs to meet the NPDES MS4 Permit requirements for all construction site runoff control measures to reduce pollutants in stormwater runoff from construction activities. • This SWMP identifies the minimum elements to develop, implement and enforce a program to address stormwater runoff from new development and redevelopment projects that disturb greater than or equal to one acre, including projects less than one acre that are part of a larger common plan of development or sale, that are located within the Town of Fuquay-Varina and discharge into the MS4. These elements are designed to minimize water quality impacts utilizing a combination of structural Stormwater Control Measures (SCMs) and/or non-structural BMPs appropriate for the community and ensure adequate long-term operation and maintenance of SCMs. • In accordance with 15A NCAC 02H .0153 and .1017, the Town of Fuquay-Varina implements the following State post-construction program requirements, which satisfy the NPDES Phase II MS4 post-construction site runoff control requirements as Qualifying Alternative Programs (QAPs) in the MS4 area(s) where they are implemented
	S.1	NPDES MS4 and Urbanizing Areas: Post-Construction Requirements 15A NCAC 02H .1017	• (Tipped Counties) MS4 and Urbanizing Areas Post-Construction Requirements o Trigger for review: ≥ 1 acre disturbance o Low Density Project: < 24% impervious or > 2 du/acre, requires infiltration practices (See 15A NCAC 02H .1003(2)) o High Density Project: 24% impervious or > 2 du/acre, requires structural control (See 15A NCAC 02H .1003(3)) o Treat first 1 inch of rainfall - 85% TSS removal o Control 1-year, 24-hr storm • DEMLR enforced and implemented

Table 6-2: Summary of Federal, Local, and State Programs and Ordinances for Town of Fuquay-Varina

Topic	EIS Key	Ordinance or Reference	Description
Floodplain	A.3	LDO § 9-1401	• Residential construction. New construction and substantial improvement of any residential structure shall have the reference level no lower than the "regulatory flood protection elevation." • Nonresidential construction. New construction and substantial improvements of any nonresidential structure shall have the reference level, including basement, elevated no lower than the "regulatory flood protection elevation." Structures located in Flood Zones may be floodproofed to the regulatory flood protection elevation in lieu of elevation provided that all areas of the structure below the regulatory flood protection elevation are watertight. • Floodplain development permit shall be required prior to commencement of any development activities within special flood hazard areas and future conditions flood hazard areas. • Requirements are similar to FEMA
Erosion and Sedimentation Control	S.2	N.C. Erosion and Sedimentation Control 15A NCAC 04B	• Program implemented and enforced by DEMLR.
	A.4	LDO § 9-1407	• Whenever land disturbing activities disturb more than one acre on a tract, an approved erosion and sedimentation control plan and land disturbance permit is required. Any person conducting a land disturbing activity must install erosion and sedimentation control devices. • All soil erosion and sedimentation control plans and measures must conform to the minimum applicable standards specified in the most current North Carolina's Erosion and Sediment Control Planning and Design Manual and the most current Town's Standard Specifications & Construction Details.
Riparian Buffer	A.1	LDO § 9-1405	• Any development within the Neuse River Basin shall comply with the North Carolina DEQ's Nutrient Sensitive Waters Management Strategy: Protection and Maintenance of Riparian Buffers. The Town of Fuquay-Varina shall be provided with approval by DEQ prior to any regulated disturbance, including submittal of copies of required, approved permits.
	S.3	Neuse River Basin: Nutrient Sensitive Waters Management Strategy: Protection and Maintenance of Existing Riparian Buffers 15A NCAC 02B .0714	• The rules require a 50-foot riparian buffer that is divided into two zones. • The 30 feet closest to the water (Zone 1) must remain undisturbed. The outer 20 feet (Zone 2) can be managed vegetation. • The riparian buffer must remain undisturbed, regardless of property size or type of land use, unless the use is listed in the rules as exempt, potentially allowable or potentially allowable with mitigation. • Diffuse flow is required on all buffered streams, regardless of property size or type of land use. It must be achieved before stormwater runoff enters the riparian buffer from any new ditch or manmade conveyance

Table 6-2: Summary of Federal, Local, and State Programs and Ordinances for Town of Fuquay-Varina

Topic	EIS Key	Ordinance or Reference	Description
Wetland Protection	A.5	LDO § 9-1452	• Environmental protection. Lots in a conventional subdivision with 20,000 square feet or less, including both major and minor subdivision, shall contain a maximum of 50 percent of land area within environmentally sensitive features, including floodplain, flood hazard soils, wetlands, riparian buffer areas or intermittent streams, in compliance with Article I Environmental Protection Standards.
	U.1	Clean Water Act § 401 and 404	• USACE permit required for any activity that includes a disturbance of wetlands or streams and for any activity that may result in a discharge to the waters of the U.S.
Open Space / Parks	A.6	Comprehensive Systemwide Parks, Recreation & Cultural Resources Master Plan	• Formal planning document established to preserve the economic, social, and environmental value of parks in the town.
	A.7	LDO § 9-1713	• All site plans, preliminary subdivision plats and phased development plans, except in the Downtown Center-1 and Downtown Center-2 Districts, Residential Mixed-Use District, Neighborhood Mixed-Use District and Urban Mixed-Use District, shall provide a landscaped buffer type transition between different uses, which have separate standards for landscaping and buffers, in accordance with the following "use type" categories. • Landscaping, vegetative buffer, and screening requirements between residential/commercial areas and public areas o Industrial land use requires 20-foot “ST” buffer between public streets o Residential land use requires 5- or 10-foot buffer between public street, depending on land use class.
Water Use	A.8	2035 Community Vision Land Use Plan	• Established strategies to reduce water consumption and use water resources wisely o Encourage site-level water conservation tools and techniques o Implementing Inflow and Infiltration Improvements o Discussion surrounding extending water and sewer service area.
	A.9	Code of Ordinances § 5-1031	• Will be subject to the requirements of Article C – Water Shortages & Conservation which purpose is to implement permanent seasonal water conservation measures, provide for the declaration of increasingly serious stages of water shortages and to define mandatory water conservation measures.
	A.14	----	• Per Section 3.14, the Town of Fuquay-Varina has implemented an AMR system for real-time leak detection. The Town commits $500,000 every year for waterline replacement. • The Town of Fuquay-Varina has developed and supports an online services webpage to allow customers to view consumption and receive detailed reports on daily consumption and notifications of high use periods.

Table 6-2: Summary of Federal, Local, and State Programs and Ordinances for Town of Fuquay-Varina

Topic	EIS Key	Ordinance or Reference	Description
Land Use	A.8	2035 Community Vision Land Use Plan	• Includes goals, policies, strategies, and an implementation plan to manage and direct growth • 2040 Community Vision (Draft) to be adopted third quarter 2022
	A.10	LDO § 9-1403	• Watershed Protected Area (WS-IV(PA)) • Uses Permitted. o Agriculture uses. Subject to the provisions of the Food Security Act of 1985 and the Food, Agricultural, Conservation & Trade Act of 1990. o Silviculture uses. Subject to the provisions of the Forest Practices Guidelines Related to Water Quality (15 NCAC 11.6101-.0209). o Residential uses. i. Single-family residential development. A single-family residential development shall not exceed two dwelling units per acre. No residential lot shall be less than one-half acre or one-third acre for projects without a curbed and guttered street systems, except within an approved open space development ii. All other residential developments shall not exceed 24 percent built-upon area for each development. For developments without a curbed and guttered street system, the development shall not exceed 36 percent built-upon area for each development.
Historic Preservation	B.1	Wake County Historic Preservation Commission	• Member of Joint Commission dedicated to the conservation of historic districts and landmarks
	A.11	LDO § 9-1004	• Promoting rehabilitation and reuse of older buildings and protecting historic buildings, sites and land that preserve the heritage of the Town and its citizens.
Tree Preservation	S.4	Session Law 2001-191 House Bill 910	• An act authorizing the City of Durham and the Towns of Cary, Garner, Morrisville, Knightdale, Fuquay-Varina, and Spencer to limit the clear-cutting of trees in buffer zones prior to development and allow for the protection of specimen trees during the development process.
	A.12	LDO § 9-1406	• Prior to any execution of a forest management plan or clear-cutting operation, the property owner/developer shall submit a general location map of existing heritage tree(s) within the perimeter buffer area to the Town. • For each heritage tree that must be removed, the landscaping plan shall include one shade tree, three-inch caliper minimum, for every ten inches of heritage tree caliper removed, and must be in addition to and supplement the street tree planting. • As an alternative, if an existing heritage tree is preserved for each heritage tree that is removed within the perimeter buffer area or within the site, then the replacement requirement shall not apply.

Table 6-2: Summary of Federal, Local, and State Programs and Ordinances for Town of Fuquay-Varina

Topic	EIS Key	Ordinance or Reference	Description
	A.13	LDO § 9-1702	• All areas of a zoning lot or parcel of land not covered by parking, drives, streets or structures shall consist of existing plant material where possible, foundation planting, natural areas, bio retention structures, trees, buffers, grass or other similar improved landscaping in accordance with this article and the Town's Standard Specifications & Construction Details.
Regional Transportation Planning	B.2	Wake Transit Plan: A Wake County Transit Investment Strategy Report	• Multi-community regional and integrated multimodal transportation plan with the purpose of adequately serving the transportation needs of the communities while minimizing direct and cumulative impacts
Endangered Species	U.2	Federal Endangered Species Act	• Prevents the harming of federal endangered and threatened animals and plants and their habitats
	A.2	Final Stormwater Management Plan – Town of Fuquay Varina (NCS000504)	• Significant populations of threatened or endangered species and/or critical habitat are not identified within the regulated MS4 urbanized area. The list of species that may be impacted by the quality of surface waters within their habitat is listed below: o Cape Fear Shiner o Red-cockaded Woodpecker o Atlantic Pigtoe o Michaux's Sumac o Southern Hognose Snake o Bog Spicebush o Carolina Madtom o Neuse River Waterdog o Yellow Lance o Dwarf Wedgemussel o Green Floater

Table 6-3: Areas of Potential Impacts to be Addressed by Permitting and Mitigation Programs

Environmental Resource	Alternative	Direct Potential Impact	Indirect and Cumulative Impact Potential	Types of Potential Impacts	Mitigation Program	EIS Key
Topography and Geology	No-action	None	Minor	Direct: • Temporary impacts during construction of raw water collection system and transmission lines • Permanent impacts from grading at pump stations, intakes, access roads, and WTP site • Permanent impacts from construction of dam or berms for a raw water storage facility or reservoir Indirect: • Topography changes from development	Floodplain Protection Riparian Buffer Protection Open Space / Parks	A.3 A.1 A.6, A.7
	Alt 1	Major	Minor			
	Alt 2	Minor	Minor			
	Alt 3	Major	Minor			
	Alt 4	Minor	Minor			
	Alt 5	Minor	Minor			
	Alt 6	Minor	Minor			
	Alt 7	Minor	Minor			
	Alt 8A	Minor	Minor			
	Alt 8B	Minor	Minor			
	Alt 9A/9B	Minor	Minor			
	Alt 9C	Minor	Minor			
	Alt 9D	Minor	Minor			
	Alt 10	Minor	Minor			
Soils	No-action	None	Minor	Direct: • Temporary from land clearing and construction activities • Permanent impacts at pump stations, intakes, access roads, and WTP site • Permanent impact from inundation for raw water storage facility or reservoir Indirect: • Soil erosion from new development	Erosion / Sed Control Open Space / Parks	S.2, A.4 A.6, A.7
	Alt 1	Minor	Minor			
	Alt 2	Minor	Minor			
	Alt 3	Minor	Minor			
	Alt 4	Minor	Minor			
	Alt 5	Minor	Minor			
	Alt 6	Minor	Minor			
	Alt 7	Minor	Minor			
	Alt 8A	Minor	Minor			
	Alt 8B	Minor	Minor			
	Alt 9A/9B	Minor	Minor			
	Alt 9C	Minor	Minor			
	Alt 9D	Minor	Minor			
	Alt 10	Minor	Minor			

Table 6-3: Areas of Potential Impacts to be Addressed by Permitting and Mitigation Programs

Environmental Resource	Alternative	Direct Potential Impact	Indirect and Cumulative Impact Potential	Types of Potential Impacts	Mitigation Program	EIS Key
Land Use	No-action	None	Minor	Direct: • Permanent conversion of agricultural and undeveloped wooded land use for utility easements, pump stations, access roads, and WTP site. • Permanent land inundation for Alternatives 1 and 3. Indirect: • Permanent conversion of agricultural and undeveloped wooded land use to residential and commercial use	Land Use Open Space / Parks	A.8, A.10 A.6, A.7
	Alt 1	Major	Minor			
	Alt 2	Moderate	Minor			
	Alt 3	Major	Minor			
	Alt 4	Moderate	Minor			
	Alt 5	Moderate	Minor			
	Alt 6	Moderate	Minor			
	Alt 7	Moderate	Minor			
	Alt 8A	Moderate	Minor			
	Alt 8B	Moderate	Minor			
	Alt 9A/9B	Moderate	Minor			
	Alt 9C	Moderate	Minor			
	Alt 9D	Moderate	Minor			
	Alt 10	Moderate	Minor			
Public Lands and Scenic, Recreational Areas, and State Natural Areas	No-action	None	None	Direct: • Temporary impacts during construction • Permanent impacts from utility easements • Permanent benefits from creation of new scenic, recreational, and natural lands at raw water storage facility or reservoir Indirect: • Conversion of adjacent land uses	Open Space / Parks	A.6, A.7
	Alt 1	Negligible to Moderate	Minor			
	Alt 2	Negligible to Moderate	Minor			
	Alt 3	Negligible to Moderate	Minor			
	Alt 4	Negligible to Moderate	Minor			
	Alt 5	Negligible to Moderate	Minor			
	Alt 6	Negligible to Moderate	Minor			
	Alt 7	Negligible to Moderate	Minor			
	Alt 8A	Negligible to Moderate	Minor			
	Alt 8B	Negligible to Moderate	Minor			
	Alt 9A/9B	Negligible to Moderate	Minor			
	Alt 9C	Negligible to Moderate	Minor			
	Alt 9D	Negligible to Moderate	Minor			
	Alt 10	Negligible to Moderate	Minor			

Table 6-3: Areas of Potential Impacts to be Addressed by Permitting and Mitigation Programs

Environmental Resource	Alternative	Direct Potential Impact	Indirect and Cumulative Impact Potential	Types of Potential Impacts	Mitigation Program	EIS Key
Prime or Unique Agricultural Land	No-action	None	Minor	Direct: • Temporary impacts during construction • Permanent conversion of agricultural land for utility easements, pump stations, access roads, and WTP site Indirect: • Conversion to other uses	Land Use	A.8, A.10
	Alt 1	Minor	Minor			
	Alt 2	Minor	Minor			
	Alt 3	Minor	Minor			
	Alt 4	Minor	Minor			
	Alt 5	Minor	Minor			
	Alt 6	Minor	Minor			
	Alt 7	Minor	Minor			
	Alt 8A	Minor	Minor			
	Alt 8B	Minor	Minor			
	Alt 9A/9B	Minor	Minor			
	Alt 9C	Minor	Minor			
	Alt 9D	Minor	Minor			
	Alt 10	Minor	Minor			
Areas of Archaeological or Historic Value	No-action	None	Minor	Direct: • Temporary impacts to Erwin Commercial Historic District during construction • Archaeological impacts are possible due to land disturbance Indirect: • Conversion of adjacent land uses	Historic Preservation	B.1, A.11
	Alt 1	Unknown	Minor			
	Alt 2	Unknown	Minor			
	Alt 3	Unknown	Minor			
	Alt 4	Unknown	Minor			
	Alt 5	Unknown	Minor			
	Alt 6	Unknown	Minor			
	Alt 7	Unknown	Minor			
	Alt 8A	Unknown	Minor			
	Alt 8B	Unknown	Minor			
	Alt 9A/9B	Unknown	Minor			
	Alt 9C	Unknown	Minor			
	Alt 9D	Unknown	Minor			
	Alt 10	Unknown	Minor			

Table 6-3: Areas of Potential Impacts to be Addressed by Permitting and Mitigation Programs

Environmental Resource	Alternative	Direct Potential Impact	Indirect and Cumulative Impact Potential	Types of Potential Impacts	Mitigation Program	EIS Key
Air Quality	No-action	None	Minor	Direct: • Temporary increase in emissions during construction Indirect: • Reduction in air quality due to increased traffic • Negative impacts to human health • Reduced visibility	Open Space / Parks Tree Preservation Regional Trans. Planning	A.6, A.7 S.4, A.12, A.13 B.2
	Alt 1	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 2	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 3	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 4	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 5	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 6	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 7	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 8A	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 8B	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 9A/9B	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 9C	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 9D	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 10	Minor (Temporary) and negligible (Permanent)	Minor			

Table 6-3: Areas of Potential Impacts to be Addressed by Permitting and Mitigation Programs

Environmental Resource	Alternative	Direct Potential Impact	Indirect and Cumulative Impact Potential	Types of Potential Impacts	Mitigation Program	EIS Key
Noise	No-action	None	Minor	Direct: • Temporary increase in noise during construction • Permanent increase in noise associated with infrastructure operation Indirect: • Increased overall noise in service area	Open Space / Parks Regional Trans. Planning	A.6, A.7 B.2
	Alt 1	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 2	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 3	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 4	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 5	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 6	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 7	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 8A	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 8B	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 9A/9B	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 9C	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 9D	Minor (Temporary) and negligible (Permanent)	Minor			
	Alt 10	Minor (Temporary) and negligible (Permanent)	Minor			

Table 6-3: Areas of Potential Impacts to be Addressed by Permitting and Mitigation Programs

Environmental Resource	Alternative	Direct Potential Impact	Indirect and Cumulative Impact Potential	Types of Potential Impacts	Mitigation Program	EIS Key
Floodways and 100-year Floodplains	No-action	None	Minor	Direct: • Temporary impacts during construction • Permanent impacts from grading for construction. • Permanent land inundation for Alternatives 1 and 3. Indirect: • Potential loss of 100-year floodplain from development • Isolation of floodplain due to stream channel entrenchment	Floodplain Protection Riparian Buffer Protection Open Space / Parks	A.3 A.1 A.6, A.7
	Alt 1	Moderate	Moderate			
	Alt 2	Minor	Minor			
	Alt 3	Moderate	Moderate			
	Alt 4	Minor	Minor			
	Alt 5	Minor	Minor			
	Alt 6	Minor	Minor			
	Alt 7	Minor	Minor			
	Alt 8A	Minor	Minor			
	Alt 8B	Minor	Minor			
	Alt 9A/9B	Minor	Minor			
	Alt 9C	Minor	Minor			
	Alt 9D	Minor	Minor			
	Alt 10	Minor	Minor			
Wetlands	No-action	None	Minor	Direct: • Temporary impacts during construction to jurisdictional wetlands • Permanent conversion of forested wetlands to non-forested wetlands • Permanent land inundation for Alternatives 1 and 3. Indirect: • Wetland loss via development • Loss of habitat and habitat fragmentation • Loss of attenuation in flow • Loss of wetland function from pollutant loading	Wetland Protection Floodplain Protection Riparian Buffer Protection Stormwater Control	A.5, U.1 A.3 A.1 A.1, A.2, S.1
	Alt 1	Major	Minor			
	Alt 2	Minor	Minor			
	Alt 3	Major	Minor			
	Alt 4	Minor	Minor			
	Alt 5	Minor	Minor			
	Alt 6	Minor	Minor			
	Alt 7	Minor	Minor			
	Alt 8A	Minor	Minor			
	Alt 8B	Minor	Minor			
	Alt 9A/9B	Minor	Minor			
	Alt 9C	Minor	Minor			
	Alt 9D	Minor	Minor			
	Alt 10	Negligible to Major	Minor			

Table 6-3: Areas of Potential Impacts to be Addressed by Permitting and Mitigation Programs

Environmental Resource	Alternative	Direct Potential Impact	Indirect and Cumulative Impact Potential	Types of Potential Impacts	Mitigation Program	EIS Key
Surface Water Resources	No-action	None	Minor	Direct: • Temporary impact from stream crossings during construction • Permanent impact from stream / reservoir withdrawal • Permanent land inundation and potential water quality impacts for Alternatives 1 and 3 • Water quantity impacts are negligible for Alternative 9A/B. • Water quality impacts of a proposed NPDES discharge for Alternatives 9A/B are negligible per Section 5.15 for the Cape Fear. Water quality impacts are negligible for the Neuse River (via the Town of Fuquay-Varina Terrible Creek WWTP) due to the addition of advanced treatment technology at the Sanford WTP to remove PFAS compounds. • Water quality impacts of the NPDES discharge for Alternative 9C will be negligible per Section 5.15. Indirect: • Water quality degradation due to increase in stormwater runoff • Water quality impacts from withdrawal • Alteration of natural hydrograph • Alteration of channel morphology	Floodplain Protection Riparian Buffer Protection Open Space / Parks Erosion / Sed Control Wetland Protection Stormwater Control Land Use Water Conservation	A.3 A.1 A.6, A.7 S.2, A.4 A.5, U.1 A.1, A.2, S.1 A.8, A.10 A.8, A.9, A.14
	Alt 1	Major	Major			
	Alt 2	Minor	Minor			
	Alt 3	Major	Major			
	Alt 4	Minor	Minor			
	Alt 5	Minor	Minor			
	Alt 6	Minor	Minor			
	Alt 7	Minor	Minor			
	Alt 8A	Negligible	Negligible			
	Alt 8B	Negligible	Negligible			
	Alt 9A/9B	Negligible	Negligible			
	Alt 9C	Negligible	Negligible			
	Alt 9D	Negligible	Negligible			
	Alt 10	Minor	Minor			

Table 6-3: Areas of Potential Impacts to be Addressed by Permitting and Mitigation Programs

Environmental Resource	Alternative	Direct Potential Impact	Indirect and Cumulative Impact Potential	Types of Potential Impacts	Mitigation Program	EIS Key
Groundwater Resources	No-action	None	Minor	Direct: • Temporary impact from excavation during construction • Permanent impact from groundwater withdrawal Indirect: • Potential for contamination leading to reduction in use for drinking water • Decrease in groundwater inflow reduces stream base flow, particularly during drought	Land Use	A.8, A.10
	Alt 1	Unknown	Minor			
	Alt 2	Unknown	Minor			
	Alt 3	Unknown	Minor			
	Alt 4	Unknown	Minor			
	Alt 5	Negligible (Temporary)	Minor			
	Alt 6	Negligible (Temporary)	Minor			
	Alt 7	Negligible (Temporary)	Minor			
	Alt 8A	Negligible (Temporary)	Minor			
	Alt 8B	Negligible (Temporary)	Minor			
	Alt 9A/9B	Negligible (Temporary)	Minor			
	Alt 9C	Negligible (Temporary)	Minor			
	Alt 9D	Negligible (Temporary)	Minor			
	Alt 10	Major	Major			
Shellfish or Fish and Habitats	No-action	None	Minor	Direct: • Temporary impacts during construction • Permanent impact from stream withdrawal • Permanent land inundation for Alternatives 1 and 3. Indirect: • Aquatic habitat degradation • Change in stream morphology • Reduction in aquatic diversity • Reduction in long-term population sustainability	Floodplain Protection Riparian Buffer Protection Open Space / Parks Erosion / Sed Control Wetland Protection Stormwater Control Land Use Endangered Species Protection	A.3 A.1 A.6, A.7 S.2, A.4 A.5, U.1 A.1, A.2, S.1 A.8, A.10 U.2, A.2
	Alt 1	Major	Major			
	Alt 2	Minor	Minor			
	Alt 3	Major	Major			
	Alt 4	Minor	Minor			
	Alt 5	Minor	Minor			
	Alt 6	Minor	Minor			
	Alt 7	Minor	Minor			
	Alt 8A	Minor	Minor			
	Alt 8B	Minor	Minor			
	Alt 9A/9B	Minor	Minor			
	Alt 9C	Minor	Minor			
	Alt 9D	Minor	Minor			
	Alt 10	Negligible	Minor			

Table 6-3: Areas of Potential Impacts to be Addressed by Permitting and Mitigation Programs

Environmental Resource	Alternative	Direct Potential Impact	Indirect and Cumulative Impact Potential	Types of Potential Impacts	Mitigation Program	EIS Key
Forest Resources	No-action	None	Minor	Direct: • Permanent conversion to other land uses Indirect: • Conversion to other land uses • Habitat fragmentation • Potential reduction in air quality	Riparian Buffer Protection Open Space / Parks Tree Preservation	A.1 A.6, A.7 S.4, A.12, A.13
	Alt 1	Minor	Minor			
	Alt 2	Minor	Minor			
	Alt 3	Minor	Minor			
	Alt 4	Minor	Minor			
	Alt 5	Minor	Minor			
	Alt 6	Minor	Minor			
	Alt 7	Minor	Minor			
	Alt 8A	Minor	Minor			
	Alt 8B	Minor	Minor			
	Alt 9A/9B	Minor	Minor			
	Alt 9C	Minor	Minor			
	Alt 9D	Minor	Minor			
	Alt 10	Minor	Minor			
Wildlife and Natural Vegetation	No-action	None	Minor	Direct: • Temporary impacts to habitat during construction • Permanent impacts to habitat at pump stations, access roads, and WTP sites • Permanent land inundation for Alternatives 1 and 3. Indirect: • Reduction in habitat • Habitat fragmentation • Reduction in species diversity and tolerance • Reduction in long-term population sustainability	Floodplain Protection Riparian Buffer Protection Open Space / Parks Endangered Species Protection	A.3 A.1 A.6, A.7 U.2, A.2
	Alt 1	Major	Major			
	Alt 2	Minor	Minor			
	Alt 3	Major	Major			
	Alt 4	Minor	Minor			
	Alt 5	Minor	Minor			
	Alt 6	Minor	Minor			
	Alt 7	Minor	Minor			
	Alt 8A	Minor	Minor			
	Alt 8B	Minor	Minor			
	Alt 9A/9B	Minor	Minor			
	Alt 9C	Minor	Minor			
	Alt 9D	Minor	Minor			
	Alt 10	Minor	Minor			

Table 6-3: Areas of Potential Impacts to be Addressed by Permitting and Mitigation Programs

Environmental Resource	Alternative	Direct Potential Impact	Indirect and Cumulative Impact Potential	Types of Potential Impacts	Mitigation Program	EIS Key
Environmental Justice	No-action	Negligible	Negligible	Direct (Temporary and Permanent) and Indirect • Environmental Justice impacts considered to be negligible. The analysis demonstrated no disproportionate impact for direct temporary, direct permanent, or indirect – minority and low-income populations are below the 50-percent threshold,	N/A	N/A
	Alt 1	Negligible	Negligible			
	Alt 2	Negligible	Negligible			
	Alt 3	Negligible	Negligible			
	Alt 4	Negligible	Negligible			
	Alt 5	Negligible	Negligible			
	Alt 6	Negligible	Negligible			
	Alt 7	Negligible	Negligible			
	Alt 8A	Negligible	Negligible			
	Alt 8B	Negligible	Negligible			
	Alt 9A/9B	Negligible	Negligible			
	Alt 9C	Negligible	Negligible			
	Alt 9D	Negligible	Negligible			
	Alt 10	Negligible	Negligible			
Introduction of Toxic Substances	No-action	None	Minor	Direct: • Temporary increase in use of hazardous and toxic materials during construction Indirect: • Increase in likelihood of contamination • Negative impacts to human health	Stormwater Control Land Use	A.1, A.2, S.1 A.8, A.10
	Alt 1	Minor	Minor			
	Alt 2	Minor	Minor			
	Alt 3	Minor	Minor			
	Alt 4	Minor	Minor			
	Alt 5	Minor	Minor			
	Alt 6	Minor	Minor			
	Alt 7	Minor	Minor			
	Alt 8A	Minor	Minor			
	Alt 8B	Minor	Minor			
	Alt 9A/9B	Minor	Minor			
	Alt 9C	Minor	Minor			
	Alt 9D	Minor	Minor			
	Alt 10	Minor	Minor			

7. Preferred Alternative

This EIS provides an assessment of alternatives to meet the project's purpose and need for delivery of a reliable permanent water supply solution to the Town of Fuquay-Varina in a time frame needed for the Town to address their water demand projections. This EIS has also documented the potential technical feasibility, environmental impacts, environmental impacts, environmental justice impacts, and financial impacts of the proposed alternatives. Table 7-1 provides the elements of each alternative as a result of the analysis for this EIS.

The water supply alternatives in the Neuse River basin are not readily implementable for the Town of Fuquay-Varina. Water supply in the Neuse River basin is finite, and several utilities in the Neuse are also investigating solutions for their future water supply needs. Based on the comparison of environmental consequences and associated implementation costs, the Neuse River basin alternatives identified in this EIS have greater cost to implement and present more significant environmental challenges and regulatory hurdles. The Neuse River basin Alternatives 1, 2, and 3 result in a total project cost greater than $0.75 billion.

Only the preferred alternative in the Cape Fear River basin is readily implementable for the Town of Fuquay-Varina. Cape Fear River basin Alternatives 4, 5, 6, 7, and 8 do not meet the Town of Fuquay-Varina's project purpose and need for a reliable permanent water supply source or water supply capacity in a time frame needed for the Town to address the water supply shortfall by 2030. Water supply capacity is fully allocated to the growth and development needs of the proposed water supply purveyors in Alternatives 4 and 5. For Alternatives 6 and 7, it is anticipated that communities with a long-term investment in Jordan Lake water resources planning and infrastructure may receive higher priority in a future allocation process. Alternative 8 will not provide water supply capacity in a time frame needed for the Town of Fuquay-Varina to address their water demand projections.

Alternatives 10, 11, and 12 do not meet or offset the project purpose and need. Water supply capacity via groundwater is not supported by the well yield for Alternative 10 in this region. The use of reclaimed water does not contribute to a substantial offset in potable water use for Alternative 11. Alternative 12 is not available to further offset potable water use.

Alternative 9A/B (Purchase Finished Water from City of Sanford) is the preferred alternative and meets the project purpose and need. The water demand and IBT projections account for water conservation per General Statute § 143-215.22L. The Town of Fuquay-Varina has proposed changes to their water conservation ordinance to be compliant with General Statute § 143-215.22L. Alternative 9A/B was selected as preferred due to fulfilling the project purpose and need, minimal environmental impact, and the least financial impact on the Town of Fuquay-Varina's ratepayers. The Town of Fuquay-Varina's water use metrics are comparable to national trends, are less than regional per capita use trends in the Cape Fear River basin and reflect the change in land use and density per the Town's 2040 Community Vision Land Use Plan. The difference between the preferred alternative to purchase water supply from the City of Sanford with and without a return of water to the Cape Fear River basin is $226.5 million in additional cost to mitigate a difference of 4.6 cfs under low flow conditions in the Cape Fear River in 2055.

Table 7-1: Summary of Key Elements of Alternatives

No.	Alternative	Differentiators
----	No-Action	• Alternative does not meet purpose and need. • Water supply deficit by 2030.
1	Surface Water, Purchase Finished Water from Raleigh Water	• Construction of a new reservoir. • Significant environmental impacts to aquatic species, surface waters, wetlands, and floodplains. • Significant property owner impacts in area of inundation. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Johnston County permission required for property acquisition. • Significant economic impact.
2	Surface Water, Purchase Finished Water from Johnston County	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Identified as Johnston County's near-term water supply project. Water supply capacity is fully allocated to growth and development of Johnston County. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Johnston County permission required for property acquisition. • Significant economic impact.
3	Surface Water, Town of Fuquay-Varina Independent Water Supply in Neuse River Basin	• Construction of a new reservoir. • Significant environmental impacts to aquatic species, surface waters, wetlands, and floodplains. • Significant property owner impacts in area of inundation. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Johnston County permission required for property acquisition. • Significant economic impact.
4	Surface Water, Purchase Finished Water from City of Dunn	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Water supply capacity at the existing Dunn raw water intake is fully allocated to growth and development for City of Dunn. • Significant economic impact.
5	Surface Water, Purchase Finished Water from Harnett County	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Negligible to minor environmental impacts. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Water supply capacity is fully allocated to growth and development of Harnett County. • Instream flow study required. • Significant economic impact.

Table 7-1: Summary of Key Elements of Alternatives

No.	Alternative	Differentiators
6	Surface Water, Raw Water from Jordan Lake (Cary/Apex)	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Challenge in obtaining allocation from Jordan Lake. • Significant economic impact.
7	Surface Water, Raw Water from Jordan Lake (Western Intake Partnership)	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Challenge in obtaining allocation from Jordan Lake. • Significant economic impact.
8A	Surface Water, Town of Fuquay-Varina Intake on the Cape Fear River with Return of Water to Cape Fear River Basin (Cape Fear River)	• Long transmission lines. • Instream flow study required. • Negligible to minor environmental impacts from construction. • Harnett County permission required for property acquisition. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Not a regional water supply solution. • Significant economic impact.
8B	Surface Water, Town of Fuquay-Varina Intake on the Cape Fear River with Return of Water to Cape Fear River Basin (Kenneth Creek)	• Long transmission lines. • Instream flow study required. • Negligible to minor environmental impacts from construction. • Harnett County permission required for property acquisition. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Not a regional water supply solution. • Significant economic impact.
9A/B	Surface Water, Purchase Finished Water from City of Sanford	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Regional water supply solution. • Least economic impact. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers.
9C	Surface Water, Purchase Finished Water from City of Sanford with Return of Water to Cape Fear River	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Regional water supply solution. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Significant economic impact.

Table 7-1: Summary of Key Elements of Alternatives

No.	Alternative	Differentiators
9D	Surface Water, Purchase Finished Water from City of Sanford with Return of Water to Cape Fear River via Western Wake Regional WRF	• Long transmission lines. • Negligible to minor environmental impacts from construction. • Regional water supply solution. • Hydrologic modeling indicates minimal quantity impact to Neuse and Cape Fear Rivers. • Capacity unavailable in Western Wake Regional WRF. • Significant economic impact.
10	Interbasin Transfer Minimization, Groundwater	• Not a regional water supply solution. • Negligible to moderate environmental impacts from construction. • Significant economic impact. • Harnett County permission required for property acquisition. • Significant public health risk of groundwater depletion for private drinking water well population. • Large number of required wells due to low groundwater yield.
11	Interbasin Transfer Minimization, Water Reuse	• Reuse water does not substantially offset potable water use. • State regulation needed to define quality of water required for indirect potable reuse via surface water augmentation. • Significant public perception hurdles.
12	Interbasin Transfer Minimization, Additional Conservation Measures	• Town of Fuquay-Varina's water use metrics is comparable to national trends and less than regional per capita use trends in the Cape Fear River basin.

8. Public Involvement and Agency Coordination

The EIS process has provided multiple opportunities for public comment via open meeting forums and public document review and comment periods. The Town of Fuquay-Varina has followed the public involvement requirements of per General Statute § 143-215.22L and 15A NCAC 01C.

8.1 Notice of Intent and Public Scoping Meetings

Following issuance of the NOI to File a Petition to the EMC on September 1, 2020, the Town of Fuquay-Varina conducted three public scoping meetings for the project. One meeting was held in the source river basin (Cape Fear River basin 2-3) upstream of the proposed withdrawal point. A second meeting was held in the source river basin downstream of the proposed withdrawal point. The third and final public meeting was held in the receiving river basin (Neuse River basin 10-1). Specifically, the public meetings were conducted in the following locations:

Meeting 1 (source basin, upstream)	Meeting 2 (receiving basin)	Meeting 3 (source basin, downstream)
October 14, 2013, 6:30 PM Chatham County Agriculture and Conference Center 1192 US Hwy 64 West Business Pittsboro, North Carolina 27312	October 20, 2020, 6:30 PM Cary Towne Center Mall 1105 Walnut Street Cary, NC 27511	October 21, 2020, 6:30 PM Cross Creek Mall 419 Cross Creek Mall Fayetteville, NC 28303

The meetings were publicly advertised in the North Carolina Register in September 2020 and in newspapers of general circulation in each county contained in the Neuse and Cape Fear River basins. The notice was also emailed and mailed in accordance with the requirements of General Statute § 143-215.22L. The comments are compiled in Appendix G.

8.2 State Environmental Review Clearinghouse Notice of Scoping

A Notice of Scoping for the project was provided to the North Carolina State Environmental Review Clearinghouse on October 7, 2020, in accordance with 15A NCAC 01C (i.e., SEPA). The purpose of SEPA scoping is to solicit feedback from state agencies to address in the EIS. Comments were provided by various state resource agencies. Comments are compiled in Appendix G.

9. Required State and Federal Permits

The following State and Federal permits are expected to be required for the water withdrawal, transfer and distribution/treatment infrastructure construction associated with the Town of Fuquay-Varina's water supply project:

- State Environmental Policy Act Environmental Impact Statement review and issuance of a Record of Decision.
- Interbasin Transfer Certificate from the Environmental Management Commission.

The City of Sanford has obtained all permits and an Authorization to Construct (ATC) for the expansion of the City's Water Treatment Plant and associated infrastructure.

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11. Qualifications of Preparers

Mary Sadler, PE, MS Env., has 26 years of experience in the environmental field. She specializes in master planning (wastewater and water supply), municipal wastewater treatment design and construction, and regulatory compliance. She has managed over thirty environmental documents to include NEPA/SEPA for a wide variety of projects. Her range of experience includes interbasin transfers, NPDES permitting, water quality issues, endangered species issues, watershed evaluations, the development of sampling and monitoring programs for regulatory compliance, secondary and cumulative impact analyses, and mitigation resolution. Ms. Sadler served as the Project Manager for this project.

Keven Arrance, BS Bio., is a biologist responsible for assisting in the generation of the natural resources sections of the EIS and the GIS analysis. She has over 20 years of experience and has performed and managed biological assessments, wetland delineations, permit applications, mitigation design and specifications, and preparation of environmental documents. Ms. Arrance has prepared or assisted in the preparation of more than thirty environmental documents throughout the United States.

Linda Diebolt, BS M.Bio., is a senior biologist responsible for assisting in the generation of the natural resources sections of the EIS. She has over 35 years of experience. Ms. Diebolt has performed and managed biological assessments, wetland delineations, permit applications, mitigation site searches, mitigation design and specifications, and preparation of environmental documents. She has prepared or assisted in the preparation of more than forty environmental documents throughout the U.S.

Kayla Bivens, BS Bio., is a biologist responsible for assisting in the generation of the natural resources sections of the EIS and the GIS analysis. She has assisted in biological assessments, wetland delineations, permit applications, and relocation of federally listed species, numerous protected species, and delineation survey documents.

Reed Palmer, PE, MS, has 25 years of experience in the engineering and environmental field. His principal focus is long-term water resource planning in the Mid-Atlantic and Northeast for water resource infrastructure permitting, design, construction, and operations. He is an expert at developing and employing basin-scale models (including OASIS) to evaluate water supply alternatives, operational adjustments, and drought conservation programs. Mr. Palmer has used the DWR Cape Fear – Neuse Combined River Basin Model since its inception in 2011. He served as the task lead for the modeling of alternatives and performed other engineering duties related to the development of the EIS.

Karyn Saunders, PE, MEng Env., has focused on water resources management, hydrologic modeling, and water treatment plant design. Her master's degree specialized in hydrology and computational fluid dynamics, which she has applied working on OASIS models and developing water modeling and planning tools. She has worked on a range of planning and design projects including long term water supply plans, surface water intake design, and life cycle cost analyses of alternatives for both water supply and biosolids management. Ms. Saunders acted as the project engineer for the modeling of alternatives, aiding in the updates to the OASIS model and creating dashboards for post processing and assessment of the modeling results.

Appendix A: Town of Fuquay-Varina Interlocal Agreements (Water and Wastewater)

Interlocal Agreement
Between Town of Fuquay-Varina and Johnston County (1999)

NORTH CAROLINA)
)
JOHNSTON COUNTY)

BULK WATER PURCHASE AGREEMENT for the TOWN OF FUQUAY-VARINA

THIS AGREEMENT, dated May 17th 1999, between JOHNSTON COUNTY, hereinafter referred to as the "County", and the TOWN OF FUQUAY-VARINA, hereinafter referred to as the "Town".

WITNESSETH:

WHEREAS, the Town desires to purchase bulk potable water from the County, and the County desires to sell bulk potable water to the Town; and

WHEREAS, the Town desires to supply potable water purchased from the County to its current and future water customers.

NOW, THEREFORE, for and in consideration of the premises and rights, powers and duties hereinafter set forth to be performed by each, the sufficiency of which are acknowledged by the parties, the County and the Town mutually do agree as follows:

I. THE COUNTY AGREES AS FOLLOWS:

1. The County agrees to supply water to the Town in an allocation amount of up to 1,000,000 gpd. The point of delivery will be the end of the existing 16" Cleveland Water District main on NC 42 at the intersection of Rock Service Station Road (SR 2736). The peak rate of delivery shall not exceed 1.5 times the allocation, which does not include short term emergency supply. For a 1,000,000 gpd allocation, the peak rate of delivery will be 1,050 gpm.

1.5 mgd

The average daily usage is defined as the total water used over a monthly period divided by the number of days in the month. Emergency supply is defined as water required for fire fighting, to supplement supply when another of the Town's supply sources is interrupted, and high demand resulting from a main break or other system failure.

2. Upon written request by the Town, the County agrees to provide additional bulk water supply to the Town up to 1,000,000 gpd, in addition to the original 1,000,000 gpd allocation under this agreement, provided such request is made in writing within five years of the date of this agreement.

3. The County will provide water to the Town meeting the requirements of the State of North Carolina Division of Environmental Health and the U.S. Environmental Protection Agency, and will sustain delivery without interruption. However, neither the delivery rate, continuity of supply nor water quality can be guaranteed due to circumstances which can be beyond the control of the County, including but not limited to force majeure, emergencies, mechanical breakdowns, power outages, etc. The County assumes no liability for interruptions in service or short term excursions in quality. The County shall maintain water quality meeting the criteria outlined in **Attachment A**.

4. The County will, at all times, operate and maintain its system in an efficient manner and will take such action as may be necessary to furnish the Town with quantities of water required by the Town, except as provided in paragraphs 1. and 3. above. Temporary or partial failures to deliver water shall be remedied with all possible dispatch. In the event of an extended shortage of water, or the supply of water available to the County is otherwise diminished over an extended period of time, the supply of water to the Town shall be reduced or diminished in the

same ratio or proportion as the supply to other County bulk customers is reduced or diminished.

5. The County agrees to pay the Town for all bulk water supplied by the Town to the County on an emergency basis a commodity charge equal to the commodity charge for water supplied by the County to the Town.

6. The County agrees to construct a 16" water main from the intersection of NC 50 and NC 42 to the intersection of NC 42 and the entrance to Sun Ridge Farm Subdivision, and agrees to contribute up to $300,000 for construction of a 16" water main from this point to the intersection of NC 42 and Rock Service Station Road (SR 2736).

II. THE TOWN AGREES AS FOLLOWS:

1. The Town agrees to pay a one time capacity charge in the amount of $2.00 per gpd of water allocation. Payment of the initial capacity charge shall be due on or before the Town makes connection to the County water main. The capacity charge of $2.00 per gpd shall apply to any additional water supply allocation requested in writing, up to a total of 2,000,000 gpd, within 5 years of the date of this agreement.

2. The Town shall construct a 16" water main from the end of the County's 16" water main on NC 42 to the Town's existing main(s) on NC 42 and a booster pumping station. The booster station shall be located approximately 2,000 l.f. west of Middle Creek. The booster pumping station shall include a bypass line to allow supply from the Town to the County on an emergency basis. The bypass line shall be 12" or larger in diameter.

3. The Town agrees to install master meters at its booster pump station in accordance with the County's specifications and design standards, and shall maintain the master meters and calibrate the meters annually. One meter shall be installed in the pumped flow main and one in

the station bypass main. The bypass main meter shall be 8" and shall be capable of measuring a flow range of at least 30 to 2,000 gpm. The County shall have access to the meters for making its own readings on a daily basis.

4. The Town shall pay a monthly commodity charge to the County within fifteen (15) days from the date of invoice for water supplied by the County. It is understood that the commodity charge is subject to adjustment annually by the County with ninety (90) days written notice. As of the date of this Agreement, the commodity charge is $1.55 per 1,000 gallons. The commodity charge applicable to water purchased by the Town from the County shall be the same as the commodity charge for all other bulk water sales by the County.

5. The Town agrees to purchase an average daily volume of water in the minimum amount of 200,000 gpd. In the event an average amount of 200,000 gpd is not purchased in any month, the commodity charge for that month shall be based on the 200,000 gpd minimum average.

6. The Town shall pay a fixed monthly charge to County. The charge will be in proportion to fixed monthly charges applicable to other County bulk purchasers on the basis of average water usage and amount of water allocation. As of the date of this Agreement, the fixed monthly charge is $200.00.

7. In the event the Town withdraws water at a rate of over 1.5 times the allocation for any 24 hour period, a commodity surcharge of $0.25 per 1,000 gallons shall be due and payable. However, the provision of this surcharge shall not apply to daily instances involving emergency circumstances as defined herein which are documented in writing by the Town.

III. ADDITIONAL COVENANTS AND AGREEMENTS:

1. Water Supply Guarantee. It is understood that a supply allocation in the amount of 1.0 mgd under this agreement is assured by the County to the Town.

2. Terms. Terms of this Agreement shall be ten (10) years, with four (4) automatic renewals for ten (10) years each, unless a one (1) year written notification for cause (cause being a material breach of this Agreement , as determined by a court of competent jurisdiction, which remains uncured after notice by the other party) is provided by either party to the other.

3. Service Area. The County shall have service rights and obligations on its main which lies between the Wake County/Johnston County line, and the intersection of NC 42 and Rock Service Station Road, (SR 2736).

4. In the event a major water customer or major group of water customers require service on the Town's 16" transmission main between the end of the County's main and the booster pump station, the Town shall, at its own cost, install, maintain, and annually calibrate a master meter meeting the County design standards and specifications. A major water customer or major group of water customers shall be one or more customers whose aggregate average daily water usage exceeds 20,000 gpd, or more than 50 customers with ¾" or larger meters.

5. Conditions Applicable to Resale of Bulk Water. For any water supplied by the County and resold by the Town to another utility, the County makes no assurances concerning water quality.

6. Notices. Any notices required to be given by this Agreement shall be deemed to have been sufficiently given if mailed by certified mail (return receipt requested), postage prepaid, and addressed as follows:

Johnston County
Attention: County Manager
Johnston County Courthouse
212 Market Street
P.O. Box 1049
Smithfield, N.C. 27577

Town of Fuquay-Varina
Attention: Town Manager
1300 East Academy Street
Fuquay-Varina, N.C. 27526

7. Entire Agreement. This writing embodies the entire agreement and understanding between the County and the Town, and there are no other agreements or understandings, oral or written, with reference to the subject matter hereof that are not merged herein and superseded hereby.

8. Binding Upon Successors and Assigns. This Agreement shall be binding upon and shall inure to the benefit of the County and the Town and the successors and assigns of each.

9. Amendment. This Agreement shall not be modified, amended or changed in any respect except in writing, duly signed by the parties hereto, and each party hereby waives any right to amend this Agreement in any other way.

IN WITNESS WHEREOF, Johnston County has caused this Agreement to be executed by its Manager and Clerk, acting under authority of the Board Commissioners of Johnston County, and the Town of Fuquay-Varina has caused this Agreement to be executed by its Manager and Clerk, acting under authority of the Board of Commissioners of the Town of Fuquay-Varina.

Entered into this day and year first above written.

Attest:

JOHNSTON COUNTY

JOYCE H. ENNIS
Clerk to the Board
(Seal)

By: _____
RICK J. HESTER
Interim County Manager

Attest:

TOWN OF FUQUAY-VARINA

Town Clerk
(Seal)

By: _____
LARRY BENNETT
Town Manager

Bulk Water Purchase Agreement for the Town of Fuquay-Varina

Attachment A

This attachment shall include a schedule of minimum water quality criteria parameters which shall be established by the managers and utility staffs of the County and Town.

Interlocal Agreement
Between Town of Fuquay-Varina and Raleigh Water (2004)

STATE OF NORTH CAROLINA

INTERLOCAL AGREEMENT

COUNTY OF WAKE

This AGREEMENT, made and entered into this 23rd day of June, 2004 by and between the City of Raleigh, a North Carolina municipal corporation, hereinafter referred to as Raleigh and the Town of Fuquay-Varina, a North Carolina municipal corporation, hereinafter referred to as FUQUAY-VARINA.

* * * WITNESSETH * * *

THAT WHEREAS, FUQUAY-VARINA and the Town of Garner entered into an agreement in 1995 regarding municipal utility services, more particularly described as Resolution No. (1995) 1486, entitled "Resolution to Establish Interlocal Agreement Between the Town of Garner and the Town of Fuquay-Varina Regarding Municipal Utility Services;" and

WHEREAS, the Town of Garner recently merged its water and sewer system with RALEIGH's water and sewer system in March, 2001; and

WHEREAS, RALEIGH assumed certain rights and responsibilities as a result of the merger such rights and responsibilities are incorporated herein by reference; and

WHEREAS, RALEIGH and FUQUAY-VARINA desire to continue many of the terms set out in Resolution (1995) 1486 and to modify other of those terms; and

WHEREAS, each jurisdiction desires to provide appropriate planning for the logical and orderly extension of municipal utility services for their respective communities and to avoid conflicts and unnecessary duplication of water and sanitary sewer services;

NOW, THEREFORE, for and in consideration of the respective rights, powers, duties and obligations herein set forth to be performed by RALEIGH and FUQUAY-VARINA, the parties mutually agree as follows:

1. RALEIGH and FUQUAY-VARINA hereby mutually agree to an established water and sanitary sewer service area boundary line that clearly delineates the municipal service areas and future limits of each jurisdiction, described as follows:

> Beginning at the point of intersection of the centerline of US 401 and S.R. 1010; thence from said point of beginning moving in an easterly direction along centerline of S.R. 1010 to a point being the intersection of the centerline of S. R. 1010 and Fanny Brown Road; cornering; thence from said point moving in a southerly direction along the centerline of Fanny Brown Road to a point being the intersection of the

centerline of Fanny Brown Road and the centerline of Old Stage Road; cornering; thence from said point moving in a southerly direction along the centerline of Old Stage Road to a point of intersection with the centerline of N.C. 42, cornering thence from said point moving in an easterly direction along the centerline of N.C. 42 to a point being the intersection of N.C. 42 and Mount Pleasant Road; cornering thence from said point in a southeasterly direction along the centerline of Mount Pleasant Road to the Wake County Line; where the water and sewer service area boundary line terminates.

2. The geographical location of the utility service area boundary line is further depicted on the Garner/Fuquay-Varina Utility Service Area Boundary Map which is hereby made a part of this agreement.

3. It is understood and agreed by both jurisdictions through this agreement that FUQUAY-VARINA's service area is located south of S. R. 1010 and west of Fanny Brown and Old Stage Roads and that RALEIGH's service area is located north of S. R. 1010 and east of Fanny Brown and Old Stage Roads. It is further understood that each jurisdiction agrees to extend and maintain water and sanitary sewer service lines only within their respective service areas as designated by this new resolution unless otherwise provided for herein. Connection to sanitary sewer and / or water service lines for a property located in one parties service area to a water or sewer line located in the other parties service area may be allowed only if the controlling party has no service line available, and if both parties agree to a temporary connection until such time as set forth in this agreement. If the service involves only a minor amount of water or sewer capacity (1,000 gallons per day or less), and if the connection is approved by the City and Town Manager of each party, then no action is required by the governing board of each jurisdiction. Otherwise, all such requests shall require approval by each jurisdiction's governing board prior to connection.

4. It is agreed by both parties that the boundaries of this water and sanitary service area shall be mutually reexamined by each governing board upon the completion of the Southern Wake Outer Loop road construction project unless both governing boards agree to waive this review.

5. It is agreed by both parties that FUQUAY-VARINA will provide a maximum of twenty-five thousand (25,000) gallons per day of sanitary sewer capacity for certain parcels located within the town limits of Garner on the northeast corner of the intersection of U.S. 401 and S. R. 1010 being further identified as the "Buffaloe Property" depicted on the aforementioned utility boundary map and incorporated as part of this agreement. It is further understood and agreed that the aforementioned tracts are currently connected to FUQUAY-VARINA's municipal sanitary sewerage system and will be connected to the RALEIGH sanitary sewer system no later than April 1, 2005. FUQUAY-VARINA shall be notified in writing by RALEIGH a minimum of thirty (30) days in advance of the completion of the construction project to connect the customers at the "Buffaloe Property" to RALEIGH sewer.

6. It is also agreed by both parties that RALEIGH will provide a maximum of twenty-five thousand (25,000) gallons per day of sanitary sewer capacity and 30,000 gallons per day of water capacity for certain parcels located within urban service area of FUQUAY-VARINA on the southeast corner of the intersection of U.S. 401 and S. R. 1010 being further identified as the "JDH

Development Property" depicted on the aforementioned utility boundary map and incorporated as part of this agreement. It is further understood and agreed that the aforementioned tracts will connect to FUQUAY-VARINA's municipal sanitary sewerage system and / or water system no later than ten (10) years from the date of the execution of this agreement. RALEIGH shall be notified in writing by FUQUAY-VARINA a minimum of thirty (30) days in advance of the connection to the FUQUAY-VARINA sanitary sewer system and /or water system for the "JDH Development Property".

7. FUQUAY-VARINA shall retain 100% of all the applicable sanitary sewer connection fees it has collected for the parcel(s) described under Section 5 above prior to the date of this sewer agreement with RALEIGH. RALEIGH shall retain 100% of the sanitary sewer connection fees collected for the parcel(s) previously described under Section 5 after the date of this agreement.

8. RALEIGH shall retain 100% of all the applicable sanitary sewer and / or water connection fees it has collected for the parcel(s) described under Section 6 above prior to the date that FUQUAY-VARINA connects said property. FUQUAY-VARINA shall retain 100% of the sanitary sewer and water connection fees collected for the parcel(s) previously described under Section 6 after the date of the connection(s) to the FUQUAY-VARINA sanitary sewer and / or water system.

9. The party providing sanitary sewer and / or water shall receive sanitary sewer and / or usage charges billed to customers at the "Buffaloe Property" who are using FUQUAY-VARINA's sewerage system. The party providing sanitary sewer and / or water shall receive sanitary sewer and / or usage charges billed to customers at the "JDH Development Property" who are using RALEIGH's sanitary sewer and / or water systems. FUQUAY-VARINA's right to receive sewer usage charges terminates for a particular customer when that customer is connected to RALEIGH's sewerage system; and RALEIGH'S right to receive sanitary sewer and / or water usage charges terminates for a particular customer when that customer is connected to FUQUAY-VARINA's sanitary sewer and / or water systems. It is further agreed that RALEIGH will be responsible for billing and collecting sewer usage charges to customers at the "Buffaloe Property," who are connected to FUQUAY-VARINA's sewerage system. FUQUAY-VARINA will receive a credit equal to the amount of the sewer usage charges billed to these customers. The sewer usage charges to be credited to FUQUAY-VARINA will be based on the current Garner sewer service area rates. Per the Merger Agreement between RALEIGH and Garner, the Garner sewer service rates cannot change before April 1, 2005. FUQUAY-VARINA will be responsible for billing and collecting sanitary sewer and / or water usage charges to customers at the "JDH Development Property," who are connected to RALEIGH's sanitary sewer and / or water system. If any discrepancies or issues arise by either party regarding usage charges, both parties will reconcile the issues as they occur. FUQUAY-VARINA will submit collected charges to RALEIGH on a monthly basis.

10. FUQUAY-VARINA shall be responsible for review and approval of sanitary sewer and / or water construction plans for the "JDH Development Property." RALEIGH will be provided with plans to review the sanitary sewer and / or water construction plans and will

coordinate with FUQAUY-VARINA to meet RALEIGH standards to receive sanitary sewer and / or water service

11. All terms and conditions specified within this agreement may be altered or terminated only upon the approval of the governing boards of both RALEIGH and FUQUAY-VARINA.

12. The terms and conditions contained herein above shall become effective upon the approval of the agreement by the governing boards of RALEIGH and FUQUAY-VARINA.

13. Maintenance and repair of the sanitary sewer collection system serving the "Buffaloe Property", including the 8-inch diameter gravity pipeline, the sanitary sewer pump station and the sanitary sewer pump station force main, is the responsibility of RALEIGH. FUQUAY-VARINA shall be notified by RALEIGH once it is aware of any damage to the sanitary sewer system that may result in additional sewer flow to FUQUAY-VARINA. Maintenance and repair of the sanitary sewer collection system serving the "JDH Development Property", including the gravity sanitary sewer pipelines, the sanitary sewer pump station and the sanitary sewer pump station force main all of which are confined within the boundary of said property is the responsibility of "JDH Development Property." FUQUAY-VARINA shall enter into a "developer agreement" with "JDH Development Property" which will include specific procedures for "JDH Development property" and FUQUAY-VARINA to notify RALEIGH once any damage is known by "JDH Development Property" and / or FUQUAY-VARINA to the sanitary sewer system and / or water system that may result in additional sanitary sewer and /or water flows provided by RALEIGH.

14. RALEIGH and FUQUAY VARINA agree that they will not discriminate in any manner on the basis of race, sex, gender, sexual orientation, creed or national origin with reference to this contract, no matter how remote.

15. This agreement shall bind the parties hereto and their respective successors and permitted assigns and transferees, but nothing herein shall be constructed as an authorization to assign rights or obligations hereunder.

16. The invalidity or unenforceability of any particular provision of this agreement shall not affect the other provisions herein and the agreement shall be construed in all respects as if such invalid or unenforceable provisions were omitted.

17. This agreement contains the entire agreement and understanding of the parties hereto with respect to the subject matter contained herein and all prior agreements or understandings of the parties hereto are hereby revoked. There are no agreements, restrictions, promises, warranties, convenants or other undertakings other than those expressly set forth herein.

18. This agreement shall be construed and enforced in accordance with the laws of the State of North Carolina. In the event a dispute arises out of this agreement, the parties agree to the proper place of venue as the General Court of Justice, Superior Court Division located in Wake County for the State of North Carolina.

IN TESTIMONY WHEREOF, RALEIGH and FUQUAY-VARINA have caused this agreement to be executed by their respective representatives their corporate seals to be affixed and attested by their respective Clerks, all by authority of the respective Councils, the day and year first above written.

ATTEST:

CITY CLERK
(Attach Municipal Seal)

CITY OF RALEIGH

CITY MANAGER

APPROVED AS TO FORM:

CITY ATTORNEY

ATTEST:

TOWN CLERK
(Attach Municipal Seal)

TOWN OF FUQUAY VARINA

MAYOR

APPROVED AS TO FORM:

TOWN ATTORNEY

PROVISIONS FOR THE PAYMENT OF THE MONEYS TO FALL DUE UNDER THIS AGREEMENT HAS BEEN MADE BY AN APPROPRIATION DULY MADE, OR BY BONDS OR NOTES DULY AUTHORIZED, AS REQUIRED BY THE LOCAL GOVERNMENT ACT.

CITY ACCOUNTANT 6/8/04 DATE

CODE no expenditures incurred $ N/A

Interlocal Agreement
Between Town of Fuquay-Varina and Raleigh Water (2021)

STATE OF NORTH CAROLINA

COUNTY OF WAKE

WATER SUPPLY AGREEMENT

THIS AGREEMENT, made and entered into the 24 day of June, 2021, by and between the CITY OF RALEIGH, hereinafter referred to as the "City" and the TOWN OF FUQUAY VARINA hereinafter referred to as the "Town" is for a time-limited supply of water from the City to the Town, as described hereinafter ("the Agreement"). The City or the Town may be referred to hereinafter as a "Party" and collectively, the "Parties".

WITNESSETH

WHEREAS, the Town is the owner and operator of a public water supply system serving customers in Fuquay Varina;

WHEREAS, the City is the owner and operator of a public water supply system in and around Wake County that services customers in the Raleigh, Garner, Knightdale, Rolesville, Wake Forest, and Zebulon service areas (the "City's Water System");

WHEREAS, the City and the Town entered into a Water Agreement on April 17, 2001 which expires on June 30, 2021;

WHEREAS, the Town is expanding its public water supply system and requires additional capacity;

WHEREAS, the City is expanding its public water supply system and has capacity that it will not need in the near term;

WHEREAS, the Town is desirous of maintaining water supply provided by contract from the City and increasing the amount of water supply provided;

WHEREAS, the City is willing to provide water service to the Town for a fifteen (15) year period pursuant to the terms of this Agreement but does not desire the City's Water System to be a part of the Town's water supply plan;

WHEREAS, the Town is seeking a new long-term supply to replace the water provided by this Agreement with water from the Cape Fear Basin;

WHEREAS, this Agreement is intended to provide a short-term supply of water until the Town has access to another source of water to meet its long-term supply needs;

WHEREAS, the Town is willing to make improvements to the existing pumping system and related lines to accept additional flow from the City up to 1.75 million gallons per day;

WHEREAS, the City and the Town have agreed upon the terms and conditions upon which water service will be provided to the Town after the effective date of this Agreement;

WHEREAS, the Town has agreed to buy and the City has agreed to sell water to the Town for no more than fifteen (15) years under the terms and conditions of this Agreement;

NOW, THEREFORE, in consideration of the respective rights, powers, conditions, duties and obligations hereinafter set forth, the Parties mutually agree as follows:

1. City will provide water to the Town in an amount up a maximum daily flow of 1.75 MGD (million gallons per day) and a rate not to exceed 1300 gallons per minute through the existing connection between the two water systems in the 12-main located along the eastern edge of the right-of-way of US Highway 401. The waterline and connections shall be referred to hereinafter as the "Pipeline."

2. Ownership and responsibility for the operation and maintenance of the Pipeline shall be divided between the City and the Town at two locations along US 401. The Town owns and shall be responsible for the operation and maintenance of the entire water booster station located on the east side of US 401, immediately south of Swift Creek. The City shall be responsible for the operation and maintenance of the Pipeline, south of the water booster station and for the portion of the Pipeline between the pump station and the meter station, located immediately south of Ten Ten Road. The City shall be responsible for maintaining the water meter station. The Town shall be responsible for maintaining the Pipeline south of the meter station.

3. The water meters installed and located at the Ten Ten Road Meter Station will be the normal means to measure water volume sold from the City to the Town. The meters shall be routinely maintained by the City without added cost to the Town beyond the consumptive contract water rate. Except as otherwise provided in this Agreement, the City will also provide replacement of the current meters at no cost to the Town. However, under any subsequent meter replacement, the Town shall be responsible for costs of purchasing the replacement meter, if necessary. The Town will not be responsible for any meter replacement cost, if the meter replacement is necessary to transmit more water to any other City customer, other than the Town. If replacement of a meter is determined to be necessary by the City, no action will be taken until the Town is consulted on the requirement for a meter replacement. The City and the Town shall have access at all times to such meters for the purpose of taking readings therefrom for checking the same for accuracy, performing maintenance, or any other lawful purpose whatsoever. The replacement meters now and in the future shall be designed to measure the volume of water in cubic feet. In the event that said meters

are found inoperable or malfunctioning, so as to render inaccurate readings, by the Public Utilities Department of the City for any reason, the consumption shall be estimated. Estimated readings will be based on historical consumption computed as the average of the three previous months of the same month in the prior year, whichever is greater.

4. Maintenance of the Pipeline between the City and the Town shall be divided as described in paragraph # 2 of this Agreement. The City reserves the right to make emergency repairs on the Town portion of the Pipeline in order to conserve water and return the Pipeline to service in a timely manner, if the Town fails to do so and to charge the Town for its direct cost for such repair. The Town will be notified in advance of the City proceeding with emergency repairs.

5. The Town shall own and be responsible for the operation and maintenance of all its distribution systems facilities located in the Town. The City shall own and be responsible for the operation and maintenance of all distribution systems facilities owned by it, which shall include the meters and meter box.

6. The Town shall purchase water from the City in the amount stated in Paragraph 1 and shall pay all contract water service rates and charges established by the City, which are reviewed and adjusted annually at the beginning of each fiscal year as part of the water and sanitary sewer enterprise fund budget adoption process. As of the date of this Agreement, those rates and charges include a monthly operation and maintenance charge and a monthly capital charge. These rates and charges may be adjusted, and new rates and charges may be added at the City's sole discretion, which shall become incorporated into this Agreement upon approval by the Raleigh City Council. In the event that the Town's use of the City's water supply at the Pipeline exceeds 1.75 MGD during any monthly billing cycle, the Town shall pay 1.5 times the amount of the rates and charges in effect during such month.

7. The Town shall charge each customer connecting to its water system a system development fee pursuant to North Carolina General Statutes Section 162A, Article 8, as the same may be amended from time to time by the Town.

8. The City shall bill the Town monthly, pursuant to this Agreement, starting on the date the City authorizes water to flow from the City's water system to the Town's which will be prorated for the first billing cycle. If the Town fails to pay the City thirty (30) days after receipt of the billing statement, the City shall have the right to immediately terminate water service at the Site and may institute an action, legal or otherwise, to enforce payment of amounts due.

9. The Town shall upgrade the existing booster pump station on US 401 as required to deliver the required flow rate to the Town's water system. The upgrade shall also include a new check valve that will allow flow south of the booster pump station when the pumps are not in service. The Town shall also pay up to $2,000,000 for the construction of a 12" water main along Rand Road and Ten Ten Road that is needed

to support the contract water supply flow rate. The City shall manage the construction of the new 12" water main and it shall be fully owned and operated by the City when completed. The Town shall reimburse the City for the cost of the construction within thirty (30) days after receipt of the billing statement for the cost of the construction.

10. The Town acknowledges that the City's water system will normally be using chloramines as their residual disinfectant and the Town will be responsible for water quality, including removal of the chloramines (if necessary), once City has delivered water to Town.

11. The City reserves the right to deny temporary water service at the Site for failure to comply with the conditions of this Agreement. The City further reserves the right to deny water service in the event that water cannot be practicably furnished without negatively impacting the operation of the City's Water System, as determined in the reasonable opinion of the City's Designated Representative. Such circumstances include but are not limited to periods of water shortage, periods when insufficient water exists to meet the requests of customers of the City's Water System, damage to infrastructure that impedes water delivery, implementation of any water restrictions by the City, or any other periods when depletion of the City's water reserves could endanger the City's ability to provide for the needs of customers of the City's Water System.

12. No later than seven (7) days following any City Council action to implement water conservation measures, the Town shall implement water conservation measures at least as restrictive as the City's for the County's retail customers supplied with water from the City's Water System.

13. The term of the Agreement is for fifteen (15) years following the date of execution by the City (the "Term"). The Parties do not anticipate extending the Term of this Agreement. While the Parties do not anticipate extending the Term, the Agreement may be extended for three successive one (1) year terms (a "Renewal Term") by a written amendment to this Agreement signed by the Parties, executed prior to the expiration of the Term or any Renewal Term as follows:

    a. First Renewal Term: The Town shall pay 1.5 times the Contract Rates and Charges.
    b. Second Renewal Term: The Town shall pay 2.0 times the Contract Rates and Charges.
    c. Third Renewal Term: The Town shall pay 3.0 times the Contract Rates and Charges.

14. This Agreement may be extended or modified only by a written amendment to this Agreement.

15. Substantial breach of the terms of this Agreement that is not cured by the breaching Party, after notice, billing disputes, equipment problems, or failure to resolve other

issues necessary for the continued effective function of the water systems of each Party are grounds for termination by either Party upon thirty days' written notice. The City may immediately terminate the transfer of water to the Town when the transfer of the water is in violation of State law, rules, or permits issued to the City or any breach of this Agreement by the Town causes the City to be in violation of any permit the City holds.

16. The City and the Town agree that no future water service will be provided to any property along the Pipeline not within the jurisdiction of the Town or the City water service area unless a declared emergency exists, as mutually agreed.

17. The Town agrees to transport water from the City to the Town of Holly Springs and/or other City water customers, via existing water system interconnections, within the capacity of those interconnections now or as improved in the future, should the City declare such an emergency. In addition, the Town agrees to transport from the Town of Holly Springs to the City, via existing water system interconnections, within the capacity of those interconnections now or as improved in the future, should the City declare such an emergency. In such a declared emergency, the City would credit the Town on their next monthly bill, a water transportation charge through the Town's system of $0.12 per CCF.

18. The Water Agreement entered between the City and the Town on April 17, 2001 is scheduled to expire on June 30, 2021. Pursuant to paragraph 17. of the Water Agreement, it can only be permanently terminated by mutual consent with 12 months prior written notice. The City and the Town mutually consent and agree to waive any notice required by the Water Agreement and the Water Agreement shall expire upon the effective date of this Agreement.

19. The Town shall not include the City's Water System or the Neuse River above North Carolina Highway 42 in the Town's Water Supply Plan. The Town shall submit a copy of the Town's Water Supply Plan that is currently under development upon receipt of the final Water Supply Plan from the Town's consultant who is preparing the plan.

20. All matters relating to this Agreement shall be governed by the laws of the State of North Carolina, without regard to its choice of law provisions, and venue for any action relating to this agreement shall be Wake County Civil Superior Court or the United States District Court for the Eastern District of North Carolina, Western Division.

21. The City shall not be liable to the Town, to any person, firm, corporation, municipality, or other water consumer for failure to supply a sufficient quantity or quality of water under this Agreement or from failure to comply with any State or Federal standards relating to drinking water; however, if the Town notifies the City that the water quality at the Site between the back flow prevention and the master meter is not in compliance with State or Federal drinking water standards, the City

agrees to undertake reasonable measures to achieve such compliance as soon as is practicable. Notwithstanding the references to third Parties in this agreement, the City shall not be liable to those Parties for any obligations within this Agreement and shall not be obligated to enforce any requirements imposed by this Agreement or by any independent agreement with third Parties. To the extent not prohibited by law, the Town shall indemnify the City and its officials, agents, and employees from and against all claims, judgments, costs, damages, fines, penalties, interest, and expenses (including but not limited to attorney's fees) imposed against the City that arise from or are in connection with the Town's receipt or nonreceipt of water pursuant to this Agreement.

22. The City shall not be responsible in any manner for loss or damage to the portion of the Pipeline at the booster pump station or south of the Ten Ten Road meter station for any cause whatsoever and the Town shall and does hereby assume, and agrees to indemnify and hold harmless the City, its successors and assigns, from and against all loss, costs, expenses including attorney's fees, damage to property caused by or in any way connected with the maintenance, use or presence of said Pipeline and appurtenances, howsoever cause, including damages resulting from insufficient quantity or quality of water, or from noncompliance with Federal or State standards applying to drinking water systems.

23. To the extent permitted by North Carolina law, the Parties hereto for themselves, their agents, officials, employees and servants agree not to discriminate in any manner on the basis of race, color, creed, national origin, sex, age, handicap, or sexual orientation with reference to the subject matter of this Agreement. The Parties further agree, to the extent permitted by law, to conform with the provisions and intent of City Ordinance 1969-889, as amended. This provision is hereby incorporated into this Agreement for the benefit of the City and its residents, and may be enforced by action for specific performance, injunctive relief, or other remedy as provided by law. This provision shall be binding on the successors and assigns of the Parties with reference to the subject matter of this Agreement.

24. No Party may transfer or assign its rights under this Agreement without prior written approval from the other Party.

25. This Agreement constitutes the entire agreement of the Parties on the matter of water supply and supersedes the prior

26. Notwithstanding any other provisions of this Agreement, this Agreement and all materials submitted to the City by the Town are subject to the public records laws of the State of North Carolina and it is the responsibility of the Town to properly designate materials that may be protected from disclosure under North Carolina law as such and in the form required by law prior to the submission of such materials to the City. The Town understands and agrees that the City may take any and all actions necessary to comply with federal, state, and local laws and/or judicial orders and such actions will not constitute a breach of the terms of this Agreement. To the extent that

any other provisions of this Agreement conflict with this paragraph, the provisions of this section shall control.

27. The Town shall comply with E-Verify, the federal E-Verify program operated by the United States Department of Homeland Security and other federal agencies, or any successor or equivalent program used to verify the work authorization of newly hired employees pursuant to federal law and as in accordance with N.C.G.S. §64-25 et seq. In addition, to the best of the Town's knowledge, any subcontractor employed by the Town as a part of this Agreement shall be in compliance with the requirements of E-Verify and N.C.G.S. § 64-25 et seq.

28. The Town certifies that, as of the date listed below, it is not on the Final Divestment List as created by the State Treasurer pursuant to N.C.G.S. § 147-86.55, *et seq*. In compliance with the requirements of the Iran Divestment Act and N.C.G.S. § 147-86.59, the Town shall not utilize in the performance of this Agreement any subcontractor that is identified on the Final Divestment List.

29. The Town certifies that it has not been designated by the North Carolina State Treasurer as an entity engaged in the boycott of Israel pursuant to N.C.G.S.§ 147-86.81.

30. This Agreement contains the entire agreement and understanding of the Parties hereto with respect to the subject matter contained herein and all prior agreements or understandings of the Parties hereto are hereby revoked. There are no agreements, restrictions, promises, warranties, covenants or other undertakings other than those expressly set forth herein.

IN WITNESS WHEREOF, the parties hereto have executed this Contract by digital signature, under seal, on the respective dates below, and this Contract shall be effective upon the date of the City's signature.

Town of Fuquay-Varina

By: _____
Town Manager or Authorized Designee

ATTEST:

By: _____

Rose H. Rich / Town Clerk
Printed Name/Title

City of Raleigh

By: _____
City Manager or Authorized Designee

ATTEST:

By: _____
(Deputy) Clerk-Treasurer

This instrument has been preaudited in the manner required by the Local Government Budget and Fiscal Control Act.

_____
Signature of Finance Officer

Approved as to form:

_____
Fuquay-Varina Town Attorney

Approved as to form:

_____ 6/24/2021
Senior Associate City Attorney

Amendment to Interlocal Agreement Between Town of Fuquay-Varina and Harnett County (2023)

Board Meeting Agenda Item

Approved by the Harnett County Board of Commissioners
Date 12/4/23
M Capps, Clerk to the Bd.

MEETING DATE: **December 4, 2023**

TO: HARNETT COUNTY BOARD OF COMMISSIONERS

SUBJECT: **Approval of Amendment for Additional Wastewater Capacity Purchase for the Town of Fuquay-Varina**

REQUESTED BY: **Steve Ward, HRW Director**

REQUEST:
This a formal request for the Board to approve an amendment between Harnett Regional Water and the Towns of Fuquay-Varina. The Town's Board has approved this amendment which formalizes the purchase of additional wastewater capacity in the planned expansion of the North Harnett Wastewater Treatment Plant. The executed agreement is enclosed for your review. Please place this item on the agenda at the next available meeting.

FINANCE OFFICER'S RECOMMENDATION:

COUNTY MANAGER'S RECOMMENDATION:

NORTH CAROLINA

COUNTY OF HARNETT

SECOND AMENDMENT
TO UTILITY AGREEMENT

THIS SECOND AMENDMENT ("Second Amendment") is made and entered into with an effective date of 4 December ~~November~~ 2023 by and between the COUNTY OF HARNETT, a body politic, organized and existing under the laws of the State of North Carolina, (hereinafter referred to as "COUNTY") and the TOWN OF FUQUAY-VARINA, a municipal corporation, organized and existing under the laws of the State of North Carolina (hereinafter referred to as "FUQUAY-VARINA").

WHEREAS, COUNTY AND FUQUAY-VARINA entered into an Agreement dated November 9, 2000 (hereinafter referred to as "Agreement") to extend the COUNTY's regional wastewater treatment system and provide wastewater treatment services to TOWN; and

WHEREAS, FUQUAY-VARINA was initially allocated 2 million gallons per day (MGD) of wastewater treatment plant capacity by COUNTY; and

WHEREAS, In the First Amendment to the Agreement, entered into on August 6, 2007, FUQUAY-VARINA was subsequently allocated an additional 600,000 gallons per day of wastewater treatment plant capacity by COUNTY, for a total of 2.6 MGD of treatment capacity in the wastewater treatment plant; and

WHEREAS, COUNTY plans to expand the Regional Wastewater Treatment Plant by 9 million gallons per day of treatment capacity at an estimated total cost of one hundred eleven million, three hundred seventy-six thousand dollars ($111,376,000.00), with the cost subject to change pending finalization of plans and acceptance of construction bids.

WHEREAS, FUQUAY-VARINA desires an additional 3.4 million gallons per day treatment capacity in the Regional Wastewater Treatment Plant over and above the 2.6 MGD of wastewater treatment plant capacity currently guaranteed for a total of 6 million gallons per day treatment capacity in the Regional Wastewater Treatment Plant;

WHEREAS in the event of an expansion of the Regional Wastewater Treatment Plant, FUQUAY-VARINA shall be responsible for its pro-rata portion of the expansion to the Regional Wastewater Treatment Plant capacity; and

NOW, THEREFORE, in consideration of the mutual benefits, representations, and agreements contained herein and for good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the parties agree as follows:

1. The TOWN's allocation of treatment capacity shall increase by 3.4 MGD gallons per day to a total allocation of 6 MGD of wastewater treatment plant capacity.

2. The TOWN shall pay its pro rata share of thirty-seven and eight tenths percent (37.8%) of the total cost of the expansion in the Regional Wastewater Treatment Plant, pursuant to Section 9, "Allocation of Additional Capacity and Method of Payment" of the Agreement.

3. In the event of change orders or delays that result in cost overruns, the TOWN will be responsible for paying its pro rata share of thirty-seven and eight tenths percent (37.8%) of any cost overruns incurred. Payment for cost overruns will be made within twenty (20) days after an invoice is presented to the TOWN for payment.

4. All other terms of the Agreement not expressly amended by this Second Amendment shall remain unchanged and in effect.

IN WITNESS WHEREOF, the parties hereto, through their duly authorized representatives or officers have executed this Amendment #2 as to the date and year first above written.

TOWN OF FUQUAY-VARINA a dash more NORTH CAROLINA

TOWN OF FUQUAY-VARINA:

By: J. Blake Massengill
J. Blake Massengill, Mayor

Date: 11/21/23

Attest:

Rose H. Rich
Rose Rich, Town Clerk

This instrument has been pre-audited in the manner required by the Local Government Budget and Fiscal Control Act.

By: JoAnne Crabtree
Name: JoAnne Crabtree
Title: Town Finance Director

COUNTY OF HARNETT:

By: Brent Trout
Brent Trout, County Manager

Date: December 4, 2023

Attest:

Melissa Capps, Clerk to the Board

This instrument has been pre-audited in the manner required by the Local Government Budget and Fiscal Control Act.

By: Kimberly Honeycutt 12.4.2023
Name: Kimberly Honeycutt
Title: County Finance Officer

Interlocal Agreement
Between Town of Fuquay-Varina and Harnett County (1989)

NORTH CAROLINA

HARNETT COUNTY

WATER PURCHASE CONTRACT

THIS CONTRACT for the sale and purchase of water is entered into as of the 23 day of February, 1989, between the NORTHEAST METROPOLITAN WATER DISTRICT OF HARNETT COUNTY (hereinafter "Northeast Metro"), and the COUNTY OF HARNETT (hereinafter "County"), said Northeast Metro and County shall be collectively referred to herein as "Sellers" and the TOWN OF FUQUAY-VARINA, (hereinafter referred to as "Purchaser" or "Town")

W I T N E S S E T H:

THAT WHEREAS, the Purchaser is a municipal corporation duly organized and existing under the laws of the State of North Carolina, and is located within Wake County, North Carolina; and

WHEREAS, Northeast Metro is a metropolitan water district organized and existing under the laws of the State of North Carolina; and

WHEREAS, County is a body politic organized and existing under the laws of the State of North Carolina; and

WHEREAS, the Purchaser, among its other functions, operates a water supply and distribution system serving water users within its corporate boundaries, and is in need of an additional supply of treated water therefor; and

WHEREAS, Northeast Metro owns a water production system and a water supply distribution system, and County, through its Department of Public Utilities is operator thereof pursuant to that certain Lease dated May 30, 1980, entered into between Northeast Metro and County; and

WHEREAS, Sellers desire to sell to Purchaser, and Purchaser desires to buy from Sellers a supply of potable water as set forth herein; and

WHEREAS, in order to transport said supply of potable water to Purchaser, it is necessary that Sellers transport the same through pipelines to be constructed and owned by the Northwest Water and Sewer District of Harnett County; and

WHEREAS, pursuant to a contract with the Northwest Water and Sewer District of Harnett County, Sellers have the right and privilege to transport water through pipelines to be constructed by said District; and

WHEREAS, pursuant to a contract entered into contemporaneously herewith, Town has made certain commitments to the Northwest Water and

Sewer District of Harnett County relative to the construction of the said District's system; and

WHEREAS, Sellers and Purchaser have agreed upon certain terms regarding the sale of water as mentioned above, and now desire to set forth the terms of their agreement; and

WHEREAS, by Resolution adopted by the District Board of the Northeast Metropolitan Water District of Harnett County at its meeting on February 27, 1989 the sale of said water to the Purchaser as provided herein was approved, and the execution of this contract by Northeast Metro was duly authorized; and

WHEREAS, by Resolution adopted by the Harnett County Board of Commissioners at its meeting on March 6, 1989, the sale of said water to the Purchaser as provided herein was approved, and the execution of this contract by County was duly authorized; and

WHEREAS, by Resolution adopted by the Board of Commissioners of the Town of Fuquay-Varina at its meeting on Feb. 21, 1989 the purchase of said water from the Sellers as provided herein was approved, and the execution of this contract by Purchaser was duly authorized;

NOW THEREFORE, in consideration of the foregoing and the mutual agreements hereinafter set forth,

A. THE SELLERS AGREE:

1. (Quality and Quantity) To furnish the Purchaser at the point of delivery hereinafter specified, during the term of this contract or any renewal or extension thereof, potable treated water meeting applicable purity standards of the Division of Health Services, Department of Human Resources of the State of North Carolina, in such quantity as may be required by the Purchaser not to exceed one million (1,000,000) gallons per day, BUT SUBJECT ALWAYS, to the provisions of Section C hereof.

2. (Point of Delivery and Pressure) That water will be furnished at a reasonable constant pressure calculated at approximately eighty-four (84) pounds per square inch from a main supply line to be installed by the Northwest Water and Sewer District of Harnett County (pursuant to that contract between Purchaser and said District) located on the Harnett County side of the Harnett County-Wake County line within or adjacent to the right of way of United States Highway 401. If a greater pressure than that normally available at the point of delivery is required by the Purchaser, the cost of providing such greater pressure shall be

borne by the Purchaser. Emergency failures of pressure or supply due to main supply line breaks, power failure, flood, fire and use of water to fight fire, earthquake or other catastrophe shall excuse the Sellers from this provision for such reasonable period of time as may be necessary to restore service.

3. (Metering Equipment) To operate at its own expense, the metering equipment described in paragraph B(2) hereof, and upon expiration of the one year warranty period described in said paragraph B(2) to maintain the same, and to calibrate such metering equipment whenever requested by the Purchaser but not more frequently than once every twelve (12) months. A meter registering not more than two percent (2%) above or below the test result shall be deemed to be accurate. The previous readings of any meter disclosed by test to be inaccurate shall be corrected for the three (3) months previous to such test in accordance with the percentage of inaccuracy found by such tests. If any meter fails to register for any period, the amount of water furnished during such period shall be deemed to be the amount of water delivered in the corresponding period immediately prior to the failure, unless Seller and Purchaser shall agree upon a different amount. The metering equipment shall be read on the first day of each month. An appropriate official of the Purchaser at all reasonable times shall have access to the meter for the purpose of verifying its readings.

4. (Billing Procedure) To furnish the Purchaser not later than the fifth (5) day of each month, with an itemized statement of the amount of water furnished the Purchaser during the preceding month.

B. THE PURCHASER AGREES:

1. (Rates and Payment Date) To pay the Sellers, not later than the fifteenth (15) day of each month, for water delivered in accordance with that schedule of rates, as adopted from time to time by Sellers, for bulk municipal customers located in Harnett County with the minimum rate to be that charge as calculated under said schedule of rates for the amount of one hundred thousand (100,000) gallons per day. The minimum rate shall first become payable to Sellers from Purchaser, upon billing, no later than one hundred eighty (180) days after the date that water is available at the point of delivery specified above, regardless of whether or not Purchaser is actually being delivered water at such time.

2. (Metering Equipment) To furnish, construct and install at its own expense at the point of delivery, the necessary metering equipment, including a meter house or pit, and required devices of standard type for properly measuring the quantity of water delivered to the Purchaser (and to measure any quantity of water supplied to Sellers by Purchaser under the provisions of paragraph D(4) hereof regarding emergency services). Such facilities shall be furnished, constructed and installed upon the following terms and conditions:

a. Purchaser shall furnish, construct and install the same in accordance with plans and specifications provided therefor by Sellers.

b. Purchasers shall obtain and acquire continuous and adequate lands or rights in land necessary to construct and install, and thereafter use, operate, inspect, repair, maintain, replace, remove, change the size of or protect said facilities.

c. The Purchaser shall cause the same to be furnished, constructed and installed in accordance with standard engineering and contracting practices and procedures, by a qualified contractor.

d. Purchaser shall obtain approval for the installation and construction of the same from the necessary federal, state, and/or local government and agencies, prior to and/or at the time of completion.

e. Purchaser shall provide Sellers with three (3) entire sets of drawings of the completed facilities as constructed and as is conveyed to Sellers as hereinafter provided.

f. Purchaser shall permit representatives of Sellers to inspect the construction and installation of the said facilities to verify that the same is being or has been constructed and installed as herein provided.

g. In the event that the construction and installation of the facilities is not completed as set forth herein, then Sellers shall notify Purchaser of such fact and in what ways the construction does not meet the terms hereof, and it shall be the duty of Purchaser to

thereafter correct such items or things as do not meet the terms hereof.

It is agreed that upon completion of the construction and installation of the above described facilities, and inspection, approval and acceptance thereof by Sellers, the same shall be conveyed by good and sufficient deed and/or other document of conveyance to Sellers, together with the land or rights in land required therefor and appurtenant thereto.

Purchaser hereby warrants and guarantees for a period of one (1) year from the date of the conveyance of the facilities to the Sellers that the same will be free from all defects due to faulty material or workmanship. Any corrections as may be necessary by reason of such defects shall be made or caused to be made be Sellers and all costs in so doing including materials and labor costs shall be borne by Purchaser.

3. (Construction and Maintenance of Certain Lines) To construct and maintain all water distribution pipelines located between the meter facility (described in paragraph B(2) above) and the boundary of Harnett County and Wake County.

C. The Sellers and Purchaser Agree with Respect to Expansion of Sellers' Water Production Facilities as follows:

1. (General) It is specifically understood that County, (through its Department of Public Utilities, and as lessee of the facilities of Northeast Metro), and Northeast Metro find that their foremost obligation is to provide water services to the citizens and residents of Harnett County. To that end, Sellers have heretofore entered into agreements with several water and sewer districts in Harnett County providing for the sale of water to such districts and intend to enter into similar agreements with proposed water service districts in the County. It is further understood that Sellers' water production facilities are currently capable of producing water in quantities in excess of the current needs within Harnett County, and that for such period as Harnett County does not require such excess capacity, the same or a portion thereof, may be sold to Purchaser as provided herein. It is the desire of the parties to provide procedures whereby the Purchaser may expand or participate in expansions of Sellers' water production facility so as to insure its right to purchase quantities of water hereunder. It is specifically acknowledged by the parties hereto that it is the intent and purpose of Section (C) of this Water Purchase Contract to make provisions for the following matters

relative to the use of the capacity of the water production facility of the Sellers:

(a) The currently existing production capacity of the Sellers' water production facility, and any additional production capacity paid for by the Sellers, shall first be allocated to the citizens and residents of Harnett County, and only such excess thereof as will not be necessary to meet the needs of the citizens and residents of Harnett County may be sold to Purchaser.

(b) Production capacity which is paid for by the Purchaser pursuant to the terms hereof, shall, for the term of this Water Purchase Contract, be the property of Purchaser and shall be allocated to the Purchaser as provided, without regard to the needs of the citizens and residents of Harnett County.

2. (Procedure Relating to Expansion) The procedure to be applied in expanding the said facility under any of the circumstances set out in this contract (unless specifically provided otherwise), shall be as follows:

(a) Sellers shall employ consulting engineers to design the necessary alterations to expand the said water production facilities. Such alterations may include, but are not limited to, the upgrading, expansion, enlargement and/or addition of filters, basins, pumping facilities and such other items as will be necessary to accomplish the desired expansion.

(b) Upon completion of the design of said alterations, pursuant to law, Sellers shall obtain the necessary permits from the applicable federal, state or local governments and/or agencies to proceed with the construction of the expansion. Thereafter, Sellers shall submit the expansion project for bids and shall award the contract(s) and proceed to construct the project. It is understood that Sellers have the right to rebid the project or take such other actions relative to the awarding of contract(s) as Sellers deem necessary and as provided by law.

(c) The pro rata cost of that portion of the expanded water production facility capacity which is to be allocated exclusively to Purchaser shall be paid by Purchaser. Such costs shall include administrative costs of the Sellers, costs of engineering and design, and attorneys fees. Such amount of the cost to be paid by Purchaser shall be due and payable to Sellers as follows:

One-third (1/3) thereof shall be due and payable within ten (10) days after the construction contract or contracts are awarded.

One-third (1/3) thereof shall be due and payable within ten (10) days after notification to Purchaser by Sellers that one-half (1/2) of the expansions are completed.

One third (1/3) thereof shall be due and payable within ten (10) days after notification to Purchaser by Sellers that the expansions are substantially completed.

3. (Incremental Expansions) It is the understanding of the Sellers and the Purchaser that because of the design of the existing water production facilities of Sellers, expansions of that water production facility must be made in increments resulting in a capacity enlargement of one million six hundred seventy thousand (1,670,000) gallons per day.

It is contemplated by the parties that expansions to the said water production facilities as provided herein will be made in such increments, and that circumstances will be such that the Sellers and Purchaser will obtain the capacity desired by each at the time of the addition of such increment. However, should the situation arise, under the various contingencies described herein, where Sellers desire to expand Sellers' production facility by an entire increment, and in order for Purchaser to make expansions to the said facility for allocation to itself, another increment must be added, then Purchaser agrees to pay for the entire cost of such additional increment. Likewise, should the situation arise where Sellers desire not to make an expansion, or desire not to make expansions to the extent necessary to complete an entire such increment (above the capacity desired by Purchaser), and in order for Purchaser to make expansions for allocation to itself, such full incremental expansion is required, then Purchaser agrees to pay for the entire cost of such increment. It is understood that should these events occur, all such water production facility expansion paid for by Purchaser shall be allocated to Purchaser.

4. (Required Expansion by Purchaser) In the event that the water consumption requirements of Harnett County reach a level where such requirements, when coupled with the needs of Purchaser, exceed 2,200,000 gallons per day, then and in that event, in order for Town to continue to purchase or begin to purchase water (whichever the case may be) from Sellers hereunder in any amount, (without a diminution of the same equal to

the needs within Harnett County), Purchaser shall be obligated to pay for such water production facility expansion as is required to increase Sellers' production capabilities to meet the maximum requirements of Purchaser hereunder, to wit: one million (1,000,000) gallons per day; that is to say, at such time as stated, Purchaser shall pay for that portion of Sellers' water production facility capacity as is required to meet the maximum requirements of Purchaser hereunder. The procedures relative to the expansion of such facilities as the same relate to Purchaser, shall be as follows:

(a) At such time as the currently existing water production facilities of Sellers, now owned by Northeast Metro, and operated by County (whether at such time owned as stated or otherwise) reach a use where the average daily water flow, together with the needs of Purchaser, exceed 2,200,000 gallons per day County and/or Northeast Metro shall initiate studies to determine the required expansion of such facilities to meet the needs of Purchaser hereunder.

(b) County or Northeast Metro shall notify Purchaser in writing that the use capacity of Sellers' water production system has exceeded 2,200,000 gallons per day and that the expansions provided for hereunder are needed. Purchaser shall, within thirty (30) days after the date of such notice, provide Sellers with a Letter of Intent as to its decision regarding participation in expansion of Sellers' water production facilities. Within One hundred sixty (160) days after the date of Sellers' notice to Purchaser, Purchaser shall provide to Sellers in writing a final binding statement as to its decision. In the event Purchaser does not elect to participate in the expansion, the rights of Purchaser hereunder shall be determined as set forth in subparagraph C(5)(a).

(c) Upon receipt of notification of Purchaser's agreement to participate in the expansions as provided, the Sellers and Purchaser shall proceed as provided in paragraph C(2) above.

5. (Procedure in the Event of Certain Contingencies) In the event that circumstances are such that the expansion of Sellers' water production facilities are not accomplished as contemplated in paragraph C(4) hereof, then where applicable, the following procedures shall be employed:

(a) In the event Purchaser does not elect to participate in the expansion as provided in paragraph C(4) and advises the Sellers of such decision [as provided in subparagraph C(4)(b)] or fails to advise Sellers of its decision, then Sellers' shall have no obligation to sell water to Purchaser, except as to any excess capacity (not necessary to meet the needs of the citizens and residents of Harnett County). In the event Purchaser should thereafter wish to expand the production facilities of Sellers so as to obtain water production facility capacity for allocation to itself, Purchaser shall notify Sellers of such fact in writing; thereafter, the procedures set forth in paragraph C(2) shall be applied except that the entire cost of the expansion shall be paid by Purchaser; and said costs shall be due and payable over the course of the construction period within ten (10) days after the submission of periodic pay estimates (as issued by the contractor(s) and/or engineer) by Sellers to Purchaser. It is understood that should this series of events occur, all such water production facility expansion paid for by Purchaser shall be allocated to Purchaser.

(b) In the event Sellers do not elect to participate in the expansion as provided in paragraph C(4), then if Purchaser desires to expand the plant, Purchaser agrees to proceed therewith and agrees to pay the entire cost of the expansion. It is understood that should this series of events occur, all such water production facility expansion paid for by Purchaser shall be allocated to Purchaser. The procedures described in paragraph C(2) shall be utilized in constructing the expansions, except as to the amount of cost, which cost shall be borne solely by Purchaser, and shall be due and payable over the course of the construction period within ten (10) days after the submission of periodic pay estimates (as issued by the contractor(s) and/or engineer) by Sellers to Purchaser.

(c) In the event Sellers should elect to expand their water production facilities prior to the time stated in paragraph C(4) or prior to the time Purchaser begins to purchase water from Sellers, Purchaser shall have the option to participate in such expansions at that time and thereby fulfill all, or a portion of, its obligations hereunder as to expansion of the Sellers' water production facilities. It is understood that this provision in no way limits Sellers rights to expand the water production facilities in any size increments Sellers desire. In the event Sellers elect to construct such expansion, Sellers shall advise Purchaser

in writing thereof, and Purchaser shall, within thirty (30) days after the date of such notice, advise Sellers in writing as to whether or not Purchaser desires to participate in the expansion and, if applicable, the size of the expansion desired by Purchaser. Should the desired expansion require the Sellers water production facilities to be expanded into an additional increment [as explained in paragraph C(3)], then the entire cost thereof shall be borne by Purchaser. The procedures relative to construction of the expansions and the payments for the same shall be as provided in paragraph C(2).

In the event Purchaser shall elect not to participate in such expansions as described in this subparagraph C(5)(c) or shall have elected to participate in the same, but not have met its obligation to provide the one million (1,000,000) gallon per day production capacity, and Sellers expand Sellers' water production facilities, it is understood that such additional capacity as is thereby created which is paid for by Sellers shall be used for the benefit of the citizens and residents of Harnett County, and only such portion thereof as is not required to meet the needs of Harnett County shall or may be sold to Purchaser. Moreover, such additional capacity in no way shall be deemed to lessen the obligations of Purchaser hereunder nor obligate Sellers to sell any portion thereof to Purchaser.

Further, should Purchaser thereafter wish to expand the production facilities of Sellers so as to obtain water production facility capacity for allocation to itself, Purchaser shall notify Sellers of such fact in writing; thereafter the procedures set forth in paragraph C(2) shall be applied except that the entire cost of the expansion shall be paid by Purchaser and said costs shall be due and payable over the course of the construction period within ten (10) days after the submission of periodic pay estimates (as issued by the contractor(s) and/or engineer) by Sellers to Purchaser. It is understood that should this series of events occur, all such water production facility expansion paid for by Purchaser shall be allocated and sold to Purchaser.

6. (Ownership of Facilities) It is understood that such upgraded, expanded, enlarged or additional facilities as are made or constructed hereunder shall be and remain the property of County and/or Northeast Metro, and Purchaser shall have no right, title or interest in or

to the same, except as to the rights of Purchaser hereunder relative to the production capacity allocations paid for by Purchaser.

7. (Additional Expansions by Sellers) In the event Sellers find that it is necessary or deem that it is advisable to make further water production facilities expansions, (beyond those described in the situations provided in this section), it is understood that such other expansions may be made at any time or the same time as any of those described. The cost of the further expansions shall be paid by Sellers.

8. (Future Expansions by Purchasers) In the event Purchaser shall desire to purchase quantities of water in excess of the amounts provided for herein, it is agreed that Purchaser may make additional expansions to the Sellers water production facilities, provided that:

(a) Sellers shall be given the option to participate in the expansion(s);

(b) Sellers shall not be required to participate in the expansion(s);

(c) Sellers shall have, without need for enlargement or expansion of any kind, sufficient water transportation facilities to deliver the quantities of water to Purchaser;

(d) Purchaser shall pay for its share of water production facility capacity which will be allocated to it; and

(e) The procedures relative to expansions as provided in paragraphs C(2) and C(3) shall be utilized in the expansion project(s); except that where the expansion project is paid for solely by Purchaser, payments for such expansion shall be made over the course of construction within ten (10) days after the submission of periodic pay estimates (as issued by the contractor(s) and/or engineer) by Sellers to Purchaser.

D. <u>It is further mutually agreed between the Sellers and the Purchaser as follows</u>:

1. (Relationship of County and Northeast Metro) As recited hereinabove, the system of Northeast Metro has been leased to County, and pursuant to the terms of said lease, County has the option to purchase the system of Northeast Metro. In the event that County should exercise its

option, and purchase the said system, it is understood that the rights and obligations of Northeast Metro hereunder shall be and hereby are transferred, assigned and conveyed to County. Likewise, in the event that County should not exercise its option, it is understood that the rights and obligations of County hereunder shall be and hereby are transferred, assigned and conveyed to Northeast Metro.

2. (Use of term "Sellers") As used herein, the term "Sellers" shall refer to County and/or Northeast Metro.

3. (Term of Contract) That this contract shall extend for a term of forty (40) years from the date of the initial delivery of any water as shown by the first bill submitted by the Seller to the Purchaser and, thereafter may be renewed or extended for such term, or terms, as may be agreed upon by the Seller and Purchaser.

4. (Emergency Services) That Sellers and Purchaser shall endeavor to provide such quantities of water each to the other as may be needed in the case of emergency water needs, such as water source contamination, production facility failure, natural disaster, or other catastrophe. The cost of such water shall be in an amount mutually agreed upon by the parties.

5. (Delivery of Water) That thirty (30) days prior to the estimated date of completion of construction of Purchaser's water main which shall connect to the meter facility (described in paragraph A(3) above), the Purchaser will notify the Sellers in writing of the date for the initial delivery of water. It is understood that no water shall be delivered until such time as the water distribution system of the Northwest Water and Sewer District of Harnett County is operational.

6. (Failure to Deliver) That the Sellers will, at all times, operate and maintain their system in an efficient manner and will take such action as may be necessary to furnish the Purchaser with quantities of water required by the Purchaser, except as provided in paragraph C. Temporary or partial failures to deliver water shall be remedied with all possible dispatch. In the event of an extended shortage of water, or the supply of water available to the Sellers is otherwise diminished over an extended period of time, the supply of water to Purchaser's consumers shall be reduced or diminished in the same ratio or proportion as the supply to Seller's consumers is reduced or diminished.

7. (Modification of Contract) That the provisions of this contract may be modified or altered by mutual agreement.

8. (Breach by Purchaser) In the event Purchaser shall breach its agreements hereunder or fail to take such actions as specified, Sellers shall have no further obligation to sell water to Purchaser hereunder. This provision in no way diminishes or prejudices any other rights or remedies of Sellers regarding any breach of this Contract.

9. (Regulatory Agencies) That this contract is subject to such rules, regulations, or laws as may be applicable to similar agreements in this State and the Sellers and Purchaser will collaborate in obtaining such permits, certificates, or the like, as may be required to comply therewith.

10. (Successor to the Purchaser) That in the event of any occurrence rendering the Purchaser incapable of performing under this contract, any successor of the Purchaser, whether the result of legal process, assignment, or otherwise, shall succeed to the rights of the Purchaser hereunder.

11. (Notices) Any notice required to be given hereunder by Sellers to Purchaser shall be made by Sellers in writing and mailed by first class mail to the Town of Fuquay-Varina at the following address:

~~Post Office Box 393~~
1300 E. Academy St.
Fuquay-Varina, NC 27526

Any notices required to be given hereunder by Purchaser to Sellers shall be made by Purchaser in writing and mailed by first class mail to the County Manager, Harnett County, at the following address:

Post Office Box 759, Lillington, N. C. 27546.

IN WITNESS WHEREOF, the parties hereto, acting under authority of their respective governing bodies, have caused this contract to be duly executed in triple counterparts, each of which shall constitute an original.

Executed by Northeast Metro, this 6th day of March, 1989.

NORTHEAST METROPOLITAN WATER
DISTRICT OF HARNETT COUNTY

By: _____
Timothy McKinnie
Chairman of the District Board

Attest:

_____
Vanessa W. Young, Clerk

(SEAL)

Executed by County, this 6th day of March, 1989.

COUNTY OF HARNETT

By: Lloyd G. Stewart
Lloyd G. Stewart, Chairman
Harnett County Board of Commissioners

Attest:
Vanessa W. Young
Vanessa W. Young, Clerk

(SEAL)

Executed by Town, this 23rd day of February, 1989.

TOWN OF FUQUAY-VARINA

By: Leo L. Matthews
Leo L. Matthews, Mayor Pro Tem

Attest:
Rachel B. Turner
Rachel B. Turner, Clerk

(SEAL)

NORTH CAROLINA

HARNETT COUNTY

Personally appeared before me, the undersigned Notary Public, Vanessa W. Young, who, being by me duly sworn, says that she knows the common seal of the Northeast Metropolitan Water District of Harnett County, and is acquainted with Timothy McKinnie who is the Chairman of the governing Board of Northeast Metropolitan Water District of Harnett County and that she, the said Vanessa W. Young, is the Clerk to said Board and saw the the said Timothy McKinnie sign the foregoing instrument in the name of Northeast Metropolitan Water District of Harnett County and that she, the said Vanessa W. Young, Clerk as aforesaid, affixed said seal of said District hereto and signed her name in attestation of said instrument in the presence of the said Timothy McKinnie, Chairman of said Board, all as authorized by the governing body of said District.

WITNESS my hand and Notarial Seal, this the 6th day of March, 1989.

KAY BLANCHARD
NOTARY PUBLIC
HARNETT COUNTY, N.C.

Kay Blanchard
Notary Public

My Commission Expires: July 22, 1992

NORTH CAROLINA

HARNETT COUNTY

I, Kay Blanchard, a Notary Public of the County and State aforesaid, certify that Lloyd G. Stewart, who, being by me duly sworn, says that he is Chairman of the Board of Commissioners of Harnett County, and that Vanessa W. Young is Clerk of said Board, that the seal affixed to the foregoing and attested instrument is the seal of Harnett County, North Carolina, and that said instrument was signed by him as Chairman of the Board of Commissioners of said County and by the Clerk of said Board, who affixed the official seal of Harnett County to said instrument; and that the said Lloyd G. Stewart, Chairman of the Board of Commissioners, acknowledged said instrument to be the act and deed of Harnett County North Carolina.

WITNESS my hand and Notarial Seal, this the 6th day of March, 1989.

KAY BLANCHARD NOTARY PUBLIC HARNETT COUNTY, N.C.

Kay Blanchard
Notary Public

My Commission Expires: July 22, 1992

NORTH CAROLINA

WAKE COUNTY

I, Kathy T. Vaughan, a Notary Public of the County and State aforesaid, certify that Leo. L. Matthews, who, being by me duly sworn, says that he is Mayor of the Town of Fuquay-Varina, and that Rachel B. Turner, is Pro Tem Clerk of said Town, that the seal affixed to the foregoing and attested instrument is the seal of said Town, and that said instrument was signed by him as Mayor in the above capacity and by the Clerk of said Town, who affixed the official seal of said Town to said instrument; and that the said Leo. L. Matthews (Mayor) in the above capacity acknowledged said instrument to be the act and deed of the Town of Fuquay-Varina.

WITNESS my hand and Notarial Seal, this the 24 day of February, 1989.

Kathy T. Vaughan
Notary Public

My Commission Expires: 5-7-90

Interlocal Agreement
Between Town of Fuquay-Varina and Harnett County (1999)

2nd 1mgd

NORTH CAROLINA,

HARNETT COUNTY

AGREEMENT

THIS AGREEMENT is made and entered into this the 3rd day of August, 1999, by and between the County of Harnett, a body politic, organized and existing under the laws of the State of North Carolina (hereinafter referred to as "County"); the Town of Fuquay-Varina, a municipal corporation organized and existing under the laws of the State of North Carolina (hereinafter referred to as "Fuquay-Varina"); and the Town of Holly Springs, a municipal corporation organized and existing under the laws of the State of North Carolina (hereinafter referred to as "Holly Springs").

WITNESSETH:

THAT WHEREAS, the parties desire to provide for the construction of a 36-inch waterline for the delivery of water to the Harnett County/Wake County line at a point to be determined, together with additional high-service pumping facilities to be located at the Harnett County Regional Water Treatment Facility in Lillington, North Carolina, a regional booster station and storage facilities, and related appurtenances necessary for the transmission of the water through said waterlines (hereinafter referred to as "The Project"); and

WHEREAS, the purpose of The Project is to provide an independent waterline capable of ultimately delivering twenty-three million gallons of water per day (23 mgd) to the Wake County line; and

WHEREAS, it has been estimated that the total cost of this project will be approximately $10,555,000 (ten million five hundred fifty-five thousand dollars); and

$\frac{23{,}000{,}000\ gds}{day} \mid \frac{1\ day}{1440\ min} \mid \frac{1\ min}{60\ sec} \mid \frac{1\ cf}{7.481\ gal} \Rightarrow \frac{(3/2)^2}{\pi} = 35.58\ cfs \Rightarrow 5\ ft/s$

36" in line area = 7.07 sf

WHEREAS, the Regional Water Treatment Facility owned by the County has a current capacity of twelve million gallons per day (12 mgd), of which Fuquay-Varina and Holly Springs each own one million gallons per day (1 mgd) of said capacity; and

WHEREAS, the County is conducting a pilot study pursuant to guidelines of the North Carolina Department of Environment, Health and Natural Resources for the purpose of obtaining approval to "high rate" the County's existing water treatment facility in order to expand the treatment capacity of the facility to eighteen million gallons per day (18 mgd); and

WHEREAS, Fuquay-Varina and Holly Springs have each requested an additional one million gallons per day (1 mgd) of the facility's capacity to be allocated out of the additional six million gallon per day (6 mgd) of the treatment capacity; and

WHEREAS, Harnett County has made application for a permit to increase its withdrawal allocation out of the Cape Fear River and Jordan Lake to twenty-four million gallons per day (24 mgd); and

WHEREAS, it is anticipated that The Project will require at least thirty (30) months to complete to include the design, approval by the State, and the bidding and awarding of construction; and

WHEREAS, the parties desire to begin the design of The Project and to take other necessary steps in order to advance the completion of said project; and

WHEREAS, pursuant to the provisions of Chapter 160A, Article 20, Part I of the North Carolina General Statutes, the parties now desire to enter into this agreement to provide for the payment of preliminary costs to include legal, engineering and land acquisition costs in connection with the implementation of The Project; and to set forth certain other understandings regarding this project;

NOW, THEREFORE, the parties agree, each with the other, as follows:

1. Purpose. The purpose of this agreement is to set forth the understandings and agreements of the parties regarding the payment of preliminary costs of The Project to include legal, engineering and land acquisition costs in connection with The Project and other related matters including the allocation of capacity in the waterline to be constructed and in the pumping facilities of the Project.

2. County is to Design and Construct The Project. The County shall design and construct The Project, and it shall be the lead agency for the funding of The Project.

3. Allocation of Capacity in the Thirty-Six Inch (36") Waterline. The capacity in the thirty-six inch (36") waterline to be constructed by the County as part of The Project from Lillington, North Carolina, to a point to be designated at the Harnett County/Wake County line shall be allocated as follows:

a. Harnett County shall have 8.42 million gallons per day (8.42 mgd) capacity in said line.

b. Fuquay-Varina shall have 5 million gallons per day (5 mgd) capacity in said line.

c. Holly Springs shall have 9.58 million gallons per day (9.58 mgd) capacity in said line.

4. Payment of Preliminary Costs. The parties agree to pay the costs for preliminary work on The Project to include legal, engineering and land acquisition costs in the following manner:

a. Harnett County shall pay 8.42/23 of the preliminary costs.

b. Fuquay-Varina shall pay 5/23 of the preliminary costs.

c. Holly Springs shall pay 9.58/23 of the preliminary costs.

Fuquay-Varina agrees to pay to the County One Hundred Forty Thousand Eight Hundred Dollars ($140,800) within thirty (30) days of executing this Agreement toward the preliminary costs of this Project. Holly Springs agrees to pay to the County Two Hundred Sixty-Nine Thousand Seven Hundred Dollars ($269,700) within thirty (30) days of executing this Agreement toward the preliminary costs of this Project. Thereafter, the engineer for the County shall prepare a schedule of estimated monthly costs, not to exceed the actual cost over the design phase, to meet the cash flow requirements of The Project. The County shall bill the parties monthly for the estimated monthly costs, and the parties shall pay said costs within ninety (90) days of the date of said bill.

5. Payment Upon Withdrawal from The Project. Should any party decide to withdraw from The Project prior to its completion, the party shall pay Harnett County the prorated share of costs incurred and/or billed as of the date of the notice of withdrawal, plus up to a maximum of fifteen per cent (15%) of the estimated total preliminary costs, depending upon the time of the withdrawal relative to the stage of design, in order to cover the costs of scaling down The Project and other costs associated with the withdrawal of the party from The Project. Upon payment of the amount required, this Agreement shall be terminated as to the withdrawing party.

6. Certification of Availability for Funding. The parties agree that at the time plans for The Project are submitted to the North Carolina Department of Environment, Health and Natural Resources, Water Supply Branch, each party shall certify to the County that funds are available for the payment of the completion of The Project.

7. Upgrading of Distribution Capacity. The current project is designed to pump 12 mgd through the thirty-six inch (36") waterline. The capacity of the initial pumping facilities of The Project shall be allocated as follows:

a. Harnett County shall have 4.393-mgd capacity in the pumping facilities.

b. Fuquay-Varina shall have 2.609 mgd capacity in the pumping facilities.

c. Holly Springs shall have 4.998 mgd capacity in the pumping facilities.

At such time as the County determines that the pumping facilities of The Project have reached ninety percent (90%) of its pumping capacity, the County shall notify the parties. Each party shall have an opportunity to participate in the expansion of additional capacity in the pumping facilities and may obtain an allocation of the expanded capacity. Those parties desiring to participate in the expansion of the pumping facilities shall share in the costs of expansion based upon the percentage of the additional pumping capacity desired by the party. If a party desires not to increase its capacity in the pumping facilities at the time notified by the County, it shall bear no costs in the expansion. For example, if Party 1 and Party 2 desire to increase its capacity in the pumping facilities by 1 mgd each, and Party 3 does not desire to participate, then Party 1 and Party 2 would each pay 50% of the costs of upgrade, and Party 3 would pay nothing.

The pumping facilities may be expanded at other times after the pumping facilities have reached ninety percent (90%) of capacity at the request of any party, and the costs will be allocated based on the percentage of participation in the expansion by the parties. For example, if only one party desired to expand the pumping facility, then that party would bear all the costs for such expansion. The County would retain control of the design and construction of any expansion to the pumping facilities.

A party's capacity in the pumping facilities shall not exceed its allocation of capacity in the thirty-six inch (36") waterline as set forth in Paragraph 3 of this agreement. Therefore, Harnett County's capacity in the pumping facilities shall not exceed 8.42 mgd; Fuquay-Varina's capacity in the pumping facilities shall not exceed 5 mgd; and Holly Spring's capacity in the pumping facilities shall not exceed 9.58 mgd.

8. Conveyance of Waterline Capacity. A party may convey any part of its allocation of capacity in the thirty-six inch (36") waterline provided that such conveyance does not result in any negative financial impact to any parties to this Agreement, any negative hydraulic impact to any of the parties, or any technical problems in the operation of the pumping and distribution facilities of The Project.

9. Real Property. The County of Harnett shall own any real property in connection with The Project, and the County of Harnett, the Town of Fuquay-Varina and the Town of Holly Springs shall own capacity in the waterlines and pumping facilities as set forth in this Agreement.

10. Amendments and Termination. This Agreement may be amended by the mutual consent of all parties, and the Agreement may be terminated by the mutual consent of all parties.

11. Term of Agreement. This Agreement shall extend for a term of forty (40) years from the date of the Agreement as set forth herein.

12. Notices. Any notice or billing given pursuant to the terms of this agreement shall be made in writing and mailed by first class mail to the following addresses:

County of Harnett
Post Office Box 759
Lillington, NC 27546

Town of Fuquay-Varina
1300 East Academy Street
Fuquay-Varina, NC 27526

Town of Holly Springs
Post Office Box 8
128 South Main Street
Holly Springs, NC 27540

IN WITNESS WHEREOF, the parties hereto, acting under authority of their respective governing bodies, have caused this agreement to be duly executed in three (3) counterparts, each of which shall constitute an original.

Executed by Harnett County, this the 21st day of June, 1999.

COUNTY OF HARNETT

By: Dan B. Andrews
Dan B. Andrews, Chairman
Harnett County Board of Commissioners

Attest:

Kay S. Blanchard
Kay S. Blanchard, Clerk to the Board

Executed by the Town of Fuquay-Varina, this 20th day of July, 1999.

TOWN OF FUQUAY-VARINA

By: Bob Barker
Bob Barker, Mayor

Attest:

Rachel B. Turner
RACHEL B. TURNER, Clerk

Executed by Town of Holly Springs, this 3rd day of August, 1999.

TOWN OF HOLLY SPRINGS

By: Gerald W. Holleman
Gerald W. Holleman, Mayor

THE TOWN of HOLLY SPRINGS 1876 WAKE COUNTY NORTH CAROLINA

Attest:

Joni Smith Powell
Joni Smith Powell, Town Clerk

This instrument has been pre-audited in the manner prescribed by the Local Government Budget and Fiscal Control Act.

John W. Ellis
Finance Officer, Town of Holly Springs

NORTH CAROLINA

HARNETT COUNTY

I, Deanna Fitzgerald, a Notary Public of the County and State aforesaid, certify that Dan B. Andrews, who being by me duly sworn, says that he is Chairman of the Board of Commissioners of Harnett County, and that Kay S. Blanchard is Clerk of said Board, that the seal affixed to the foregoing and attested instrument is the seal of Harnett County, North Carolina, and that said instrument was signed by him as Chairman of the Board of Commissioners of said County and by the Clerk of said Board, who affixed the official seal of Harnett County to said instrument; and that the said Dan B. Andrews, Chairman of the Board of Commissioners, acknowledged said instrument to be the act and deed of Harnett County North Carolina.

WITNESS my hand and Notarial Seal, this the 21st day of June, 1999.

Deanna Fitzgerald
Notary Public

My Commission Expires: 11-14-2001

_____

_____, Clerk

NORTH CAROLINA

WAKE COUNTY

I, Rose H. John, a Notary Public of the County and State aforesaid, certify that Bob Barker, who being by me duly sworn, says that he is Mayor of the Town of Fuquay-Varina, and that Rachel B. Turner, is the Clerk of said Town, that the seal affixed to the foregoing and attested instrument is the seal of said Town, and that said instrument was signed by him as Mayor in the above capacity and by the Clerk of said Town, who affixed the official seal of said Town to said instrument; and that the said Bob Barker (Mayor) in the above capacity acknowledged said instrument to be the act and deed of the Town of Fuquay-Varina.

WITNESS my hand and Notarial Seal, this the 20th day of July, 1999.

Rose H. John
Notary Public

My Commission Expires: 08/27/2002

Interlocal Agreement
Between Town of Fuquay-Varina and Harnett County (2022)

NORTH CAROLINA

HARNETT COUNTY

BULK WATER SUPPLY AGREEMENT

THIS AGREEMENT is made and entered into this 18th day of April, 2022, by and between the County of Harnett, a body politic, organized and existing under the laws of the State of North Carolina (hereinafter referred to as "County"), and the Town of Fuquay-Varina, a municipal corporation, organized and existing under the laws of the State of North Carolina (hereinafter "Town).

WITNESSETH

WHEREAS, County operates and manages water treatment facilities and water distribution systems located within its boundaries, and has established Harnett Regional Water for the purpose of operating and managing the facilities and systems; and

WHEREAS, Town operates and manages a water distribution system located within its boundaries, and has established a Department of Public Utilities for the purpose of operating and managing the facilities and systems; and

WHEREAS, County and Town recognize that a regional approach to water supply and treatment benefits both the County and the Town by increasing their capacity to serve their citizens and that there exists a limited and finite capacity to supply, treat and distribute potable water; and

WHEREAS, County and Town entered into a Water Purchase Contract on February 23, 1989 to purchase 1 million gallons per day ("MGD") of water capacity in the Harnett Regional Water Treatment Plant; and

WHEREAS, County and Town entered into an Agreement on August 3, 1999 to purchase an additional 1 MGD of water capacity in the Harnett Regional Water Treatment Plant for a total

of 2 MGD of water capacity in the Harnett Regional Water Treatment Plant and 5 MGD capacity in the Harnett County/Wake County thirty-six inch waterline; and

WHEREAS, County and Town desire for County to provide an additional 2 MGD bulk supply of potable water to the Town for a period of 10 years and the parties desire to set forth the terms and conditions of this Agreement; and

NOW, THEREFORE, in consideration of the mutual benefits, representations, and agreements contained herein and for good and valuable consideration, the receipt and sufficiency of which are hereby acknowledge, the parties agree, each with the other, as follows:

I. Purpose. The purpose of this Agreement is to set forth the understandings and agreements of the parties regarding the sale of an additional 2 MGD bulk supply of potable water from the County to the Town This sale of 2 MGD bulk supply of potable water along with the existing 2 MGD of water capacity that the Town owns in the Harnett Regional Water Plant brings the total amount of water supplied from County to Town to a maximum of 4 MGD subject to the term of this Agreement.

II. Definitions. In addition to the foregoing, the following definitions and/or explanation of terms shall be used for the purpose of this Agreement.

A. "County Water Distribution Systems" shall mean the County's network of water distribution lines and other related appurtenances and/or facilities necessary for the delivery of potable water to town connection points.

B. "Metering Points" shall mean those points County shall measure where potable water flows into the Town's distribution system.

III. County agrees as follows:

A. Quality and Quantity. To furnish the Town at a single designated point of delivery located at the existing meter on Fleming Road in Wake County during the term of this Agreement or any renewal and/or extension thereof, potable treated water meeting the applicable purity standards of the North Carolina Department of Environmental Quality in such quantity that shall not exceed the demand limitations as further defined in Section IV., subsectionC. of this Agreement.

B. Point of Delivery and Pressure. Notwithstanding Section, V., subsection I., the County shall provide water purchased through this Agreement, the February 23, 1989 Agreement, the August 3, 1999 Agreement, and any other prior agreements still in effect to the connection point located on Fleming Road in Wake County. The water will be furnished at a reasonable constant pressure to the overflow elevation of the Town's existing and future elevated water storage structures. Emergency failures of pressure or supply due to main supply line breaks, power failure, flood, fire and use of water to fight fire, earthquake or other catastrophe shall excuse the County from this provision for such reasonable period of time as may be necessary to restore service.

C. Metering Equipment. To furnish, install, operate and maintain at its own expense at points of delivery, the necessary metering equipment, including a meter house or pit, and required devices of standard type for properly measuring the quantity of water delivered to the Town and to calibrate such metering equipment as may be agreed upon by County and Town. A meter registering not more than two percent (2%) above or below the test result shall be deemed to be accurate. The previous readings of any meter disclosed by test to be inaccurate shall be corrected for the

three months previous to such test in accordance with the percentage of inaccuracy found by such tests. If any meter fails to register for any period, the amount of water furnished during such period shall be deemed to be the amount of water delivered in the corresponding period immediately prior to the failure, unless the County and Town agree upon a different amount. The metering equipment shall be read by the last day of each calendar month. An appropriate official of the Town shall at all reasonable times have access to the meter for the purpose of verifying its readings.

D. Billing Procedure. To furnish the Town at the designated address not later than the 5th day of each month, with an itemized statement of the amount of water furnished the Town during the preceding month.

IV. Town agrees as follows:

A. Rates and Payment Date. To pay the County, not later than the 20th day of each month, for the additional 2 MGD of water delivered under this Agreement in accordance with the following schedule of rates:

$2.60/1,000 gallons of water

$0.25/1000 gallons pumping charge

Town shall pay the above rate charge and pumping charge for the bulk water purchased under this Agreement for a total of $2.85 per 1000 gallons of water used. Said rate charge and pumping charge are subject to change at any time by the Harnett County Board of Commissioners.

B. Connection Fee. That for any future mutually agreed to connections by the Town to the County's distribution system, to pay as a connection fee a sum of money sufficient to cover any and all costs of the County for furnishing and installation of said connection to include all necessary labor, appurtenances, and metering equipment.

C. Demand Limitations. Notwithstanding, Section V., subsection I., demand limitation for the provision of all water provided under this Agreement, the February 23, 1989 Agreement, the August 3, 1999 Agreement, and any other agreements in effect is hereby amended to take into account the increase in the total supply of water provided by the County to the Town. The Town shall limit its demand in any 24-hour period to that which can be supplied by a constant 2,776 gallons per minute (gpm) flow rate supplied by the County.

V. General Provisions. It is further mutually understood and agreed by the parties that:

A. Term of Contract. That this contract shall extend for a term of ten (10) years from the date of the Agreement and, thereafter, may be renewed or extended for such term, or terms, as may be agreed upon by both parties. This ten (10) year term is specific to the additional 2 MGD bulk water supply and does not modify or alter the duration of the February 23, 1989 Agreement, August 3, 1999 Agreement, or any other agreements in effect. County and Town, in addition to all other legal remedies may terminate this Agreement for any material default or breach of this Agreement. County and Town agree that a minimum of 1-year notification must be provided prior to any termination.

B. Failure to Deliver. That County will, at all times, use reasonable diligence to provide uninterrupted water supply to Town. County shall not be liable to Town or any consumer purchasing water from Town for damage(s) for failure in, temporary interruption or temporary suspension of water supply, so long as such failure, interruption or suspension is not caused by the willful conduct of County. County reserves the right to suspend the supply, without liability on its part, at such time, for such period, and in such manner as it may deem necessary for the purpose of making adjustments to, changes in, or repairs to the infrastructure and facilities for which suspension of supply and shall provide written notice to Town of any planned suspension no less than ten (10) days in advance of suspension. In the event of an emergency that impairs the supply of potable water to Town, County shall contact Town as soon as reasonably possible.

C. Waiver and Indemnity. To the fullest extent allowed by law, County assumes responsibility for and shall hold harmless, defend and indemnify Town against all liability, claims, judgments, losses, costs, and expenses (including reasonable attorneys' fees), for any injury, loss, or damage to persons or property including fines by any Federal or State agency and also including personal injury or property damage on account of, or in any way arising out of, the maintenance and operation of water utility infrastructure owned by County. County explicitly disclaims and excludes any warranties under the Uniform Commercial Code, or any other law, including, but not limited to, an implied warranty of fitness for a particular purpose or an implied warranty of merchantability.

To the fullest extent allowed by law, Town assumes responsibility for and shall hold harmless, defend and indemnify County against all liability, claims, judgments, losses, costs, and expenses (including reasonable attorneys fees) for any and all injury, loss, or damage to persons or property, including fines by any Federal or State agency, and also including personal injury or property damage to County, its employees, customers, tenants, and citizens on account of, or in any way arising out of the maintenance and operation of water utility infrastructure owned by Town.

Neither party shall be responsible to indemnify the other against bodily injury or property damage to the extent that such damages are caused by the negligence of the other. Each party shall notify the other in writing of any claim for indemnification hereunder, and shall describe in such notice the nature and cause of the claim. The party against whom the claim is asserted shall be allowed a reasonable time and opportunity to cure, mitigate, defend and otherwise address the claim.

C. Modification of Contract. That the provisions of this Contract pertaining to the schedule of rates to be paid by the Town for water delivered are subject to and governed by the Ordinances adopted by County for Harnett Regional Water and subject to change at any time by the Harnett County Board of Commissioners.

Other provisions of this contract may be modified or altered by mutual agreement.

D. Regulatory Agencies. That this contract is subject to such rules, regulations, or laws as may be applicable to similar agreements in this State and the County and Town will collaborate in obtaining such permits, certificates, or the like, as may be required to comply therewith.

E. Franchise. The Town agrees that the County shall have a franchise to furnish water to the master meter of the Town. The County agrees that the Town shall maintain the rights to at any such time during the term of the agreement secure alternate back-up water supply from sources as may be identified by the Town.

F. Transfer or Assignment. The covenants and agreements contained in this Agreement are specifically binding on the parties hereto, and the covenants and agreements contained in this Agreement and the commitment by the County to provide services to Town is limited to the Town of Fuquay-Varina and may not be transferred or assigned to any other party or parties without the express written consent of County, which consent shall not be unreasonably withheld Furthermore, the covenants and agreements contained in this Agreement and the commitment by the County to provide services to Town is limited to County and may not be transferred or assigned to any other party or parties without the express written consent of the Town, which consent shall not be unreasonably withheld.

G. Mediation. Any claim, dispute or other matter in question arising out of or related to this Agreement shall be subject to mediation as a condition precedent to the institution of legal or equitable proceedings by either party. The Parties agree that the mediation will be conducted and governed by the North Carolina Rules Implementing Statewide Mediated Settlement Conferences in Superior Court Civil Actions, and N.G.G.S. Sect. 7A-38.1(c) except as specifically provided otherwise herein. The parties shall share the mediator's fee and any filing fees equally. The mediation shall be held in Harnett County, unless another location is mutually

agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

H. Governing Law. This Agreement shall be governed by the laws of the State of North Carolina. The place of the Agreement, its situs and forum, shall be Harnett County, North Carolina, where all matters, whether sounding in Contract or in tort, relating to its validity, construction, interpretation and enforcement shall be determined. County and Town agree and submit, solely for matters relating to the Agreement, to the jurisdiction of the courts of the State of North Carolina, and stipulates that Harnett County shall be the proper venue for all matters.

I. Entire Agreement. This Agreement represents the entire and integrated agreement between County and Town and supersedes all prior negotiations, representations or agreements, either written or oral, except that it does not modify, supersede, or alter the terms of the February 23, 1989 Agreement or the August 3, 1999 Agreement, except as specifically set forth in this Agreement . This Agreement may only be amended by written instrument signed by County and Town.

J. No Third-Party Beneficiaries. Nothing contained in this Agreement shall create a contractual relationship with or cause of action in favor of a third party against Town or County.

K. Severance Clause. In the event any provision of this Agreement is adjudged to be not enforceable or found invalid, such provision shall be stricken and the remaining provisions shall be valid and enforceable.

L. Notices. All notices or other communications which shall be made pursuant hereto shall be in writing and shall be deemed to be given and received (a) when hand

delivered to the address stated below, (b) three (3) days after being mailed to the address stated below, postage prepaid by certified or registered mail of the United States, return receipt requested to the address set forth below:

TO: Town of Fuquay-Varina:
134 N. Main Street
Fuquay-Varina, North Carolina 27526
Attn: Town Manager

TO: County of Harnett:
c/o Harnett Regional Water
700 McKinney Pkwy
Lillington, North Carolina 27546
Attn: Director of Harnett Regional Water

With copy to:

County of Harnett
Post Office Box 238
Lillington, North Carolina 27546
Attn: Senior Staff Attorney

Town of Fuquay-Varina
134 N Main Street
Fuquay-Varina, North Carolina 27526
Attn: Public Utilities Director

Either party to this Agreement may change its designated person or designated address at any time and from time to time by giving notice of such change to the other party in the manner set forth above.

IN WITNESS WHEREOF, the parties hereto, through their duly authorized representatives or officers have executed this Agreement as to the date and year first above written.

COUNTY OF HARNETT

BY: _____
Lewis W. Weatherspoon, Board of Commissioners Chairman

ATTEST:

_____
Melissa Capps, Clerk

TOWN OF FUQUAY-VARINA

By: _____
J. Blake Massengill, Mayor

ATTEST:

_____
Rose Rich, Clerk

Interlocal Agreement
Between Town of Fuquay-Varina and Harnett County (2000)

NORTH CAROLINA,

HARNETT COUNTY AGREEMENT

THIS AGREEMENT is made and entered into this the 9th day of ~~April~~ Nov., 2000, by and between the **COUNTY OF HARNETT**, a body politic, organized and existing under the laws of the State of North Carolina (hereinafter referred to as "County"), and the **TOWN OF FUQUAY-VARINA**, a municipal corporation organized and existing under the laws of the State of North Carolina (hereinafter referred to as "Fuquay-Varina").

W I T N E S S E T H:

THAT WHEREAS, the parties desire for the construction of a wastewater interceptor line for the delivery of wastewater from Fuquay-Varina's current wastewater treatment facility to a regional wastewater treatment facility to be located at the Harnett County Regional Wastewater Treatment Facility at Lillington; and

WHEREAS, Fuquay-Varina also desires to initially obtain an allocation of two million gallons per day (2 mgd) of treatment capacity in the regional wastewater facility with the ability to obtain an additional four million gallons per day (4 mgd) in the future; and

WHEREAS, the County desires to provide such capacity in the regional wastewater facility to Fuquay-Varina; and

WHEREAS, the parties desire to begin the design of the wastewater interceptor line and the regional wastewater treatment facility (the "Project") and to take other steps necessary in order to advance the completion of the Project; and

WHEREAS, pursuant to the provisions of Chapter 160A, Article 20, Part I of the North Carolina General Statutes, the parties now desire to enter into this Agreement to provide for the payment of preliminary costs to include the preparation of a 201 Facilities Plan, obtaining environmental assessments, and the design of the Project; and to set forth certain other understandings regarding this project;

NOW, THEREFORE, in consideration of the mutual representations and agreements contained herein and for good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the parties agree, each with the other, as follows:

1. Purpose. The purpose of this Agreement is to set forth the understandings and agreements of the parties regarding environmental work and the design and construction of the wastewater interceptor line from the Fuquay-Varina wastewater treatment facility at Kennis Creek

to the Harnett County Regional Wastewater Treatment Facility at Lillington to be constructed on the present site of the Town of Lillington's treatment facility (the design and construction of the interceptor line shall be sometimes referred to hereafter as "the Project"); to set forth provisions for the payment of costs in connection with the Project, and to set forth other related matters including the allocation of capacity in the interceptor line and capacity in the regional wastewater treatment facility.

2. Responsibility for Design and Construction of the Interceptor Line. Fuquay-Varina shall design and construct the portion of the wastewater interceptor line from the Fuquay-Varina wastewater treatment facility to a metering point to be located at approximately the Wake County-Harnett County line. The exact location of the metering point shall be determined by the engineers for Fuquay-Varina and the County. The County shall design and construct the wastewater interceptor line from the metering point to the regional wastewater facility located at Lillington.

The County as the lead applicant of the 201 Facility Planning shall be responsible for the 201 Facility Planning Study and the Environmental Assessment.

3. Payment of Preliminary Costs of the Interceptor Line. The parties agree to pay the costs for preliminary work on the interceptor line, to include a 201 Facility Plan, environmental assessments and design of the interceptor line, in the following manner:

a. 201 Facility Plan: Fuquay-Varina and the County shall each pay one-half (1/2) of the costs of the 201 Facilities Plan.

b. Environmental Assessment: Fuquay-Varina shall pay for the cost of the initial environmental assessment from the Fuquay-Varina treatment facility to the metering point. Fuquay-Varina and the County shall each pay one-half (1/2) of the cost for the initial environmental assessment from the metering point to the regional wastewater treatment facility at Lillington.

Any environmental work done beyond the initial assessment, including any work relating to mitigation, shall be paid according to the location of the portion of the interceptor line which necessitates the additional work. That is, if the additional work is required due to conditions along the interceptor line from the Fuquay-Varina treatment plant to the metering point, Fuquay-Varina shall pay the costs for the additional work. If the additional work is due to conditions between the metering point and the regional facility in Lillington, the costs for the work shall be paid one-half (1/2) by Fuquay-Varina and one-half (1/2) by the County.

c. Design: Fuqua-Varina shall pay for the design of the interceptor line from the Fuquay-Varina treatment plant to the metering point. Fuquay-Varina and the County shall each pay one-half (1/2) of the costs of design from the metering point to the regional wastewater facility at Lillington.

Fuquay-Varina agrees to pay to the County ten percent (10%) of the estimated preliminary costs of the interceptor line within thirty (30) days of executing this Agreement. Thereafter, the engineer for the County shall prepare a schedule of estimated monthly costs, not to exceed the actual cost through the design phase, to meet the cash flow requirements of the preliminary costs of the interceptor line. The engineer for the County shall keep the engineer for Fuquay-Varina informed during the process of preparing the schedule of estimated monthly costs. The County shall bill Fuquay-Varina monthly for the estimated monthly costs, and Fuquay-Varina shall pay said bill within twenty (20) days of the date of said bill.

4. Allocation of Capacity in the Interceptor Line. The capacity in the interceptor line, which is to be constructed from Fuquay-Varina's treatment facility to the regional wastewater treatment facility at Lillington, shall be allocated as follows:

a. Fuquay-Varina shall have six million gallons per day (6 mgd) average daily flow of capacity in said line.

b. Harnett County shall have two million gallons per day (2 mgd) average daily flow of capacity in said line.

The design of the interceptor line and the determination of capacity is based upon a peaking factor of 2.0. Any excess capacity above eight million gallons per day (8 mgd) average daily flow (based on a peaking factor of 2.0) shall be shared by the parties on a 3 to 1 ratio; with Fuquay-Varina having 3/4 of the excess average daily capacity and the County having 1/4 of the excess average daily capacity.

5. Payment for Construction of Interceptor Line. Fuquay-Varina shall pay for all land and easement acquisition costs, including attorneys' fees and other associated costs, in connection with the construction of the interceptor line from the Fuquay-Varina Treatment Facility to the metering point. The County and Fuquay-Varina shall each pay one-half (1/2) of all land acquisition costs, including attorneys' fees and other associated costs, in connection with the construction of the interceptor line from the metering point to the regional wastewater facility in Lillington. The land shall be procured based upon applicable State and Federal guidelines and

shall be based upon fair market value. The land acquisition costs will be due and payable by Fuquay-Varina to the County of Harnett within twenty (20) days of billing by the County. Fuquay-Varina shall pay all costs of the construction of the interceptor line from the Fuquay-Varina Treatment Plant to the metering point. The County and Fuquay-Varina shall each pay one-half (1/2) of the costs of construction from the metering point to the regional wastewater facility.

The construction costs for the portion of the interceptor line from the metering point to the regional facility shall be due and payable due to the County as follows:

a. Fuquay-Varina shall pay ten percent (10%) of its share of the construction costs within twenty (20) days after the award of the contract or contracts for construction.

b. Thereafter, Fuquay-Varina shall pay its proportionate share of each invoice within twenty (20) days after the date the County sends notice of the invoice to Fuquay-Varina until such time as Fuquay-Varina has paid its total proportionate share of the construction costs.

6. Ownership and Maintenance of Interceptor Line. Fuquay-Varina shall own, operate and maintain that portion of the interceptor line from the Fuquay-Varina Treatment Plant to the metering point. The County shall own, operate and maintain that portion of the interceptor line from the metering point to the regional wastewater facility in Lillington.

7. Initial Allocation of Capacity in the Regional Wastewater Treatment Facility. Fuquay-Varina shall be initially allocated two million gallons per day (2 mgd) of treatment capacity in the expansion of the Regional Wastewater Facility at Lillington.

8. Payment for Initial Allocation of Capacity. The pro-rata costs of the portion of the expansion of the current Regional Wastewater Treatment Facility which is to be allocated exclusively to Fuquay-Varina shall be paid by it as set forth herein. Such costs shall include administrative costs of the County, costs of engineering and design, and attorneys' fees. Such amount of the costs of the expansion to be paid by Fuquay-Varina shall be due and payable to the County as follows:

a. Ten percent (10%) thereof shall be due and payable within twenty (20) days after the award for the contract or contracts for construction.

b. Thereafter, Fuquay-Varina shall pay its proportionate share of each invoice within twenty (20) days after the date the County sends notice of the invoice to Fuquay-Varina, until such time as Fuquay-Varina has paid its total proportionate share of the costs of expansion.

9. Allocation of Additional Capacity and Method of Payment. Fuquay-Varina shall be entitled to purchase an additional four million gallons per day (4 mgd) of treatment capacity in the regional facility in the future. It is the intent of this Agreement that the parties provide each other advance notice of their planning for wastewater expansions to enable the parties to coordinate expansion efforts and provide the benefits of economy of scale in plant expansion.

The County shall in the future advise Fuquay-Varina in writing of its intent to expand the regional facility in order to provide Fuquay-Varina with the option of purchasing its additional capacity. Fuquay-Varina shall, within forty-five (45) days after date of such notice, provide sellers with a letter of intent as to its decision regarding participation in expansion of the regional facility. Within one hundred sixty (160) days after the date of the County's notice to Fuquay-Varina, Fuquay-Varina shall provide the County in writing a final binding statement as to its decision.

The pro-rata cost of that portion of the expanded regional wastewater treatment facility capacity which is to be allocated exclusively to Fuquay-Varina shall be paid by Fuquay-Varina. Such costs shall include administrative costs of the seller, costs of engineering and design, and attorneys' fees. The County shall inform Fuquay-Varina of the progress of design and construction and as to the costs of any expansion project. Such amount of the cost to be paid by Fuquay-Varina shall be due and payable as follows:

a. Fuquay-Varina shall pay ten percent (10%) of its share of the expansion costs within twenty (20) days after the award of the contract or contracts for construction and/or expansion.

b. Thereafter, Fuquay-Varina shall pay its proportionate share of each invoice within twenty (20) days after the date the County sends notice of the invoice to Fuquay-Varina until such time as Fuquay-Varina has paid its total proportionate share of the construction costs.

In the event Fuquay-Varina desires to obtain its additional capacity allocation or a portion thereof at a time when the County is not expanding the treatment facility, Fuquay-Varina may expand the regional facility up to its additional allocation of capacity and Fuquay-Varina shall pay all costs of the expansion. The procedure to be applied in expanding the regional facility shall be as follows:

i). Fuquay-Varina shall notify the County in writing of its intent to expand the regional facility and of the size of the desired expansion.

ii). The County shall employ consulting engineers to design the necessary alterations to expand the said wastewater treatment facilities.

iii). Upon completion of the design of said alterations, pursuant to law, the County shall obtain the necessary permits from the applicable federal, state or local governments and/or agencies to proceed with the construction of the expansion. Thereafter, the County shall submit the expansion project for bids and shall award the contract(s) and proceed to construct the project. It is understood that the County has the right to re-bid the project or take other such actions relative to the awarding of contract(s) as County deems necessary and as provided by law.

iv). Fuquay-Varina shall pay ten percent (10%) of the expansion costs within twenty (20) days after the award of the contract or contracts for construction and/or expansion including engineering contracts.

v). Fuquay-Varina shall pay all other costs of expansion within twenty (20) days of billing by the County.

10. Ownership of Regional Wastewater Facility. It is understood that the County shall own and operate the regional wastewater treatment facility and any expansions, upgrades, enlargements, or additions to the facility, and Fuquay-Varina shall have no right, title or interest in or to the facility, except as to the rights to capacity in the interceptor line and treatment capacity allocations paid for by it as set forth herein.

11. Cooperation in Obtaining Financing. The parties hereby agree to cooperate in efforts to obtain and secure financing for the construction of the interceptor line and the initial expansion of the existing wastewater treatment plant currently owned by the Town of Lillington.

12. Operational Costs. The parties shall enter into an additional operational agreement at a later date for the treatment of the wastewater by the County from the interceptor line. The costs for treatment will be tied to the County's bulk municipal sewer rate as established by the County and pumping costs and in accordance with the 201 Facilities Plan requirements.

13. Pre-Treatment Program. The County and Fuquay-Varina shall adopt a Pre-Treatment Program in accordance with State and Federal guidelines that will protect the wastewater treatment process in accordance with the approved Facilities Plan.

14. Amendments and Termination. This Agreement may be amended by the mutual consent of all parties, and the Agreement may be terminated by the mutual consent of all parties.

15. Term of Agreement. This Agreement shall extend for a term of forty (40) years from the date of the Agreement set forth herein and shall be automatically renewed for an additional forty (40) years unless mutually terminated by the parties.

16. Notices. Any notices or billing given pursuant to the terms of this Agreement shall be made in writing and mailed by first class mail to the following addresses:

County of Harnett
c/o County Manager
Post Office Box 759
Lillington, NC 27546

Town of Fuquay-Varina
c/o Town Manager
1300 East Academy Street
Fuquay-Varina, NC 27526

IN WITNESS WHEREOF, the parties hereto, acting under authority of their respective governing bodies, have caused this Agreement to be duly executed in two (2) counterparts, each of which shall constitute an original.

Executed by Harnett County, this the 9th day of ~~April~~ November, 2000.

COUNTY OF HARNETT

By: Dan B. Andrews
Dan B. Andrews, Chairman
Harnett County Board of Commissioners

Attest:

Kay S. Blanchard
Kay S. Blanchard, Clerk to the Board

Executed by the Town of Fuquay-Varina, this 27th day of April, 2000.

TOWN OF FUQUAY-VARINA

By: John W. Ellis III
John Ellis, Mayor

Attest:

Rachel B. Turner
Rachel Turner, Clerk

NORTH CAROLINA
HARNETT COUNTY

I, Elizabeth P. Covington, a Notary Public of the County and State aforesaid, certify that Dan B. Andrews, who being by me duly sworn, says that he is Chairman of the Board of Commissioners of Harnett County, and that Kay S. Blanchard is Clerk of said Board, that the seal affixed to the foregoing and attested instrument is the seal of Harnett County, North Carolina, and that said instrument was signed by him as Chairman of the Board of Commissioners of said County and by the Clerk of said Board, who affixed the official seal of Harnett County to said instrument; and that the said Dan B. Andrews, Chairman of the Board of Commissioners, acknowledged said instrument to be the act and deed of Harnett County North Carolina.

WITNESS my hand and Notarial Seal, this the 9 day of ~~April,~~ November 2000.

Elizabeth P. Covington
Notary Public

My Commission Expires: 6/20/01

NORTH CAROLINA
WAKE COUNTY

I, Rose H. John, a Notary Public of the County and State aforesaid, certify that John Ellis, who being by me duly sworn, says that he is Mayor of the Town of Fuquay-Varina, and that Rachel Turner, is the Clerk of said Town, that the seal affixed to the foregoing and attested instrument is the seal of said Town, and that said instrument was signed by him as Mayor in the above capacity and by the Clerk of said Town, who affixed the official seal of said Town to said instrument; and that the said John Ellis, Mayor, in the above capacity acknowledged said instrument to be the act and deed of the Town of Fuquay-Varina.

WITNESS my hand and Notarial Seal, this the 27th day of April, 2000.

Rose H. John
Notary Public

My Commission Expires: 08/27/2002

Interlocal Agreement Between City of Sanford, Town of Fuquay-Varina, Town of Pittsboro, and Town of Holly Springs (2023)

INTERLOCAL AGREEMENT FOR THE EXPANSION OF THE SANFORD WATER FILTRATION FACILITY BY THE CITY OF SANFORD, THE TOWN OF HOLLY SPRINGS, THE TOWN OF FUQUAY-VARINA, AND THE TOWN OF PITTSBORO, AND THE MANAGEMENT AND OPERATIONS OF THE JOINTLY OWNED EXPANDED FACILITY

WHEREAS, N.C.G.S. § 160A-461 authorizes units of local government to enter into interlocal agreements with each other to execute any undertaking and allows the participating units to determine the reasonable duration of the agreements; and

WHEREAS, N.C.G.S. § 160A-461 requires that interlocal agreements be ratified by resolution of the governing board of each participating unit, and the resolution spread upon the minutes of the governing board; and

WHEREAS, the City of Sanford, the Town of Holly Springs, the Town of Fuquay-Varina, and the Town of Pittsboro desire to expand the Sanford Water Filtration Facility ("WFF") from twelve (12) MGD capacity to thirty (30) MGD capacity (the "Project"), and share ownership and costs associated with the operation of the Expanded WFF at 30 MGD capacity ("Expanded WFF"); and

WHEREAS, the Parties each recognize the importance of the Project to each other, and in particular the continued and uninterrupted operation of the WFF and the delivery of water to the Participants; and

WHEREAS, the Parties each recognize that the City of Sanford is not a guarantor of water; and

WHEREAS, at the completion of the Project, the City of Sanford, the Town of Holly Springs, the Town of Fuquay-Varina, and the Town of Pittsboro will jointly own the Expanded WFF; and

WHEREAS, the Parties desire to memorialize agreements concerning the ownership, management, maintenance, and operation of the Expanded WFF such that all four jurisdictions may secure allocations of Finished Water produced by the plant; and

WHEREAS, the City of Sanford has agreed to construct or let for construction the Project; and

WHEREAS, the Parties agree that the City of Sanford will manage, operate, and maintain the Expanded WFF upon completion of the Project, and the other Parties to this Agreement will own a portion of the Expanded WFF as set out in the agreed-upon Ownership Formula in Section 12; and

NOW, THEREFORE, in consideration of the terms, conditions, covenants and promises to pay contained herein, it is agreed by the Parties as follows:

1. **Parties, Participants, and Obligations**. The initial Parties to this interlocal agreement are the City of Sanford ("Sanford"), the Town of Holly Springs ("Holly Springs"), the Town of Fuquay-Varina ("Fuquay-Varina"), and the Town of Pittsboro ("Pittsboro") (altogether, the "Parties"). Holly Springs, Fuquay-Varina and Pittsboro are referred to collectively as Participants and each individually as a Participant.

2. **Authority and Consideration**.

a. Authority. Pursuant to N.C. Gen. Stat. § 160A-461 et seq., the Parties have authority to enter into an agreement to expand the WFF and to agree that Sanford will manage and operate the Expanded WFF. Sanford, for $10.00 and other good and valuable consideration, including the sums of money to be paid by Participants to Sanford as detailed in Sections 6 and 12 of this Agreement, accepts the role of sole manager of the Expanded WFF.

b. Consideration. All Parties agree to all obligations set out in this Agreement in exchange for good and valuable consideration, including the covenants and rights in this Agreement, receipt of which is hereby acknowledged.

3. **Description of the Project**. The Project is the design and construction of an eighteen (18) MGD expansion of the Sanford Water Filtration Facility from its present capacity of twelve (12) MGD to thirty (30) MGD, which includes the elements and their necessary components, generally depicted on the 90% design drawings by Hazen and Sawyer titled "Sanford Water Filtration Facility 30 MGD Expansion" dated December 2022: an administrative facility, a chemical facility, clearwell and associated piping/vaults, existing filter media replacement, Finished Water pump station, granular activated carbon (GAC) absorbers, a maintenance building, raw water intake, residuals handling facilities, and yard piping and vaults.

a. Design Responsibilities. Pursuant to the Interlocal Agreements previously entered into by each Participant with Sanford, dated January 18, 2021 (Town of Fuquay-Varina), September 21, 2021 (Town of Holly Springs), and January 12, 2022 (Town of Pittsboro), Sanford is responsible for engaging and coordinating with an engineering firm for the design of the Project. In addition, Sanford is wholly responsible for bidding, awarding, holding and managing all construction contracts for the Project.

b. Timeline for Closing on Financing. Each Party contemplates the potential need to finance some or all of its Construction Cost Allocation. The Parties agree that time is of the essence in closing on any financing and beginning construction of the Project. Therefore, all Parties agree to take any and all reasonable and necessary steps to close on any bonds that will be used to finance the Construction Cost Allocation according to the timelines set out in this subsection. Prior to putting the Project out for bid, Sanford shall provide an updated engineer's estimate of the cost to construct the Project (the "Estimated Construction Cost"). The Estimated Construction Cost plus a reasonable contingency cost percentage or a fixed amount as recommended by Sanford shall be the Construction Cost Budget ("Construction Cost Budget"):

i. Timelines and Review of Bids. The Parties will review this Agreement within ten (10) days after the last day on which bids may be accepted for construction for the Project ("Bid Closing Date"). Sanford shall transmit bid information to the Participants by the close of the next Business Day following the opening of the bids.

1. If the opened bids are within the Construction Cost Budget, the Parties will close on financing no more than ninety (90) days from the Bid Closing Date.

2. If the opened bids are in excess of the Construction Cost Budget, Sanford will negotiate as permitted by statute and provide Participants notice of the outcome of the negotiations no more than sixty (60) days from the date the bids were opened. If, following this negotiation, the bids are within the construction bond contingency percentage, the Parties will close on financing no more than one hundred twenty (120) days from the date the bids were opened.

3. If there are insufficient responsive bids, or the Parties need additional time to allow for review by the Local Government Commission, or if any other material requirement has not been met such that Sanford is not prepared to recommend bids to the Sanford City Council for approval, the Parties will determine a reasonable amount of time needed to rebid and finance the Project.

c. Review Prior to Construction. The Parties will review this Agreement within ten (10) days after bids are taken for construction for the Project. If the bids that Sanford's City Manager is prepared to recommend to Council for approval are in excess of the Construction Cost Budget, any Party may request an adjustment to the Timeline for Closing on Financing set out in Section 3(b) herein, and all Parties will agree to extend the timeline to close on any and all financing needed for the Project of up to an additional thirty (30) days.

d. Separate Transmission Line and Supply Line Contracts. The water line(s) that will transmit water from the Expanded WFF to the Point(s) of Delivery (the "Transmission Lines") and Participants' Supply Lines are not part of the Project and are not the subject of this Agreement. Sanford, Fuquay-Varina and Holly Springs will enter into a separate agreement concerning the joint Transmission Line that will serve Fuquay-Varina and Holly Springs. Sanford and Pittsboro will enter into a separate agreement concerning the Transmission Line that will serve Pittsboro.

4. **Meter(s)**. Sanford will own, inspect and test the meter(s) at the Point(s) of Delivery. These meters will be read and the information transmitted to the Participants. The Point of Delivery is Participant specific. For Holly Springs and Fuquay-Varina, the Point of Delivery to both Participants is the meter depicted in Exhibit B on the 36" pipeline and noted as the "Flowmeter location." For Pittsboro, the Point of Delivery is the meter on the 36" pipeline depicted in Exhibit B. Parties agree to calibrate the meter(s) using a third party at a frequency of at least once every twelve (12) months. Any Party may request additional calibrations. A meter registering less than two percent (2%) of a variance of the test result shall be deemed to be accurate. If, during the additionally requested calibration, it is determined that the meter is accurate, the Party requesting the additional calibration will pay any and all costs for calibration. If, during the additionally requested calibration, it is determined that the meter is not accurate, Sanford will pay any and all

costs for the additional calibration. The previous readings at any meter disclosed by a test to be inaccurate will be corrected for all months following the last accurate test and before and including the inaccurate test in accordance with the percentage of inaccuracy found by such tests. If any meter fails to register for any period, the amount of water passing through the Point of Delivery during such period will be deemed to be as follows: if the period of failure occurs in the first year of the Term of this Agreement, the amount of water shall be deemed to be the amount delivered in the corresponding period immediately prior to the failure; if the period of failure occurs after the first year of the Term of this Agreement, the amount of water shall be deemed to be the amount delivered in the same period of the prior year; or a different amount agreed to by the Parties.

5. **Other Interim Agreements**. During the design and construction of the Project and upon its completion, some or all of the Parties may enter into additional agreements for the construction or financing of water facilities and purchase of water.

6. **Ownership and Capacity**.

a. Ownership. In return for ownership in the Expanded WFF, each Participant agrees to pay its Construction Cost Allocation. Upon completion of the Project and once the Expanded WFF is placed in service, the Parties will own a pro rata share of the Expanded WFF equal to the percentage of ownership stated in Section 12(a), "Ownership Formula." "Ownership" for Participants includes the purchased capacity as supplied by each Participant's share of the Expanded Sanford WFF. Concurrently with the execution of this Agreement, each Participant will enter into a Construction Management Agreement that designates Sanford as its agent to contract for the construction, equipping, furnishing, and payment of the Project. Upon ownership transfer, each Participant shall receive a certificate of ownership.

b. Capacity. The parties' purchased capacities in the Expanded WFF are as follows:

i. Sanford = 17.0 MGD

ii. Fuquay-Varina = 6.0 MGD

iii. Holly Springs = 4.0 MGD

iv. Pittsboro = 3.0 MGD

7. **Prohibited Use of Ownership Share as Collateral**. Each Participant agrees that it will not pledge any portion of the Expanded WFF as collateral.

8. **Term**. The Term of this Agreement is ninety-nine (99) years from the date of the last execution by any Party. This term does not apply to any Party's ownership in the Expanded WFF. At the end of the Term, each Participant will have the option to renew this Agreement for the period of ninety-nine (99) years under revised provisions mutually agreed on by the Participant and Sanford. This option arises at the end of each Term. The decision of any one Participant to not renew does not impact the ability of the other Participants to renew.

a. Exercising the Option to Renew: A Participant may indicate its intention to exercise the option to renew this Agreement so long as that Participant owns some portion of the Expanded WFF by (1) providing written notice to Sanford in the manner prescribed in Section 58 herein; or (2) by paying the O&M Costs set out in Section 12(d) that become due following the expiration of the previous term.

b. Payment Must Be Current before Renewal. A Participant must be current on any and all payments and obligations required under this Agreement in order to exercise the option to renew in Section 8(a).

9. **Management and Operations**. Sanford, by and through its elected officials, appointed officials, employees, contractors, and/or agents, will exercise all management and operations functions of the Expanded WFF for all Parties. In exercising these powers and duties, Sanford will have sole authority and discretion, including the power and duty to appoint the personnel necessary to the execution of this undertaking. In a Force Majeure situation, Sanford will continue to be sole manager.

10. **Payment of Costs**.

a. As owner of the Expanded WFF, each Participant will pay to Sanford its relative share of each cost outlined in this Agreement, including the Capital Cost Allocation, the O&M Variable Cost Allocation, the O&M Fixed Cost Allocation, and any O&M True-Up, when applicable.

b. The Parties acknowledge that each Party may finance a portion of its share of the costs of the Expanded WFF with obligations the interest on which is not included in the gross income of the owners thereof for purposes of federal income taxation. Each of the Parties covenants with the other that it will not take any action with respect to its ownership interest in the Expanded WFF and its use of the capacity thereof that would jeopardize the federal income tax treatment of interest on obligations that any other Party issues to finance its share of costs of the Expanded WFF. Each of the Parties agree to provide to all other Parties such certifications and other instruments as may be reasonably requested to evidence compliance with this covenant in connection with the issuance by the any other of debt or similar obligation for such costs.

11. **Capital Improvements**. Sanford has exclusive decision-making authority over anticipated and unanticipated capital improvement costs related to the continued ability of the Expanded WFF to reasonably and prudently provide Finished Water.

a. Cost for Capital Improvements. Cost will be borne by the Parties as set out in the Capital Improvement Cost Allocation provision in Section 12(c).

b. Types of Capital Improvements. There are three types of potential capital improvements:

i. **Plant Expansions**: Sanford will have the unequivocal right to expand the Expanded WFF, and fund such expansion, without needing consent or

contributions from the Participants and without increasing the Participants' ownership and the proportion of rights and liabilities that follow. Sanford may also increase the Expanded WFF with the participation of any Party or Parties. Further, Sanford may expand the Expanded WFF with any other local government or government not a Party to this Agreement. Sanford may expand the Expanded WFF with a private party provided that Sanford must receive an opinion of nationally recognized bond counsel to the effect that such expansion will not adversely affect the federal and state income tax treatment of the interest on any outstanding bonds of the Parties, the interest in which is intended to be excludable from gross income of the owners thereof for purposes of federal income taxation.

ii. **Anticipated Capital Improvements**: Sanford retains sole decision-making authority regarding annual capital improvements to the Expanded WFF. Sanford will provide a capital improvement budget estimate to the Participants in February of every year. At the end of each fiscal year, there will be a True-Up for the cost of annual capital improvements. The Participants will pay interest on any amounts paid more than thirty (30) days after the invoice is sent, unless any Participant's share of the capital improvement cost is greater than one million dollars ($1,000,000), in which case the Parties will agree on a reasonable payment schedule to accommodate necessary financing. If no Participant's share of the capital improvement cost is greater than one million dollars ($1,000,000), and any Participant fails to make a payment required as a result of the True-Up within thirty (30) days of the date on which the Participant receives an invoice from Sanford concerning amounts due as a result of the True-Up, Sanford may charge such late Participant an amount equal to the amount of the invoice plus interest at the SIFMA Index Rate in effect on the date of the invoice, which payment the late Participant shall pay within seven (7) Business Days. An anticipated capital improvement includes, but is not limited to, a capital improvement listed in Sanford's capital improvement plan.

iii. **Unanticipated Capital Improvements**: Sanford retains sole decision-making authority regarding unanticipated capital improvements. Sanford will notify the Participants of the need for an unanticipated capital improvement within five (5) Business Days of a reasonable determination of such need. Sanford will tell Participants the estimated cost of the unanticipated capital improvement within a reasonable time of estimating such cost. Costs associated with an unanticipated capital improvement may include use of force account labor and city-owned equipment. The Participants will pay interest on any amounts paid more than thirty (30) days after the invoice is sent, unless any Participant's share of the capital improvement cost is greater than five hundred thousand dollars ($500,000), in which case the Parties will agree on a reasonable payment schedule to accommodate necessary financing. If no Participant's share of the capital improvement cost is greater than five hundred thousand dollars ($500,000), and any Participant fails to make a payment required within thirty (30) days

of the date on which the Participant receives an invoice from Sanford concerning amounts due as a result of the unanticipated capital improvement, Sanford may charge such late Participant an amount equal to the amount of the invoice plus interest at the SIFMA Index Rate in effect on the date of the invoice, which payment the late Participant shall pay within seven (7) Business Days.

c. Five-Year Capital Improvement Plans. Sanford will provide to Participants its proposed five-year capital improvement plan by February 1st of each year and the capital improvement plan adopted by the City Council of the City of Sanford following its adoption.

d. Budget Amendments. If Sanford needs to make a budget amendment due to an Expanded WFF capital improvement, either anticipated or unanticipated, Sanford will provide reasonable notice of the need for a budget amendment to the Participants.

12. **Ownership and Cost Formulas**.

a. Ownership Formula: All Parties agree that the value of the WFF for the purposes of this Agreement can be based on the actual cost of the Project. The value of the WFF using the estimated construction cost of the Project is one hundred fifty-eight million dollars ($158,000,000) at twelve (12) MGD. Based on the value of the estimated construction costs for the Project, the Expanded WFF at the time the Project is complete will be approximately three hundred ninety-five million dollars ($395,000,000) for thirty (30) MGD. In order to determine each Party's ownership percentage, a Party's Construction Cost Allocation (in dollars) is divided by the value of the Expanded WFF (in dollars). If the cost of construction for the Project increases, each Party's Construction Cost Allocation will increase proportionately as will the value of the WFF. Therefore, the Parties' relative percentage of ownership will remain the same regardless of any change between the current estimated construction cost of the Project and the final construction cost of the Project. The Parties' percentage of ownership in the Expanded WFF will be as follows:

i. **Sanford** = 59.5%

ii. **Fuquay Varina** = 18.7%

iii. **Holly Springs** = 12.5%

iv. **Pittsboro**= 9.3%

b. Construction Cost Allocation: The Parties will pay their proportionate share of construction cost for the Project in the manner required pursuant to the Construction Management Agreement and as set out in Exhibit C, page 2, in accordance with Section 6.

c. Capital Improvement Cost Allocation: Upon substantial completion of the Project, and on a monthly basis thereafter, the Parties will pay their percentage share of capital improvement costs for the Expanded WFF, which percentages are set out in Exhibit D, the "Partner Usage and Capacity Summary" chart under "Percent Capacity in Expanded WFF," and which correspond to the Parties' purchased capacity set out in Section 6(b).

d. Operation and Maintenance (O&M) Costs: On or around February 1st of each fiscal year, each Participant will provide to Sanford an estimate of the amount of water that Participant expects to draw from the Expanded WFF over the next fiscal year (the "Estimated Use for O&M"). The Participants will pay Sanford O&M Variable Costs based on the Estimated Use for O&M. Within fifteen (15) days of the end of each quarter of the fiscal year, Sanford will provide to the Participants an accounting of the actual O&M costs versus the amounts that the Participants have paid, excluding any due or paid Overage Charge. No later than thirty (30) days from the date that Sanford provides an invoice to the Participant, the Parties will reconcile the actual O&M costs and paid O&M costs. Any due and/or paid Overage Charge will not factor into that calculation.

    i. **O&M Variable Cost**: On a monthly basis, the Parties will pay their proportionate share of variable operations and maintenance costs for the Expanded WFF based on the volume of water passing through the relevant Point of Delivery and the formula set out in the example in Exhibit D, unless otherwise provided in this Agreement. Variable Costs will be those categories listed in Exhibit E.

    ii. **O&M Fixed Cost**: Upon substantial completion of the Project, and on a monthly basis thereafter, the Parties will pay their proportionate share of fixed operations and maintenance for the Expanded WFF according to the formula set out in the example in Exhibit D. Fixed Costs will be those categories listed in Exhibit E.

    iii. **O&M True-Up**: The Parties will reconcile actual amounts of O&M for the Expanded WFF incurred during the year and amounts the Participants paid for O&M during the year, excluding any due or paid Overage Charge, and any difference owed to or from any Party will be reconciled and paid by December 31st of the same year.

e. Interest Rate Applicable for Late Payments. If any Participant fails to make a payment required under Section 12(c) or (d) of this Agreement within thirty (30) days of the date on which the Participant receives an invoice from Sanford, and such payment is not otherwise governed by the Construction Management Agreement, Sanford may, at its option, pay any amounts owed on the late Participant's behalf and charge such late Participant an amount equal to the amount Sanford paid on the late Participant's behalf, plus interest on such amount at the SIFMA Index Rate in effect on the date Sanford made such payment on the Participant's behalf, which the late Participant shall pay within seven (7) Business Days.

13. **Merger or Acquisition**. If Sanford merges with a Participant or acquires a Participant's capacity through any method, Sanford will acquire the rights of the Participant with respect to capacity and the responsibilities with respect to the costs set out in Section 12, but in no case will Sanford become a "Participant" as that term is defined and used throughout this Agreement. If Sanford sells its capacity, the purchaser may become a participant under this Agreement but will not acquire Sanford's sole rights and duties under this Agreement.

14. **Insurance**. Sanford will maintain insurance coverage on the WFF, the Project, and the Expanded WFF of the type and quantity as a prudent municipality would maintain in the same or similar circumstances. Sanford will name each Participant as an additional insured to any insurance policy for the Expanded WFF and provide a certificate of insurance to each Participant in July of each year.

15. **Procedure to Avoid Exceeding Capacity of the Expanded WFF**. All Parties recognize the need to avoid a situation in which the Parties' use of water from the Expanded WFF exceeds the Expanded WFF's capacity. The Parties also recognize the need to respect the ability of any one Party to draw its Total Capacity. The Parties have agreed upon the following procedure to prevent and deter a situation in which any metered amount exceeds the Participant's Total Capacity. When water is being supplied to Participants, the Maximum Usage Warning Limit will be set for each Participant at eighty percent (80%) of each Participant's Total Capacity (MGD). For so long as Fuquay-Varina and Holly Springs share a meter, the Total Capacity of Fuquay-Varina and Holly Springs will be their combined capacity, and the Maximum Usage Warning Limit for Fuquay-Varina and Holly Springs will be 80% of their combined Total Capacity.

a. Consequences of Participant Reaching Maximum Usage Warning Limit. If any Participant(s) average usage over three (3) calendar months is at or greater than the Maximum Usage Warning Limit, the Participant(s) must create a plan to enter into an agreement to lease capacity from another Party, obtain water from another service provider, or otherwise prevent use over its Total Capacity (MGD) (the "Usage Warning Limit Plan"). Sanford and the Participant(s) will work together to revise the Usage Warning Limit Plan until Sanford and the Participant(s) approve of the Usage Warning Limit Plan. If the Participant(s) purchases or leases additional capacity, both the transferring and receiving Party's Maximum Usage Warning Limit and eighty percent (80%) threshold will be recalculated accordingly. The Usage Warning Limit Plan must be executed and implemented by or before the Participant(s) uses ninety-five percent (95%) of its/their Total Capacity (MGD).

b. Consequences of Exceeding 100% of Total Capacity.

i. Fixed Costs. If any Participant(s) average usage for one billable month exceeds one hundred percent (100%) of its/their Total Capacity (MGD), that Participant(s) will pay the O&M Fixed Cost that corresponds with the amount of capacity used, not capacity owned.

ii. Overage Charge. When any Participant's average usage for a one calendar month period exceeds its/their Total Capacity, the Participant(s) will pay one hundred twenty-five percent (125%) of the cost calculated by the method described in Sections 12(d)(i-iii) for that month. For each

consecutive month in which the Participant(s) exceed(s) its/their Total Capacity, the Participant(s) will pay two hundred percent (200%) of the cost calculated by the method described in Sections 12(d)(i-iii) for that month. If a Participant incurs an Overage Charge two (2) or more times in a rolling 12-month period, Sanford will apply a two hundred percent (200%) Overage Charge to any additional months in that rolling 12-month period in which that Participant's average usage over a one calendar month period exceeds its/their Total Capacity.

iii. Sanford's Right to Reduce Service. If a Participant has not created or is not diligently pursuing a Usage Warning Limit Plan approved by Sanford, Sanford has the right to reduce service to the Participant.

16. **Water Conservation Policies**. If any Party is experiencing conditions that require the implementation of a water shortage response plan, and said Party has implemented water conservation measures for its retail customers, then water conservation measures shall apply to all Parties only if so required by the State or by Sanford. If a water conservation measure is required, the water conservation measures will meet the minimum water conservation measures published, from time to time, on the Department of Environmental Quality website.

17. **Supply Interruptions or Shortages**. Sanford shall use reasonable care and diligence to provide uninterrupted service as provided herein but reserves the right at any time to temporarily interrupt service for reasons of Force Majeure and maintenance purposes. Sanford will give notice to Participants not less than forty-eight (48) hours in advance of any such planned service interruption, except that in emergencies, it will give notice that is reasonable under the particular circumstances. During an emergency, such as a break or leak in a Participant's Supply Line, in which despite its exercise of reasonable care and diligence, Sanford will significantly lose the ability to serve its own citizens if Sanford continues to supply a Participant with a break or leak, Sanford has the authority to make any reasonably necessary temporary reduction of service to one or more Participants in order to maintain service to other Participants and its own citizens. No change shall be made to Participants' share of costs.

18. **Sale or Lease of Ownership or Capacity**. The Parties may sell or lease any part of their share of Total Capacity (MGD) pursuant to the provisions of this section. Except as otherwise allowed in this Agreement, sales or leases of ownership or capacity may only be executed among the Parties and not with any party or entity not a Party to this Agreement. Capacity or ownership may be sold or leased on terms mutually acceptable to the Participants involved, and approved by Sanford (such approval shall not be unreasonably withheld), and only on conditions that (a) the buyer or lessee assumes all financial responsibilities to Sanford that flow from the transfer; and (b) both are jointly liable to Sanford in the event that the receiving Participant fails to meet all financial responsibilities to Sanford. Notwithstanding the foregoing, Sanford will have a right of first refusal to acquire any ownership or capacity that a Participant wishes to sell, and the price to Sanford will be the same price per unit of capacity as the Construction Cost Allocation. Sanford will have one hundred twenty (120) days to notify the selling Participant of its intent to exercise the right of first refusal. If Sanford does not convey its intent to exercise the right of first refusal, or if Sanford affirmatively provides notice that it will not exercise its right of first refusal, the other Participants may acquire any ownership or capacity that the Participant wishes to sell, and the cost will be the same price per unit of capacity as the Construction Cost Allocation.

a. Recalculation of Capacity. If ownership or capacity is bought, sold, or leased, each Participant's Total Capacity will be recalculated.

19. **Bulk Water Sales Allowed by Participants**. Parties may set their rate structures to their respective end users in any manner they deem appropriate without approval of another Party. Bulk Water Sales are defined as a continuing contract by a Party to provide water to either another Party or a third party over a period exceeding thirty (30) days. Bulk Water Sales by any Party to this Agreement to any entity not a Party to this Agreement are allowed on the condition that a Participant-seller of Bulk Water will remain financially responsible to Sanford for all amounts sold by the Participant, and all requirements placed on Participants under this Agreement remain in full force and effect and may be applied against the Participant making a Bulk Water Sale in the same manner as they would have applied had the Bulk Water Sale quantity been used by the Participant. Any Participant making a Bulk Water Sale will provide the Bulk Water Sale agreement to Sanford, and Sanford may request additional details within reason.

20. **Future Expansion**. If the Parties' use of water from the Expanded WFF reaches eighty percent (80%) of the total maximum capacity created as a result of the Project for seven (7) consecutive days, then the Parties shall negotiate in good faith to amend this Agreement for an additional expansion of the Expanded WFF's total capacity.

21. **Annual Meeting of the Parties**. Unless otherwise agreed by all Parties, the Parties will meet annually in Sanford, or at another location determined to be convenient to all Parties, to discuss all matters pertaining to this Agreement.

22. **Loss of a Purchasing Participant Prior to All Parties Signing**. If at any time prior to all Parties signing this Agreement any one Party no longer wishes to enter into the Agreement, the signatories to the Agreement will negotiate in good faith to recalculate the size of the Project and each Participant's allocation of cost. In the event that the signatories, having negotiated in good faith, are unable to recalculate the size of the Project and each Participant's allocation of cost, Sanford may, at its option, terminate this Agreement by giving written notice to the remaining Parties.

23. **Water Quality and Quantity**.

a. **Water Quality**. By this Agreement, Sanford agrees to operate and manage the Expanded WFF such that it is able to supply potable water at the Point of Delivery, meeting the applicable purity standards of the North Carolina Division of Health and the applicable water quality standards of the North Carolina Department of Environmental Quality (or any successor State division or department) as amended from time to time, subject to any reductions or failures of pressure or supply due to causes beyond Sanford's control, including, but not limited to, any Force Majeure event, Transmission Line damage, or the use of water to fight fire. In the event of a loss of water quality, Sanford shall work with reasonable diligence to regain the water quality. A loss of water quality shall not be deemed a breach of this Agreement or an event of Default.

b. **Water Quantity**. By this Agreement, Sanford agrees to operate and manage the Expanded WFF such that it is able to supply the quantity of water that each

Participant is entitled to, subject to any reductions or failures of pressure or supply due to causes beyond Sanford's control including, but not limited to, any Force Majeure event, Transmission Line damage, or the use of water to fight fire. In the event of a loss of water quantity, Sanford shall work with reasonable diligence to regain the level of water quantity. In the event of Transmission Line damage affecting a Participant(s) but not the citizens of Sanford, Sanford shall make such repairs with the same reasonable care and diligence as it would to repair those lines effecting citizens of Sanford. A loss of water quantity shall not be deemed a breach of this Agreement or an event of Default.

24. **Performance Obligations of Sanford**. Sanford will perform the services customarily performed by water utility systems with respect to the Expanded WFF for the benefit of all customers of the system, including: maintain, repair, and improve the Expanded WFF in a timely manner and operate and manage the Expanded WFF in a manner consistent with good business and operating practices for comparable facilities and in full compliance with all issued permits, operational requirements, industry standards, and the applicable laws, rules, and regulations of regulatory bodies, governmental units, or agencies thereof.

25. **Notifications Required**. Sanford will make reasonable efforts to notify all Participants of any planned or detected interruptions in water quality or quantity. Sanford shall provide frequent status updates about any loss of water quality or quantity to Participants until any water quality or quantity issue is resolved. In the event that a Participant detects a loss of water quality or quantity as defined under this Agreement, the Participant will notify Sanford of the loss of water quality or quantity as soon as reasonably possible under the circumstances but in no event later than twenty-four (24) hours from the detection.

26. **Resolution Process**. If the Parties do not agree on the existence of an event of Default (the "Claim"), the Parties agree to first use good faith efforts to resolve the dispute. Where good faith efforts to negotiate do not resolve the Claim within thirty (30) days of the date of the notice of Default, the Parties agree to mediate the dispute prior to filing a lawsuit. Mediation will occur pursuant to the following process: the non-defaulting Party (the "Claimant(s)") shall have thirty (30) additional days within which to submit the Claim to mediation under the auspices of any dispute resolution center or other such independent agency or certified individual providing similar services upon which the Parties may mutually agree. If Claimant(s) does not submit the claim to mediation within sixty (60) days after notice of Default, Claimant(s) shall be deemed to have waived the Claim, and the defaulting Party (the "Respondent(s)") shall be released and discharged from any and all liability to Claimant(s) on account of such Claim; provided, nothing herein shall release or discharge Respondent(s) from any liability to Persons that are not subject to the foregoing proceedings. If the Claimant(s) and Respondent(s) do not settle the Claim within thirty (30) days after submission of the matter to the mediation process, or within such time as determined reasonable or appropriate by the mediator, the mediator shall issue a notice of termination of the mediation proceedings. Such notice shall set forth when and where the Claimant(s) and Respondent(s) met, that they are at an impasse, and the date that mediation was terminated. In the event that mediation does not resolve the dispute, all Parties have the right to file a lawsuit with venue in Lee County or the United States District Court for the Middle District of North Carolina.

27. **Audit Rights**. If Sanford does not perform its annual audit as required by G.S. § 159-34 by December 31st of each year, each Participant will have the right to inspect and audit all accounting reports, books, or records that concern Sanford's management and operations of the Expanded WFF that would be required under G.S. § 159-34. The Participant exercising its audit rights must provide thirty (30) days' notice to Sanford. The Parties agree to prioritize requests from other Parties for operational financial information regarding the Expanded WFF throughout the year so long as such requests are reasonable with respect to scope and frequency.

28. **Inspection Rights**. Each Participant will have the right to inspect any or all of the Expanded WFF at a time convenient to the Participant and Sanford, but in no event more than twenty (20) days after providing Sanford the request for inspection. Such inspection rights may be exercised no more than once annually. This right is not limitless, and Sanford has a right to stop an inspection where such inspection interferes with the continued ability of the Expanded WFF to reasonably and prudently provide Finished Water.

29. **Unwinding Mechanism**. If one or more of the Participants Default in the performance or discharge of its or their obligations in the Project or any other material obligation under this Agreement such that the Party is in material Default, the other Parties may assume, pro rata or otherwise, the obligations of such defaulting Party or Parties and will succeed to such rights and interests of the defaulting Party or Parties according to the Ownership Formula. Further, Sanford shall have a right of first refusal to assume all or part of the defaulting Party's share at the same price as the Construction Cost Allocation. A Party that assumes the obligations of any other Party is entitled to reasonable legal fees and costs incurred as a direct result of the Default from the defaulting Party.

30. **Liability**.

a. No Liability Downstream of the Point of Delivery. Sanford shall not be liable for any condition, quality, purity, impurity, or contamination of the water provided to Participants or any issue related to the quantity of the water provided to the Participants downstream of the Point of Delivery.

b. No Liability at Point of Delivery with Exceptions. Sanford shall not be liable for any condition, quality, purity, impurity, or contamination of the water provided to Participants, or any issue related to the quantity of the water provided to the Participants at the Point of Delivery, except where:

i. **Gross Violation of Industry Standard Exception**: Sanford commits a gross violation of industry standards that causes such condition, quality, purity, impurity, or contamination of the water; or

ii. **Intentional and Knowingly Exception**: Sanford intentionally and knowingly limits the quantity or quality (including minimum pressurization to meet the design requirements of the Parties' Transmission Lines) of water for any purposes that are within the full control of Sanford. This exception does not include any action that Sanford would take that is in accordance with its right and obligations under this Agreement or any action that Sanford would take as the result of a Force Majeure event, Transmission

Line damage, maintenance, the use of water to fight fire, or any other externality outside of the control of Sanford. However, in the event of a Transmission Line damage, Sanford shall make such repairs with the same reasonable care and diligence as it would to repair those lines effecting citizens of Sanford.

iii. **Clarification**. For clarification, subsections (b)(i) and (b)(ii) are disjunctive.

c. Exceptions in Subsection (b)(i) and (ii) Not Applicable During Default. If any Participant on a Transmission Line with a water quality or quantity issue described above is in Default, the exceptions in Section 30(b)(i) and (ii) shall not apply and Sanford shall not be liable.

d. Consumers and Third Parties. Each Participant shall take steps to ensure that the consumer receives potable water, but liability shall be limited and transferred to the Participants once the water passes from the Point of Delivery. No Party hereto shall be liable under this Agreement to any third party, and each shall indemnify and hold harmless the other for against any and all claims brought by third parties. Sanford shall not be liable for failures of any element of a Participant's water system.

31. **Sole Remedy**. In the event that there is a water quality or quantity issue at the Point of Delivery as outlined in Section 30, Sanford shall pay the costs associated with remedying the condition, quality, purity, impurity, or contamination of the water, or quantity issue. Participants will have no other remedy for such violation.

32. **Disposition of Property at Termination**. Upon termination of this Agreement by any Party, all real property of the terminating Party reverts to Sanford.

33. **Method of Termination**. This Agreement may be terminated only by the mutual consent of all Parties participating in this Agreement at the time of Termination.

34. **Disposition of Property at Expiration**. As long as any Participant still owns shares in the Extended WFF, the Parties agree that they will negotiate extensions or a new agreement.

35. **No Waiver of Sole Management**. Sanford's acts, including acts of its officers and employees, cannot be interpreted to waive its rights and entitlements, including sole right to manage.

36. **Changes in the Law**. In the event that there is a change in North Carolina law that impacts this Agreement, the Parties agree to review the Agreement and may mutually consent to amend this Agreement. In the event an amendment to N.C. Gen. Stat. 162A-200 et seq. requires an amendment to this Agreement, the Parties agree to negotiate in good faith to amend any and all impacted provisions.

37. **Default**.

a. Pre-Funding of Acquisition and Construction Fund Default: If at any time after the Agreement becomes effective but before any funds are first deposited in the Acquisition and Construction Fund that will be created pursuant to the Construction Management Agreement for any part of the Project, any Party gives written notice to all other Parties that such Party anticipates defaulting on this Agreement or the Construction Management Agreement—whether such Default is anticipated with respect to obligations that have arisen or will arise—the Parties to the Agreement shall negotiate in good faith to recalculate the size of the Project, proportion of ownership, and share of costs using the corresponding formulas in Section 12. The agreed-upon method of recalculation shall be the same methodology that was used to produce the summary numbers represented in Exhibits C – E. Sanford shall have a right of first refusal to any portion of the Expanded WFF on which a Participant anticipates defaulting and a right to Liquidated Damages from the Participant anticipating Default. In the event that the Parties, having negotiated in good faith, are unable to recalculate the size of the Project and each Participant's allocation of cost, Sanford may, at its option, give the remaining Parties written notice of Sanford's election to terminate this Agreement. In the event of a termination by Sanford, any non-defaulting Participant(s) may recover from the defaulting Participant(s) any direct costs that are otherwise not recoverable or avoidable to the non-defaulting Participant(s).

b. Post-Deposit and Pre-Project Completion: If a Party defaults on this Agreement at any time after any other Party has deposited funds in the Acquisition and Construction Fund and before the Project is completed, and such Default cannot be cured within sixty (60) days or by the negotiation of additional agreements, the remaining Parties to the Agreement shall negotiate in good faith to recalculate each Party's proportion of ownership and share of costs using the corresponding formulas in Section 12. Sanford shall have a right of first refusal to acquire any portion of the Expanded WFF during such renegotiation. The agreed upon method of recalculation shall be the same methodology that was used to produce the summary numbers represented in Exhibits C – E. In the event that the Parties, having negotiated in good faith, are unable to recalculate each Participant's allocation of cost, Sanford may, at its option, give the remaining Parties written notice of Sanford's election to terminate this Agreement. In the event of a Default under this subsection, all Participants will continue to be liable to Sanford for their share of Construction Cost Allocation and any other costs outlined in Section 12 until the earlier of: (1) the remaining non-defaulting Participants, having negotiated in good faith to recalculate each non-defaulting Participant's proportion of ownership, execute an agreement reflecting those negotiations; or (2) Sanford's release of the Participants from obligations under this Agreement.

c. Default Post-Project Completion: From and after the completion of the Project, and upon the Expanded WFF being put into service, any one or more of the following events shall constitute an event of Default under this Agreement.

i. **Participant's Failure to Make Payment(s)**. The failure of a Participant to make payment of any amount due hereunder, which failure shall have continued for a period of fifteen (15) days after receipt of written notice from Sanford that the Participant has failed to make timely payments as required by this Agreement, shall constitute an event of Default on the part of a Participant that fails to pay. Unless otherwise stated herein, a failure to make any payment due and owing under this Agreement for ninety (90) days or more constitutes a material Default.

ii. **Party's Failure to Perform Any Obligation**. Except in Force Majeure situations and as otherwise stated in this Agreement, the failure of any Party to perform any of its obligations under this Agreement, if such failure continues for a period of thirty (30) days after receipt by the defaulting Party of written notice of such failure (the "Default Notice"), shall constitute an event of Default. It shall not be considered an event of Default if the Default is of a nature that cannot be cured within thirty (30) days and the defaulting Party has commenced action reasonably designed to cure the Default and pursued that action with due diligence.

d. Consequence of Participant's Default: If a Participant defaults, and the Default has not been cured, the other Party or Parties may, at their option, pursue any and all rights they have in law and equity including, without limitation, specific performance and the recovery of monetary damages.

i. A non-defaulting Participant that shares a Supply Line with a Participant that has defaulted because it has failed to make a payment due to Sanford under this Agreement may cure the non-payment default by making the defaulting Party's payment in addition to their own payment.

e. Consequence of Sanford's Default: If Sanford defaults, and the Default has not been cured, a non-defaulting Participant may exercise and pursue any and all rights and remedies it shall have at law or in equity, including, without limitation, specific performance but specifically excluding the right to terminate this Agreement or refuse to fully pay any outstanding payments as they become due and owing.

38. **Process Following Sanford's Right of First Refusal**. Wherever in this Agreement Sanford has a right of first refusal to acquire, purchase, or lease a portion of or all of a Participant's capacity or ownership, and Sanford does not exercise that right, the other Participants may acquire, purchase, or lease the capacity ownership, and the cost for the first time such capacity is purchased by another Participant will be the same price per unit of capacity as the Construction Cost Allocation. If no Party wishes to purchase the capacity at that price, the Participant and another Party may agree to a lower price.

39. **Sale or Lease to a Third Party**. No Party can sell its capacity or ownership or lease capacity to a non-Party for the life of this Agreement unless such sale is agreed to by all Parties (such consent will not be unreasonably withheld).

40. **This Document Is Also a Contract**. In addition to being governed by N.C.G.S. § 160A-461, this Agreement is a contract, and North Carolina contract law shall apply.

41. **Joint Undertaking; No Joint Venture**. Nothing in this Agreement shall be construed to establish a joint venture, partnership, or any other relationship among the Parties other than the relationship contemplated for entry into an Interlocal Agreement pursuant to G.S. § 160A-461.

42. **No Abrogation of Sovereign Immunity**. Nothing in this Agreement shall be construed as an abrogation of any Party's sovereign immunity.

43. **Prohibition on Assignment**. No Participant shall sell, assign, or transfer this Agreement, or any part thereof, without the express written consent of Sanford, except as allowed by Section 18 of this Agreement.

44. **Amendments**. The provisions of this Agreement may be amended at any time upon mutual written agreement of the governing boards of all Parties.

45. **Administrative Amendments**. Notwithstanding Section 44, minor amendments to this Agreement may be made upon the request of any Party and agreed to by all Parties' respective City or Town Manager, or their designee, without public notice or a public hearing where (1) the City Attorney of Sanford confirms in writing that such change is a minor amendment of this Agreement; and (2) such minor amendment substantially conforms with the material terms of this Agreement. Administrative Amendments must still be reduced to writing and signed.

46. **Force Majeure**. It shall not be considered a breach of this Agreement or an event of Default and Parties shall not be responsible for an inability to perform or for any delays, damages, costs, expenses, liabilities, or other consequences that may arise as a result of Force Majeure. In order to avail itself of this provision, a Party must take reasonable actions to remedy the consequences of the Force Majeure event. The impacted Party shall give notice of the Force Majeure event to all other Parties as soon as practicable, but in no case more than forty-eight (48) hours after the Party's performance has been impacted, stating the period of time the occurrence is expected to continue. Upon request of any Party, the Parties shall meet to discuss the causes of the Force Majeure event and the period of time the occurrence is expected to continue. A Force Majeure is defined as any event arising from causes beyond the reasonable control of the Parties. Force Majeure events may include, but are not limited to, fire, flood, drought, power failure, cyber attacks, earthquake, chemical or toxic spill, acts of God, foreign or domestic terrorism, war, pandemic, natural disaster, nuclear disaster including radiological contamination, vandalism, third-party acts outside of the reasonable control of any Party, intentional and/or malicious acts of an individual, water pollution, failure of industrial pretreatment, contamination including raw water contamination, algae blooms, biological constituents, tornado, hurricane, civil strikes or labor disputes, riots, system failure, broken pipes, or other actions causing an inability to serve beyond the reasonable control of Sanford. Temporary or partial failures to deliver water shall be remedied with all possible dispatch but shall not constitute a breach or an event of Default so long as such remedy is diligently being pursued.

47. **Severability**. If any of the provisions of this Agreement are held invalid, illegal, void or unenforceable, the enforceability of the remaining provisions shall not be impaired thereby.

48. **No Third-Party Beneficiaries**. There are no third-party beneficiaries to this Agreement.

49. **Entire Agreement**. This Agreement constitutes the entire agreement and understanding between the Parties, and it is understood and agreed that all undertakings, negotiations, representations, promises, inducements, and agreements heretofore entered into among the Parties with respect to the matters contained herein are merged in this Agreement.

50. **No Oral Amendments**. This Agreement may not be changed orally, but only by a written document approved by the governing boards of all Parties.

51. **No Waiver**. No waiver of any of the provisions of this Agreement shall be valid unless in writing and signed by the Party against whom it is sought to be enforced. Mere inaction or failure to pursue a Default shall not be deemed a waiver.

52. **Benefits to Successors and Assigns**. The provisions of this Agreement shall inure to the benefit of and be binding upon the Parties hereto and their respective successors and assigns, provided the assignment has been approved by all relevant Parties as determined by the nature of the assignment.

53. **Applicable Law**. The provisions of this Agreement shall be governed by and construed and enforced in accordance with the laws of the State of North Carolina.

54. **Headings**. The headings contained in this Agreement are solely for the convenience of the Parties and do not constitute a part of this Agreement and shall not be used to construe or interpret any provisions hereof.

55. **Joint Effort of All Parties**. This Agreement shall be considered for all purposes as having been prepared by the joint efforts of the Parties and shall not be construed against any Party or the other as a result of preparation, substitution, submission, or event of negotiation.

56. **Execution in Counterparts**. This Agreement may be executed in any number of counterparts each of which shall be deemed an original and all of which taken together shall constitute one and the same instrument, and the Parties hereto may execute this Agreement by signing any such counterpart.

57. **Incorporation by Reference**. Capitalized terms shall have the meanings assigned thereto in Exhibit A attached hereto. Exhibits B – E shall be incorporated in this Agreement by reference.

58. **Notice**. Notice shall be given in writing directed to the people listed below, as amended and updated from time to time (see Appendix A for current contacts). For emergencies, Parties should contact operational officials first; for contract issues, Parties should contact attorneys first; for administrative issues, Parties should contact managers or finance directors. All Parties shall endeavor to keep accurate cell phone numbers available to all other Parties.

City Manager, or the equivalent
Public Works Director, or the equivalent
Utilities and Engineering Director, or the equivalent
City Attorney, or the equivalent
Finance Director, or the equivalent

IN WITNESS WHEREOF, the City of Sanford has caused this instrument to be executed by its Mayor, attested by its Clerk and its municipal seal to be affixed, all by authority of its governing board, first duly given. The Town of Holly Springs has caused this instrument to be executed by its Mayor, attested by its Clerk and its municipal seal to be affixed, all by authority of its governing board, first duly given. The Town of Fuquay-Varina has caused this instrument to be executed by its Mayor, attested by its Clerk and its municipal seal to be affixed, all by authority of its governing board, first duly given. The Town of Pittsboro has caused this instrument to be executed by its Mayor, attested by its Clerk and its municipal seal to be affixed, all by authority of its governing board, first duly given.

City of Sanford

~~(seal)~~

By: Rebecca Wyhof Salmon

~~Attest:~~

City Clerk

This instrument has been preaudited in the manner required by the Local Government Budget and Fiscal Control Act.

By:

[signatures continued on next page]

Town of Holly Springs

_____ **(seal)**

By: Mayor Sean Mayefskie

Attest:

_____

Town Clerk

This instrument has been preaudited in the manner required by the Local Government Budget and Fiscal Control Act.

_____

By:

[signatures continued on next page]

Town of Fuquay-Varina

(seal)

By: Mayor J. Blake Massengill

Attest:

Deputy **Town Clerk**

This instrument has been preaudited in the manner required by the Local Government Budget and Fiscal Control Act.

By:

[signatures continued on next page]

Town of Pittsboro

Cindy Perry (seal)

By: Mayor Cindy Perry

Attest:

Carrie L. Bailey

Town Clerk

This instrument has been preaudited in the manner required by the Local Government Budget and Fiscal Control Act.

Heather E.R. Meacham

By: Heather E.R. Meacham
Finance Director

LIST OF EXHIBITS

EXHIBIT A	**Definitions**
EXHIBIT B	**Project Component Summary**
EXHIBIT C	**Sanford WFF Construction Cost Estimate (90% Design)**
EXHIBIT D	**Sanford WFF Expansion O&M Cost Allocation Example Based on Projected O&M Costs**
EXHIBIT E	**Projected O&M Expenses**
APPENDIX	**Current Contacts**

EXHIBIT A
Definitions

Acquisition and Construction Fund means the "Sanford Water Filtration Facility Expansion Project Acquisition and Construction Fund" created pursuant to the Construction Management Agreement.

Bulk Water Sales means a continuing contract by a Party to provide water to either another Party or a third party over a period exceeding thirty days.

Business Day(s) has the meaning set forth in the Construction Management Agreement.

Construction Cost Allocation shall mean the cost to be paid by each Participant for constructing the Project, as shown in detail in Exhibit C, page 3.

Construction Cost Budget means the Estimated Construction Cost plus a reasonable contingency cost percentage or a fixed amount as recommended by Sanford.

Construction Management Agreement means the Construction Management Agreement dated _____, 2023 between the Parties and Regions Bank, as escrow agent.

Default means failure, refusal, or inability of a Party to meet an obligation set out in this Agreement and is governed by Section 37.

Estimated Construction Cost means the estimated cost of constructing the Project as determined by Hazen and Sawyer ("Estimated Cost").

Estimated Use for O&M is the estimate provided by each Participant to Sanford on or around February 1st of each fiscal year that provides an estimate of water to be used during the upcoming fiscal year.

Expanded WFF shall mean the Sanford Water Filtration Facility at its capacity of thirty (30) MGD after the Project is complete.

Finished Water shall mean the water that is introduced into the distribution system of a public water system and is intended for distribution and consumption.

Force Majeure has the meaning set out in Section 46.

Liquidated Damages. As used in Section 37(a), Liquidated Damages includes costs incurred for work done by third-party engineers, consultants, and/or attorneys to recalculate the size of the Project and renegotiate the Agreement. If a Participant's Default causes delay, Liquidated Damages will also include the increase in finance costs and increase in construction costs, if any.

Maximum Usage Warning Limit. When water is being supplied to Participants, the Maximum Usage Warning Limit shall be set for each Participant at eighty percent (80%) of each Participant's "Total Capacity" (MGD).

MGD shall mean million gallons per day.

Overage Charge shall mean the amount charged when a Participant's average usage over a one calendar month period exceeds its/their Total Capacity and is further described in subsection 15(b)(ii).

Participants shall mean the Town of Holly Springs, the Town of Fuquay-Varina, and the Town of Pittsboro.

Parties shall mean the City of Sanford, the Town of Holly Springs, the Town of Fuquay-Varina, and the Town of Pittsboro. When used in the singular, "Party" shall refer to only the relevant party in the context of this Agreement.

Point of Delivery is Participant-specific and is shown in Diagram B.

Project shall mean the construction of the expansion of the Sanford Water Filtration Facility from its present capacity of twelve (12) MGD to thirty (30) MGD, which includes, but is not limited to, the following elements: an administrative facility, a chemical facility, clearwell and associated piping/vaults, existing filter media replacement, Finished Water pump station, GAC absorbers, a maintenance building, raw water intake, residuals handling facilities, and yard piping and vaults cost.

SIFMA Index Rate has the meaning set forth in the Construction Management Agreement.

Supply Line shall mean any lines supplying water from the Point of Delivery to the Participant(s).

Total Capacity shall mean the amount of capacity in the Expanded WFF that is available to a Participant in MGD, which amounts are set out in Section 6(b), and corresponds to the proportion of capacity created by that Participant's Construction Cost Allocation. For so long as Fuquay-Varina and Holly Springs share a meter, the Total Capacity of Fuquay-Varina and Holly Springs will be their combined capacity, and the Maximum Usage Warning Limit for Fuqua-Varina and Holly Springs will be 80% of their combined Total Capacity.

Transmission Line(s) shall mean the water line(s) built to transmit water from the Expanded WFF to the Point(s) of Delivery.

True-Up shall mean the payment made at the end of the fiscal year to adjust for any difference between the estimated and paid cost, and the actual cost determined using financial metrics that become known only at the end of the fiscal year.

Usage Warning Limit Plan shall mean the plan that must be created by a Participant and agreed to by Sanford in the event the Participant averages its Maximum Usage Warning Limit for any three (3) consecutive months.

WFF shall mean the Sanford Water Filtration Facility at its present capacity of twelve (12) MGD.

EXHIBIT B
Project Component Summary

Project Component Summary

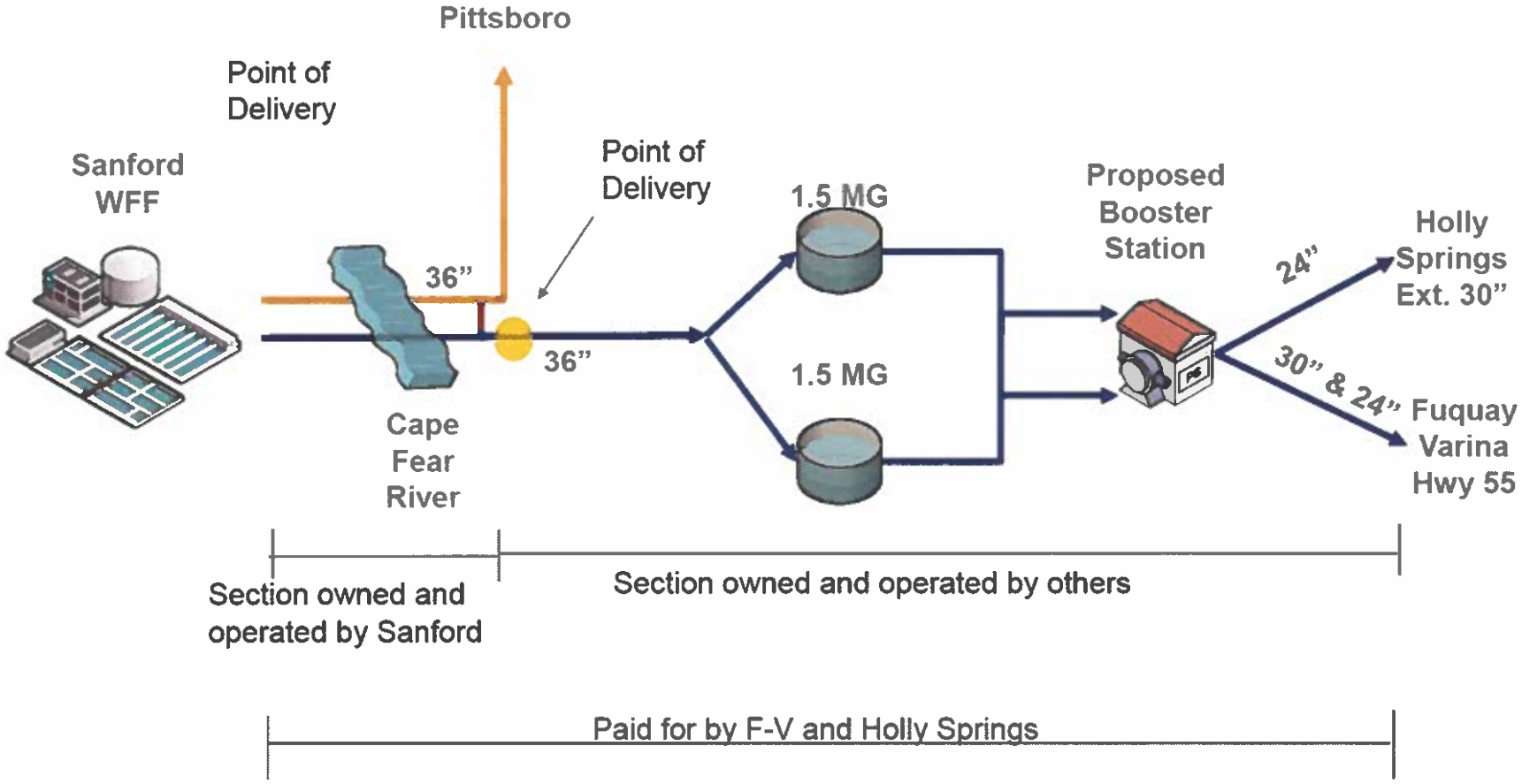


EXHIBIT C
Sanford WFF Construction Cost Estimate (90% Design)

Sanford WFF Construction Cost Estimate (90% Design)

Hazen

Facility Summary

Admin Facility: Defer / Include	Conventional Treatment: Defer / Include	MV Electrical: Defer / Include
Chemical Facility: Defer / Include	Finished Water: Defer / Include	Raw Water: Defer / Include
Clearwells: Defer / Include	GAC Facility: Defer / Include	Residuals: Defer / Include
	Maint Building: Defer / Include	Site Work and Yard Piping: Defer / Include

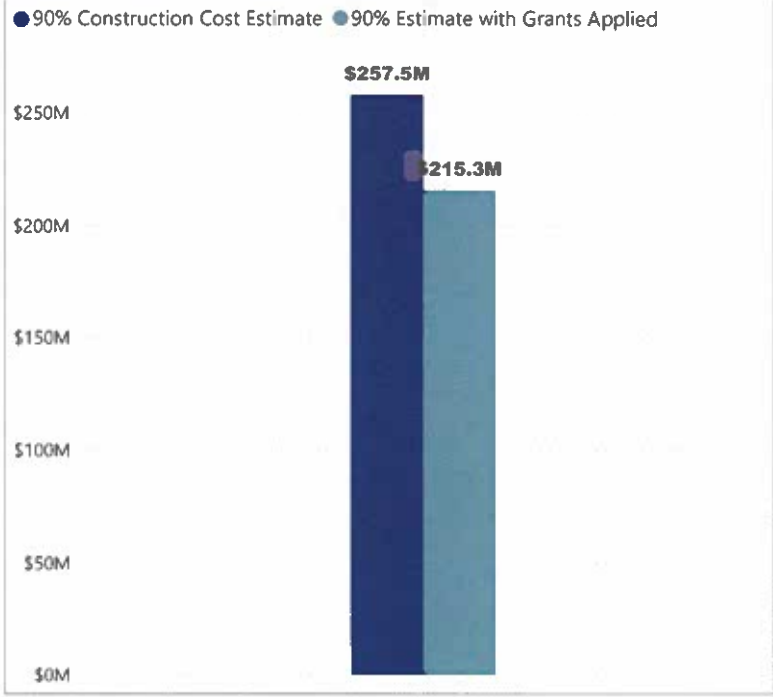
Grant Funding Applied

Grant Funding - GAC	Grant Funding - Other
$0	$42,200,000

Construction Cost Summary Table by Facility

Facility	Cost	Grant Applied Costs	Percentage of Total Costs (Grants Applied)
Administrative Facility	$4.6M	$3.7M	1.7%
Chemical Facilities	$20.7M	$16.6M	7.7%
Clearwells	$10.7M	$8.6M	4.0%
Conventional Treatment Facilities	$57.6M	$46.3M	21.5%
Finished Water Pump Stations	$21.7M	$17.4M	8.1%
GAC Facility	$42.0M	$42.0M	19.5%
Maintenance Building and Warehouse	$2.5M	$2.0M	0.9%
MV Electrical and Generators	$13.4M	$10.7M	5.0%
Raw Water Intake, Pump Station, and Transmission	$28.6M	$23.0M	10.7%
Residuals Handling Facilities	$19.7M	$15.9M	7.4%
Site Work, Yard Piping, and Vaults	$36.2M	$29.1M	13.5%
Total	**$257.5M**	**$215.3M**	**100.0%**

90% Sanford WFF Construction Cost Opinion



Cost Allocation Method Selection

Admin Facility
- ○ Custom Allocation
- ◉ Incremental Capacity

Finished Water
- ○ Custom Allocation
- ◉ Incremental Capacity

Chemical Facilities
- ○ Custom Allocation
- ◉ Incremental Capacity

GAC Facility
- ○ Custom Allocation
- ○ Incremental Capacity
- ◉ Total Capacity

Clearwells
- ○ Custom Allocation
- ◉ Incremental Capacity

Maint Bldg and Warehouse
- ○ Custom Allocation
- ◉ Incremental Capacity

Conventional Treatment
- ○ Custom Allocation
- ◉ Incremental Capacity

Raw Water Intake, PS, and Transmission
- ○ Custom Allocation
- ◉ Incremental Capacity

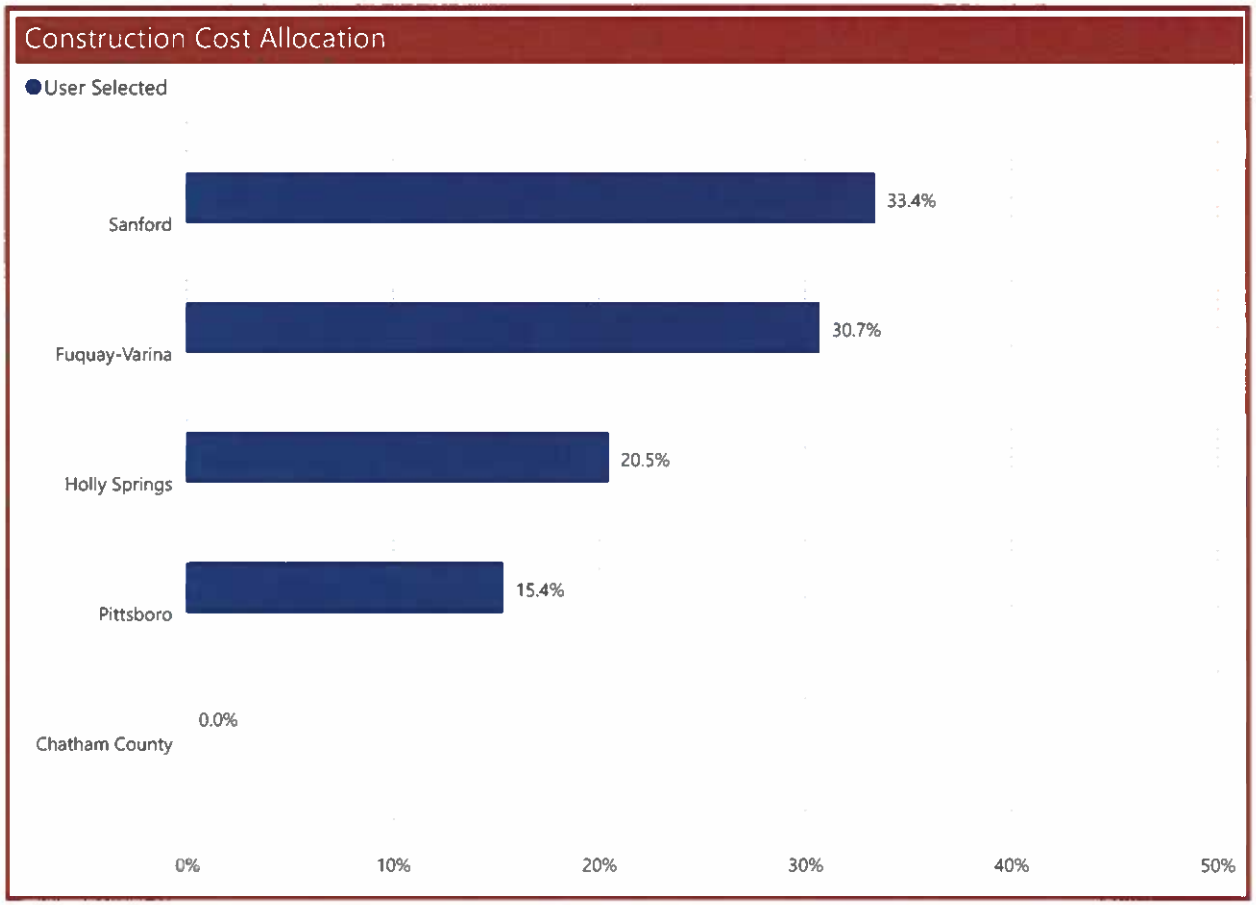
MV Elec and Generators
- ○ Custom Allocation
- ◉ Incremental Capacity

Residuals Handling Facilities
- ○ Custom Allocation
- ◉ Incremental Capacity

Site Work, Yard Piping, and Vaults
- ○ Custom Allocation
- ◉ Incremental Capacity

Sanford WFF Expansion Construction Cost Allocation Scenario Selection

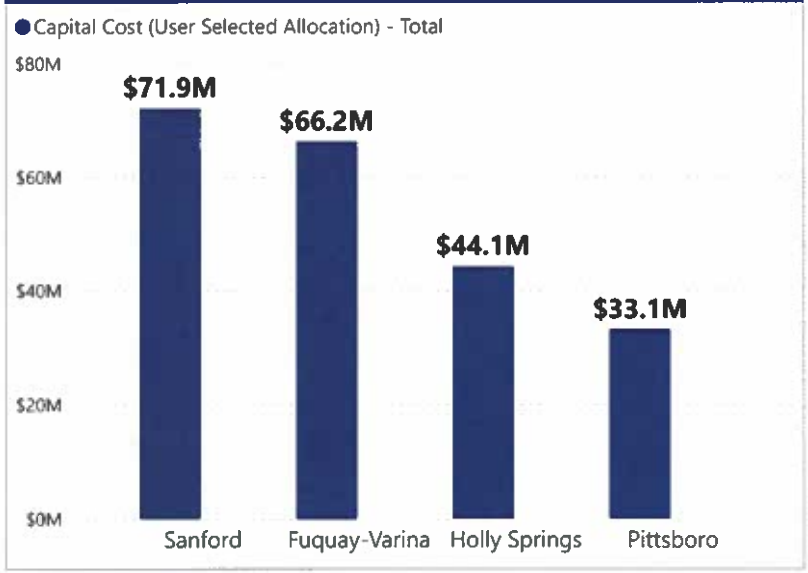
Hazen



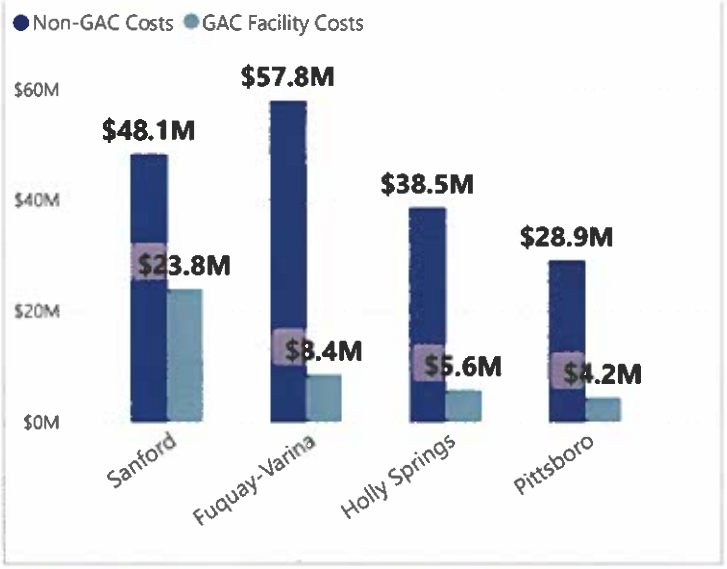
Sanford WFF Expansion Construction Cost

Hazen

Construction Cost Allocation - Total Costs



Construction Cost Allocation - GAC and Non-GAC



Grant Funding Applied

Grant Funding GAC

$0

Grant Funding - Other

$42,200,000

User Determined Partner Purchased Capacities

Sanford	Pittsboro	Chatham County
5.0	3.0	0.0

Fuquay-Varina	Holly Springs	Additional Capacity
6.0	4.0	18.0

Sanford WFF Construction Cost Summary with Grant Funding Applied

Utility	Total Construction Cost (After Grants Applied)	GAC Construction Cost	GAC Construction Cost Allocation	Non-GAC Construction Cost	Non-GAC Construction Cost Allocation
Sanford	$71.9M	$23.8M	56.7%	$48.1M	27.8%
Fuquay-Varina	$66.2M	$8.4M	20.0%	$57.8M	33.3%
Holly Springs	$44.1M	$5.6M	13.3%	$38.5M	22.2%
Pittsboro	$33.1M	$4.2M	10.0%	$28.9M	16.7%
Total	**$215.3M**	**$42.0M**	**100.0%**	**$173.3M**	**100.0%**

EXHIBIT D
Sanford WFF Expansion O&M Cost Allocation Example Based on Projected O&M Costs

Sanford WFF Expansion O&M Cost Allocation Example Based on Projected O&M Costs

Hazen

Operating Cost Summary

Cost Description	Fixed O&M Costs	Variable O&M Costs	Total O&M Costs
401 K	$33,013	$0	$33,013
ADMINISTRATION EXPENSE	$181,845	$0	$181,845
CELL PHONES	$1,238	$0	$1,238
CHEMICALS		$755,185	$755,185
CONTRACTUAL SERVICES	$22,255	$0	$22,255
DEPARTMENT SUPPLIES & MATL	$19,193	$0	$19,193
DUES & SUBSCRIPTIONS	$8,883	$0	$8,883
EMPLOYEE TRAINING	$2,434	$0	$2,434
FICA	$48,832	$0	$48,832
FUEL & VEHICLE SUPPLIES	$2,915	$0	$2,915
GAC		$1,704,000	$1,704,000
INSURANCE	$122,650	$0	$122,650
INSURANCE & BONDS	$44,876	$0	$44,876
MAINTENANCE & REPAIR - AUTO	$945	$0	$945
MAINTENANCE & REPAIR - BUILDIN	$32,391	$0	$32,391
MAINTENANCE & REPAIR - EQUIPMENT	$201,633	$0	$201,633
MISCELLANEOUS	$1,893	$0	$1,893
OPEB EXPENSE	$123,648	$0	$123,648
POSTAGE	$6,395	$0	$6,395
PRINTING	$160	$0	$160
Total	**$1,910,974**	**$3,328,469**	**$5,239,443**

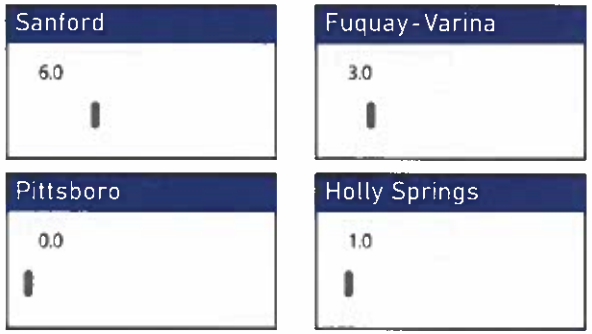
Partner Usage and Capacity Summary

Partner	Average Daily Demand	Partner Pct ADD	Capacity in Expanded WFF	Percent of Capacity in Expanded WFF
Pittsboro	0.0	0.0%	3.0	10.0%
Holly Springs	1.0	10.0%	4.0	13.3%
Fuquay-Varina	3.0	30.0%	6.0	20.0%
Sanford	6.0	60.0%	17.0	56.7%
Total	**10.0**	**100.0%**	**30.0**	**100.0%**

Cost Summary

Partner	Annual O&M Fixed Cost	Variable Cost per kgal	Annual O&M Variable Cost	Total (Fixed and Variable)
Sanford	$1,082,885	$0.91	$1,997,081	$3,878,797
Fuquay-Varina	$382,195	$0.91	$998,541	$1,780,151
Holly Springs	$254,797	$0.91	$332,847	$720,782

Average Daily Demand (MGD)



10.0

Average Daily Demand

Estimated O&M Cost Share

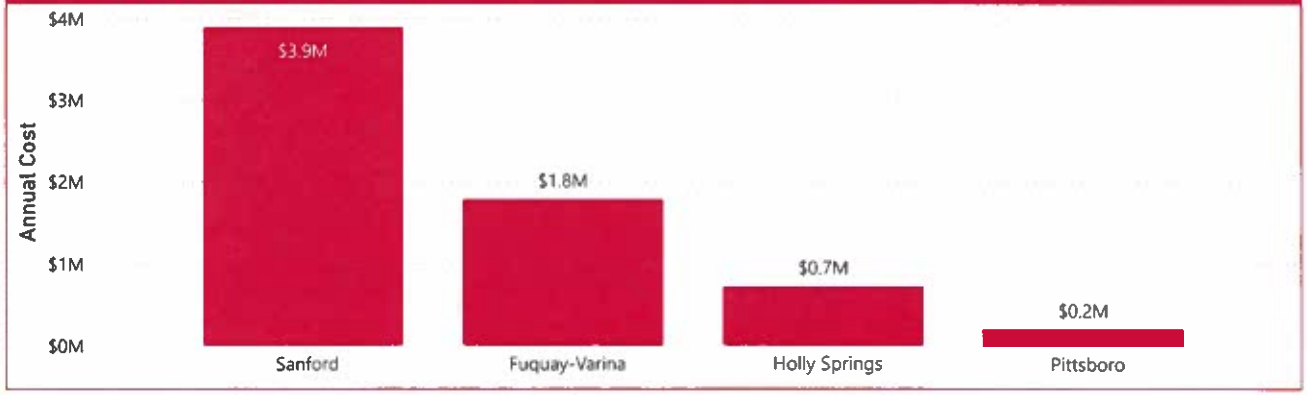


EXHIBIT E
Projected O&M Expenses

Sanford WFF Projected FY2026 O&M Expenses

Summary of FY26 Annual O&M Costs by Type

O&M Cost Description	WFF Facility Capacity	Cost Type	FY2026 Annual Cost Projection
SALARY AND WAGES	Existing	Fixed	$670,077
401 K	Existing	Fixed	$33,013
FICA	Existing	Fixed	$48,832
INSURANCE	Existing	Fixed	$122,650
RETIREMENT	Existing	Fixed	$90,762
UNEMPLOYMENT INSURANCE	Existing	Fixed	$775
OPEB EXPENSE	Existing	Fixed	$123,648
EMPLOYEE TRAINING	Existing	Fixed	$2,434
PROFESSIONAL SERVICES	Existing	Fixed	$84,620
TELEPHONE	Existing	Fixed	$4,689
CELL PHONES	Existing	Fixed	$1,238
WIRELESS CONNECTIVITY	Existing	Fixed	$937
PRINTING	Existing	Fixed	$160
MAINTENANCE & REPAIR - BUILDIN	Existing	Fixed	$32,391
MAINTENANCE & REPAIR - EQUIPMENT	Existing	Fixed	$201,633
MAINTENANCE & REPAIR - AUTO	Existing	Fixed	$945
POSTAGE	Existing	Fixed	$6,395
FUEL & VEHICLE SUPPLIES	Existing	Fixed	$2,915
DEPARTMENT SUPPLIES & MATL	Existing	Fixed	$19,193
UNIFORMS	Existing	Fixed	$3,915
CONTRACTUAL SERVICES	Existing	Fixed	$22,255
DUES & SUBSCRIPTIONS	Existing	Fixed	$8,883
INSURANCE & BONDS	Existing	Fixed	$44,876
MISCELLANEOUS	Existing	Fixed	$1,893
ADMINISTRATION EXPENSE	Existing	Fixed	$181,845
ADMINISTRATION EXPENSE	New	Fixed	$0
SALARY AND WAGES - Operations	New	Fixed	$200,000
GAC	New	Variable	$1,704,000
UTILITIES	Existing	Variable	$727,154
CHEMICALS	Existing	Variable	$755,189
SLUDGE REMOVAL	Existing	Variable	$142,124
TOTAL			**$5,239,441**

O&M Cost Projection Unit Cost Assumptions

Cost Assumptions	Value
Annual Esacalation of Exisiting Non-Volume Based	3.0%
Average Daily Production in 2026 (MGD)	10
Utilites ($/kgal)	$0.20
Chemicals ($/kgal)	$0.21
Sludge Removal ($/kgal)	$0.04
GAC-Reactivated ($/MGD/year)	$170,400

Sanford WFF 2022 O&M Budget Summary

ORG	OBJ	ACCOUNT DESCRIPTION	YTD EXPENDED
30098110	60000	SALARY AND WAGES	570,192.08
30098110	60000	SALARY AND WAGES	12,322.19
30098110	60000	SALARY AND WAGES	1,643.06
30098110	60002	401 K	28,049.36
30098110	60002	401 K	616.09
30098110	60002	401 K	82.15
30098110	60003	FICA	41,566.56
30098110	60003	FICA	942.62
30098110	60003	FICA	125.69
30098110	60004	INSURANCE	109,496.89
30098110	60005	RETIREMENT	43,779.84
30098110	60005	RETIREMENT	1,398.59
30098110	60005	RETIREMENT	186.49
30098110	60006	UNEMPLOYMENT INSURANCE	207.38
30098110	60008	OPEB EXPENSE	60,700.80
30098110	60100	EMPLOYEE TRAINING	2,455.21
30098110	60200	PROFESSIONAL SERVICES	58,818.67
30098110	61100	TELEPHONE	4,592.37
30098110	611001	CELL PHONES	900.00
30098110	61150	WIRELESS CONNECTIVITY	601.72
30098110	61200	PRINTING	300.00
30098110	61551	MAINTENANCE & REPAIR - BUILDIN	10,323.55
30098110	61600	MAINTENANCE & REPAIR - EQUIPMENT	33,013.56
30098110	61700	MAINTENANCE & REPAIR - AUTO	1,058.96
30098110	62000	UTILITIES	540,647.29
30098110	63000	POSTAGE	6,557.36
30098110	63100	FUEL & VEHICLE SUPPLIES	3,352.84
30098110	63200	CHEMICALS	634,163.33
30098110	63300	DEPARTMENT SUPPLIES & MATL	10,944.69
30098110	63600	UNIFORMS	3,177.10
30098110	64400	SLUDGE REMOVAL	109,325.18
30098110	64500	CONTRACTUAL SERVICES	17,952.20
30098110	65300	DUES & SUBSCRIPTIONS	7,545.00
30098110	65400	INSURANCE & BONDS	39,550.68
30098110	65700	MISCELLANEOUS	1,776.36
30098110	67410	CAPITAL - MACHINERY & EQUIPMT	12,500.00
		Total 30098110 UF WATER FILTRATION	2,370,865.86
		Grand Total	2,370,865.86

Sanford WFF 2021 O&M Budget

ORG	OBJ	ACCOUNT DESCRIPTION	YTD EXPENDED
30098110	60000	SALARY AND WAGES	614,717.20
30098110	60000	SALARY AND WAGES	
30098110	60000	SALARY AND WAGES	
30098110	60002	401 K	30,369.19
30098110	60002	401 K	
30098110	60002	401 K	
30098110	60003	FICA	44,698.12
30098110	60003	FICA	
30098110	60003	FICA	
30098110	60004	INSURANCE	114,411.60
30098110	60005	RETIREMENT	97,353.94
30098110	60005	RETIREMENT	
30098110	60005	RETIREMENT	
30098110	60006	UNEMPLOYMENT INSURANCE	111.01
30098110	60008	OPEB EXPENSE	148,994.74
30098110	60100	EMPLOYEE TRAINING	1,301.90
30098110	60200	PROFESSIONAL SERVICES	93,302.00
30098110	61100	TELEPHONE	4,720.47
30098110	611001	CELL PHONES	1,200.00
30098110	61150	WIRELESS CONNECTIVITY	617.26
30098110	61200	PRINTING	0.00
30098110	61551	MAINTENANCE & REPAIR - BUILDIN	32,149.13
30098110	61600	MAINTENANCE & REPAIR - EQUIPMENT	300,699.27
30098110	61700	MAINTENANCE & REPAIR - AUTO	676.16
30098110	62000	UTILITIES	523,740.91
30098110	63000	POSTAGE	5,884.36
30098110	63100	FUEL & VEHICLE SUPPLIES	2,160.50
30098110	63200	CHEMICALS	546,297.06
30098110	63300	DEPARTMENT SUPPLIES & MATL	12,706.20
30098110	63600	UNIFORMS	3,678.06
30098110	64400	SLUDGE REMOVAL	101,843.20
30098110	64500	CONTRACTUAL SERVICES	21,650.00
30098110	65300	DUES & SUBSCRIPTIONS	8,450.00
30098110	65400	INSURANCE & BONDS	39,820.34
30098110	65700	MISCELLANEOUS	1,302.01
30098110	67410	CAPITAL - MACHINERY & EQUIPMT	172,280.00
		Total 30098110 UF WATER FILTRATION	2,925,134.63
		Grand Total	2,925,134.63

Sanford WFF 2020 O&M Budget

ORG	OBJ	ACCOUNT DESCRIPTION	YTD EXPENDED
30098110	60000	SALARY AND WAGES	587,189.99
30098110	60000	SALARY AND WAGES	
30098110	60000	SALARY AND WAGES	
30098110	60002	401 K	28,878.41
30098110	60002	401 K	
30098110	60002	401 K	
30098110	60003	FICA	
30098110	60003	FICA	42,825.88
30098110	60003	FICA	
30098110	60004	INSURANCE	103,009.07
30098110	60005	RETIREMENT	99,203.75
30098110	60005	RETIREMENT	
30098110	60005	RETIREMENT	
30098110	60006	UNEMPLOYMENT INSURANCE	1,746.63
30098110	60008	OPEB EXPENSE	119,882.90
30098110	60100	EMPLOYEE TRAINING	2,729.71
30098110	60200	PROFESSIONAL SERVICES	73,431.01
30098110	61100	TELEPHONE	3,185.79
30098110	611001	CELL PHONES	1,200.00
30098110	61150	WIRELESS CONNECTIVITY	1,277.54
30098110	61200	PRINTING	127.00
30098110	61551	MAINTENANCE & REPAIR - BUILDIN	43,864.21
30098110	61600	MAINTENANCE & REPAIR - EQUIPMENT	203,732.43
30098110	61700	MAINTENANCE & REPAIR - AUTO	784.16
30098110	62000	UTILITIES	565,745.23
30098110	63000	POSTAGE	4,604.44
30098110	63100	FUEL & VEHICLE SUPPLIES	2,256.48
30098110	63200	CHEMICALS	514,184.41
30098110	63300	DEPARTMENT SUPPLIES & MATL	27,507.68
30098110	63600	UNIFORMS	3,578.82
30098110	64400	SLUDGE REMOVAL	107,757.50
30098110	64500	CONTRACTUAL SERVICES	19,718.42
30098110	65300	DUES & SUBSCRIPTIONS	7,683.00
30098110	65400	INSURANCE & BONDS	40,243.99
30098110	65700	MISCELLANEOUS	1,967.91
30098110	67410	CAPITAL - MACHINERY & EQUIPMT	106,720.00
		Total 30098110 UF WATER FILTRATION	2,715,036.36
		Grand Total	2,715,036.36

ORG	OBJ	ACCOUNT DESCRIPTION	YTD EXPENDED
30098110	60000	SALARY AND WAGES	648,309.00
30098110	60000	SALARY AND WAGES	
30098110	60000	SALARY AND WAGES	
30098110	60002	401 K	32,142.00
30098110	60002	401 K	
30098110	60002	401 K	
30098110	60003	FICA	49,177.00
30098110	60003	FICA	
30098110	60003	FICA	
30098110	60004	INSURANCE	121,462.00
30098110	60005	RETIREMENT	77,784.00
30098110	60005	RETIREMENT	
30098110	60005	RETIREMENT	
30098110	60006	UNEMPLOYMENT INSURANCE	0.00
30098110	60008	OPEB EXPENSE	0.00
30098110	60100	EMPLOYEE TRAINING	4,000.00
30098110	60200	PROFESSIONAL SERVICES	125,000.00
30098110	61100	TELEPHONE	4,800.00
30098110	611001	CELL PHONES	1,200.00
30098110	61150	WIRELESS CONNECTIVITY	1,200.00
30098110	61200	PRINTING	0.00
30098110	61551	MAINTENANCE & REPAIR - BUILDIN	15,000.00
30098110	61600	MAINTENANCE & REPAIR - EQUIPMENT	50,000.00
30098110	61700	MAINTENANCE & REPAIR - AUTO	1,500.00
30098110	62000	UTILITIES	605,584.00
30098110	63000	POSTAGE	5,500.00
30098110	63100	FUEL & VEHICLE SUPPLIES	5,250.00
30098110	63200	CHEMICALS	710,000.00
30098110	63300	DEPARTMENT SUPPLIES & MATL	12,000.00
30098110	63600	UNIFORMS	4,800.00
30098110	64400	SLUDGE REMOVAL	120,000.00
30098110	64500	CONTRACTUAL SERVICES	29,580.00
30098110	65300	DUES & SUBSCRIPTIONS	9,300.00
30098110	65400	INSURANCE & BONDS	47,396.12
30098110	65700	MISCELLANEOUS	3,000.00
30098110	67410	CAPITAL - MACHINERY & EQUIPMT	75,000.00
30098110	67400	CAPITAL - VEHICLES	37,700.00
		Total 30098110 UF WATER FILTRATION	2,796,684.12
		Grand Total	2,796,684.12

Sanford WFF Historic O&M Budget Summary

Historic Sanford WFF O&M Costs By Type

Category	Type	2022	2021	2020	Three Year Avg
SALARY AND WAGES	Fixed	$584,157	$614,717	$587,190	$595,355
401 K	Fixed	$28,748	$30,369	$28,878	$29,332
FICA	Fixed	$42,635	$44,698	$42,826	$43,386
INSURANCE	Fixed	$109,497	$114,412	$103,009	$108,973
RETIREMENT	Fixed	$45,365	$97,354	$99,204	$80,641
UNEMPLOYMENT INSURANCE	Fixed	$207	$111	$1,747	$688
OPEB EXPENSE	Fixed	$60,701	$148,995	$119,883	$109,859
EMPLOYEE TRAINING	Fixed	$2,455	$1,302	$2,730	$2,162
PROFESSIONAL SERVICES	Fixed	$58,819	$93,302	$73,431	$75,184
TELEPHONE	Fixed	$4,592	$4,720	$3,186	$4,166
CELL PHONES	Fixed	$900	$1,200	$1,200	$1,100
WIRELESS CONNECTIVITY	Fixed	$602	$617	$1,278	$832
PRINTING	Fixed	$300	$0	$127	$142
MAINTENANCE & REPAIR - BUILDIN	Fixed	$10,324	$32,149	$43,864	$28,779
MAINTENANCE & REPAIR - EQUIPMENT	Fixed	$33,014	$300,699	$203,732	$179,148
MAINTENANCE & REPAIR - AUTO	Fixed	$1,059	$676	$784	$840
POSTAGE	Fixed	$6,557	$5,884	$4,604	$5,682
FUEL & VEHICLE SUPPLIES	Fixed	$3,353	$2,161	$2,256	$2,590
DEPARTMENT SUPPLIES & MATL	Fixed	$10,945	$12,706	$27,508	$17,053
UNIFORMS	Fixed	$3,177	$3,678	$3,579	$3,478
CONTRACTUAL SERVICES	Fixed	$17,952	$21,650	$19,718	$19,774
DUES & SUBSCRIPTIONS	Fixed	$7,545	$8,450	$7,683	$7,893
INSURANCE & BONDS	Fixed	$39,551	$39,820	$40,244	$39,872
MISCELLANEOUS	Fixed	$1,776	$1,302	$1,968	$1,682
CAPITAL - MACHINERY & EQUIPMT	Fixed	$12,500	$172,280	$106,720	$97,167
UTILITIES	Variable	$540,647	$523,741	$565,745	$543,378
CHEMICALS	Variable	$634,163	$546,297	$514,184	$564,882
SLUDGE REMOVAL	Variable	$109,325	$101,843	$107,758	$106,309
Total		**$2,370,866**	**$2,925,135**	**$2,715,036**	**$2,670,346**

Historic Sanford WFF O&M Unit Costs

	2022	2021	2020	Three Year Avg
Fixed	$1,086,730	$1,753,253	$1,527,349	$1,455,778
Variable	$1,284,136	$1,171,881	$1,187,687	$1,214,568
Water Produced (MGD)	7.480	7.440	7.498	7.473
Water Produced (MG/year)	2,730	2,716	2,737	2,728
Water Produced (kgal/year)	2,730,200	2,715,600	2,736,770	2,727,523
Total O&M ($/kgal)	$0.87	$1.08	$0.99	$0.98
Volume Based O&M ($/kgal)	$0.47	$0.43	$0.43	$0.45
Utilites ($/kgal)	$0.20	$0.19	$0.21	$0.20
Chemicals ($/kgal)	$0.23	$0.20	$0.19	$0.21
Sludge Removal ($/kgal)	$0.04	$0.04	$0.04	$0.04

APPENDIX
Current Contacts

August 1, 2023 Executed ILA for Water Treatment Plant Expansion
Appendix Current Contacts

Name	Title	Phone
City of Sanford		
Hal Hegwer	City Manager	919-777-1110
Victor Czar	Public Works Director	919-777-1117
Paul Weeks	Utilities and Engineering Director	919-777-1119
Susan Patterson	City Attorney	919-777-1105
Beth Kelly	Finance Director	919-777-1106
For Water Treatment Plant Emergencies		
Scott Christiansen	Water Filtration Administrator	919-777-1800
Nathan Cotton	Chief Operator	919-777-1802
Control Room		919-777-1803
For Distribution and Collections Emergencies		
Gerald Cox	Distribution/Collection Administrator	919-777-1210
Alvan Davis	Distribution/Collection Coordinator	919-777-1211
For emergencies after hours		**919-775-8268**
Town of Fuquay-Varina		
Adam Mitchell	Town Manager	919-552-1401
Tracy Stephenson	Public Works Director	919-753-1039
Mike Wagner	Public Utilities Director	919-567-3911
Matt Poling	Town Engineer	919-552-1035
James Adcock	Town Attorney	919-552-2929
JoAnne Crabtree	Finance Director	919-552-1438
Town of Holly Springs		
Randy Harrington	Town Manager	919-557-3924
Kendra Parrish, PE	Executive Director of Utilities & Infrastructure	919-557-3935
Seann Byrd	Deputy Director of Utilities & Infrastructure	919-577-1090
John Schifano	Town Attorney	919-557-2917
Tina Stroupe	Finance Director	919-557-3912
For emergencies after hours		**919-557-9111 (Town Police Dispatch)**

Appendix B: Technical Memorandum for Population, Water Demand, and Interbasin Transfer Projections

Hazen and Sawyer
4011 WestChase Blvd, Suite 500
Raleigh, NC 27607 • 919.833.7152
Firm License No. C-0381

TECHNICAL MEMORANDUM

To:
Mike Wagner
Public Utilities Director
Town of Fuquay-Varina

Copies:
File

From:
Hazen and Sawyer

Date:
June 2025

Subject:
Population, Water Demand, and Interbasin Transfer Projections
Town of Fuquay-Varina Water Supply and Interbasin Transfer
Appendix to Environmental Impact Statement

1. Introduction

Population, water demand, and interbasin transfer (IBT) projections were developed to support the Town of Fuquay-Varina's request for a transfer of water from the Cape Fear River basin (2-3) to the Neuse River basin (10-1). This analysis supports the Purpose and Need in the Environmental Impact Statement (EIS). The planning window for the IBT is 30 years using 2025 as the beginning of the planning period. This Technical Memorandum documents the assumptions and methodology for the projection analyses.

The Town of Fuquay-Varina is located in southern Wake County. The Town's service area consists of municipal Town limits and extraterritorial jurisdiction (ETJ). The Town's service area abuts the Wake-Harnett County line. The Wake-Johnston County line is to the east of the service area. The service area extends north to the west of U.S. 401. The interbasin transfer (IBT) boundary between basin 2-3 (Cape Fear) and basin 10-1 (Neuse) is located almost through the center of the Town's service area, following U.S. 55 to Judd Parkway and Holland Road and then turning south along U.S. 55 toward the Wake-Harnett County line. Exhibit 1 provides the location of the Town's municipal limits, ETJ, and IBT boundary. The Town's Urban Services Area extends east from the ETJ to the Wake-Johnston County line south of Highway 42, approximately 1.1 miles east of the ETJ north of Highway 42, and approximately 1 mile west of the ETJ in the southwest corner of the Town's service area near the Wake-Harnett County line.

2. Data Sources

Hazen compiled data from several sources to evaluate population, water, and interbasin transfer projections. Data was compiled from the Town's Local Water Supply Plans (LWSP), a *Water Capacity Study* (WithersRavenel | Freese and Nichols, 2017), population data from the North Carolina Office of State Budget and Management (OSBM), and American Community Survey data from the U.S. Census Bureau. The Town provided billing data for 2019. A summary of account data over multiple years was compiled from the Town's LWSPs.

The Town's Geographic Information System (GIS) Department was contacted to obtain the most recent GIS shapefiles of the water distribution system, wastewater collection system, and municipal boundaries. The Town provided a GIS database that designated parcels that are physically located in either the Neuse or the Cape Fear River basins along with current water and sewer lines. The database designates the terminal treatment facility for each sewer area. Wake County provided GIS data for well locations and parcels served by septic. Parcels were categorized by the number of vacant and non-vacant parcels located in the Neuse and Cape Fear basins for water distribution and sewer service. Table 1 provides the data sources used for the GIS analysis, population projections, and water demand projections.

Table 1: Data Sources Used for GIS Analysis, Population Projections, and Water Demand Projections

Data	Source
American Community Survey block group data, 2010 – 2018	United States Census Bureau
Town of Fuquay-Varina service area population, 1997, 2002, 2006, 2009 – 2020	Local Water Supply Plans prepared by Town of Fuquay-Varina for North Carolina Division of Water Resources
Municipal and County population data	North Carolina Office of State Budget and Management
Water and sewer infrastructure GIS data	Town of Fuquay-Varina GIS Department
Traffic Analysis Zone (TAZ) data, 2045 projections	Capital Areas Metropolitan Planning Organization (2018)
Town of Fuquay-Varina customer account data, 2000 – 2015.	Town of Fuquay-Varina Finance Department
Town of Fuquay-Varina utilities billing data, 2019.	Town Finance Department
Wake County Tax Parcels	Wake County GIS Property Mapping Team
Average persons per single-family residential account	Vickers, Amy, 2001. Handbook of Water Use and Conservation: Homes, Landscapes, Businesses, Industries, Farms, First Edition

3. Summary of Water and Wastewater Infrastructure

Section 3 provides a summary of the Town's water and wastewater infrastructure. Exhibits 2 and 3 provide an illustration of the Town's water and sewer infrastructure, respectively. Exhibits 2 and 3 also illustrate the location of parcels on private wells and septic systems in the service area, respectively.

3.1 Service Area Characterization

Table 2 provides a summary of the number of parcels on water and sewer service in the municipal boundary and ETJ. Approximately 5,000 non-vacant parcels are on private wells in the Town's service area. Approximately 5,200 non-vacant parcels are on a septic system in the service area, of which approximately 208 and 438 non-vacant parcels are on water lines and septic in the Neuse and Cape Fear, respectively. The fraction of the Town's current water demand in the Neuse River and Cape Fear River basins is approximately 62 percent and 38 percent, respectively.

Hazen

Table 2: Summary of Water and Sewer Data in Fuquay-Varina Service Area

Description	Parcel Count
Number of parcels	21,879
Number of non-vacant parcels	18,873
Number of non-vacant parcels in Neuse	12,951
Number of non-vacant parcels in Cape Fear	5,922
Sewer Summary	
Number of parcels on sewer lines	13,337
Number of non-vacant parcels on sewer lines	11,452
Number of non-vacant parcels to Harnett County North Regional WWTP	6,058
Number of non-vacant parcels on Terrible Creek WWTP lines [1]	4,986
Number of non-vacant parcels on Brighton Forest WWTP lines	408
Number of non-vacant parcels on sewer in Neuse	7,273
Number of non-vacant parcels on sewer in Cape Fear	4,884
Number of non-vacant parcels on sewer, total	12,157
Water Summary (Fuquay Varina Lines)	
Number of Parcels on Fuquay-Varina water lines	12,735
Number of non-vacant parcels on Fuquay-Varina water lines	11,358
Number of non-vacant parcels on Fuquay-Varina water lines in Neuse	7,180
Number of non-vacant parcels on Fuquay-Varina water lines in Cape Fear	4,178
Water Summary (Harnett County Lines)	
Number of Parcels on Harnett County water lines	397
Number of non-vacant parcels on Harnett County water lines	300
Number of non-vacant parcels on Harnett County water lines in Neuse	0
Number of non-vacant parcels on Harnett County water lines in Cape Fear	300
Total Water Summary (Fuquay-Varina and Harnett County)	
Number of parcels on water lines	13,132
Number of non-vacant parcels on water lines	11,658
Number of non-vacant parcels on water lines in Neuse	7,180
Fraction of demand in Neuse	62%
Number of non-vacant parcels on water lines in Cape Fear	4,478
Fraction of demand in Cape Fear	38%
Water Lines on Septic Summary	
Number of non-vacant parcels on water line and septic in Neuse	208
Number of non-vacant parcels on water line and septic in Cape Fear	438
Number of non-vacant parcels on water line and septic, total	646

Table 2: Summary of Water and Sewer Data in Fuquay-Varina Service Area

Description	Parcel Count
Well Systems on Sewer Summary	
Number of non-vacant parcels using wells on sewer, Neuse	142
Number of non-vacant parcels using wells on sewer, Cape Fear	298
Number of non-vacant parcels using wells on sewer, total	440

[1] *Approximately 512 non-vacant parcels are geographically located in the Cape Fear hydrologic boundary but legislatively located in the Neuse River basin per General Statute § 143-215.22L.*

3.2 Water Distribution

The Town owns and operates the water distribution system in the majority of the service area. Harnett County provides water service to 397 accounts in the southern end of the Town's service area near the Wake-Harnett County line. The Town's water distribution system network includes approximately 250 miles of water line, three pump stations, one ground storage tank, and two elevated storage tanks.

Finished water is delivered to the Town via three bulk finished water wholesale purveyors. Harnett County supplies the Town from the primary connection at the Wake County groundwater storage tank and pump station located at Fleming Road. The secondary connection point with Harnett County is at U.S. 401 near the Wake County and Harnett County border. Raleigh Water's connection to the Town's distribution system is at U.S. 401 and Ten Ten Road. The connection point with Johnston County is located at Highway 42 and Mount Pleasant Church Road.

3.3 Wastewater Collection and Treatment

The Town's collection system has been designed based on the hydrologic basin boundary between the Neuse and Cape Fear River basins. The Town currently conveys all produced wastewater in the Cape Fear River basin portion of the Town's service area to Harnett County's North Regional Wastewater Treatment Plant (WWTP) for treatment and discharge. The North Harnett Regional WWTP discharges to the Cape Fear River via National Pollutant Discharge Elimination System (NPDES) permit NC0021636. The Town conveys the majority of produced wastewater in the Neuse River basin to the Terrible Creek WWTP for treatment and discharge. The Terrible Creek WWTP was expanded to a maximum month capacity of 3 million gallons per day (mgd) in 2018 and is currently being expanded to 6 mgd. A small fraction of produced wastewater (i.e., 0.117 mgd) in the Neuse River basin is treated at the Town of Fuquay-Varina's Brighton Forest WWTP, which serves single family homes in the Brighton Forest Subdivision. The Town of Fuquay-Varina has never had the ability to transfer raw wastewater between the Cape Fear and Neuse River basins.

The Town previously owned and operated the 1.2 mgd Kenneth Branch WWTP. The Kenneth Branch WWTP was located in the Cape Fear portion of the Town's service area. The Kenneth Branch WWTP discharged to Kenneth Creek as authorized by NPDES permit NC0028118. The Kenneth Creek receiving stream is a tributary to Neals Creek, which is tributary to the Cape Fear River upstream of the Town of Lillington. In March 2008, the Town decommissioned the Kenneth Branch WWTP and rescinded the NPDES permit NC0028118 (NCDENR, 2008). The Town of Fuquay-Varina deeded the property to the

Wake County Public School System in 2022. The Wake County Public School System is constructing middle and elementary schools on this property.

3.4 Interlocal Agreements for Bulk Finished Water and Wastewater Allocation

Table 3 provides a summary of the Town of Fuquay-Varina's Interlocal Agreements (ILAs) with neighboring communities for bulk finished water supply and wastewater allocation. The summary includes the contract amount, expiration date, and comments regarding the likelihood of contract renewal. The Town of Fuquay-Varina has signed temporary interlocal lease agreements with Raleigh Water, Harnett County, and Johnston County for the purchase of bulk finished water. The Town of Fuquay-Varina signed an ILA with Harnett County for the purchase of wastewater allocation in the North Harnett Regional WWTP. The following sections provide a summary of the interlocal agreements.

Table 3: Summary of Town of Fuquay-Varina's Interlocal Agreements for Water Supply and Wastewater Capacity

Supplier	Contract Value	Service	Comment
Johnston County	1.5 mgd	Water	Contract expires in 2049. Town does not anticipate a contract renewal.
Raleigh Water	0.75 mgd	Water	Contract expired in 2021.
Raleigh Water	1.75 mgd	Water	Town signed new contract for 1.75 mgd until 2035. Contract renewal is not anticipated per correspondence with Raleigh Water.
Harnett County	2 mgd	Water	Contract expires in 2040. Town anticipates a contract renewal in 2040.
Harnett County	2 mgd	Water	The Town has negotiated an additional 2 mgd with contract expiring in 2032.
Harnett County	2.6 mgd	Wastewater	Contract expires in 2040 and automatically renews for an additional 40 years. The Town is working with Harnett County for the purchase of the Town's additional 3.4 mgd wastewater allocation in the North Harnett Regional WWTP (NC0021636) for a total of 6 mgd.
City of Sanford	6 mgd	Water	Contract expires in 2122 with option to renew for another 99 years. The Town's LWSP lists water supply from the City of Sanford as follows: 8 mgd in 2045, 10 mgd in 2050, and 11 mgd in 2055.

3.4.1 Wastewater Allocation

The Town signed an ILA with Harnett County for the purchase of wastewater allocation in the North Harnett Regional WWTP in 2000. Per the ILA, the Town does not have any right of ownership in the North Harnett Regional WWTP. Therefore, the Town of does not own actual treatment capacity in the Harnett County wastewater treatment facility. The Town's ILA with Harnett County allows the Town of Fuquay-Varina to increase the Town's wastewater allocation in the North Harnett Regional WWTP by an additional 3.4 mgd, for a total of 6 mgd. The ILA expires in 2040 and automatically renews for an additional 40 years. Harnett County issued a Letter of Intent (Harnett County, 2021) to the Town of Fuquay-Varina that confirms the Town of Fuquay-Varina's participation in the North Harnett Regional WWTP expansion project. The Town and Harnett County executed an amendment to the ILA in 2023 for

the Town's purchase of the additional 3.4 mgd of capacity.

The Town's ILA with Harnett County also included a 15-mile interceptor to convey wastewater flow from the Town's service area in the Cape Fear watershed to the North Harnett Regional WWTP. Per a 201 Facilities Plan for the Town of Fuquay-Varina and Harnett County (Marziano and Minier, 2002), a 36-inch interceptor was proposed from the former Kenneth Branch WWTP site. The Town of Fuquay-Varina owns the 36-inch diameter interceptor segment in Wake County. The Town of Fuquay-Varina's ownership of the interceptor terminates at the meter vault at the Wake and Harnett County line. Harnett County owns the remaining 42 and 48-inch diameter interceptor segments from the meter vault to a pump station located on the north side of the Cape Fear River. The pump station pumps raw wastewater to the North Harnett Regional WWTP located on the south side of the Cape Fear River.

The Town and Harnett County interceptor was designed and constructed in accordance with applicable design criteria in the 1996 version of the Minimum Design Criteria for the Permitting of Gravity Sewers (DWR) to meet the capacity needs of the proposed project in 2000. The hydraulic capacity of the Town of Fuquay-Varina's allocation in the interceptor is 6 mgd average day flow with a hydraulic peak flow of 12 mgd. The capacity of the 36-inch interceptor was confirmed with a hydraulic model.

3.4.2 Bulk Finished Water

The Town has not secured a permanent water supply source. The Town does not own a raw water intake, water treatment infrastructure, or purchased permanent water supply capacity from a neighboring community. The Town has historically signed temporary ILAs with neighboring communities for wholesale finished water.

The Town signed an ILA with Harnett County for the purchase of a bulk finished water allocation in the Harnett County Regional WTP over a 50-year term. The first ILA was signed in 1989 and specified a finished water allocation of 1 mgd. A second ILA was signed in 1999 and specified an additional 1 mgd of allocation, for a total allocation of 2 mgd to the Town of Fuquay-Varina. The Town of Holly Springs was also included in the 1999 agreement. The 1989 and 1999 ILAs expire in 2040. Per the ILA, the Town of Fuquay-Varina does not have any right of ownership or title to the Harnett County Regional WTP. The Town has the right to expand the Harnett Regional WTP only in expansion increments specified by Harnett County. The Town must purchase a minimum of 100,000 gallons per day (gpd). Per the 1989 ILA, Harnett County reserves the right to curtail water supply proportionally to Harnett County customer restrictions or in emergency situations.

The 1999 ILA with Harnett County included a 36-inch finished water transmission line and an increase in the finished water pumping capacity at the Harnett County Regional WWTP. The Town does own real property in the 36-inch finished water transmission main and finished water pump station at 5 mgd and 2.609 mgd, respectively. Harnett County owns the property associated with the project.

In 2022, the Town negotiated with Harnett County for an additional 2 mgd increase in water allocation until 2032. This additional 2 mgd of allocation was not included in the IBT calculations. The Town's agreement with Harnett County is a temporary measure to provide water to the Town to mitigate the anticipated extended timing of construction of the City of Sanford's Water Filtration Facility (WFF) and the associated finished water transmission main. The Town will not utilize the temporary lease agreement for

the additional 2 mgd of water allocation from Harnett County once the City of Sanford's WFF expansion project is completed.

The Town signed a temporary ILA with Raleigh Water for the purchase of bulk finished water in 2021. The Town's first ILA with Raleigh Water was signed in 2000 and expired in 2021. The 2021 ILA allows the Town to purchase up to 1.75 mgd until 2035. The ILA states that the agreement is intended to provide a short-term supply of water until the Town can secure another water supply. The ILA states that Raleigh Water has the right to deny the Town of Fuquay-Varina water service in the event that water cannot be supplied without negatively impacting City of Raleigh customers.

The ILA between the Town of Fuquay-Varina and Johnston County is for the purchase of up to 1.0 mgd average day and up to 1.5 mgd peak. The ILA specifies that the Town of Fuquay-Varina's supply will be reduced in the event of an extended water shortage or water supply is unavailable to Johnston County. The rate of reduction for the Town is stated in the ILA to be the same as for Johnston County's other bulk finished water customers. The ILA has a contract expiration date of 2049. Per correspondence with Johnston County, the Town understands that the ILA with Johnston County will not be renewed after 2049.

The Town of Fuquay-Varina signed an ILA with the City of Sanford for the purchase of 6 mgd. Per the ILA, the Town of Fuquay-Varina has a right of ownership in the City of Sanford's WTP per the formula specified in the ILA. The Town of Fuquay-Varina has the right to future expansion of the water treatment infrastructure. The ILA also specifies that water conservation measures must be followed if stipulated by the City of Sanford or the State of North Carolina.

4. Water Billing

4.1.1 Water Consumption Charges

The Town of Fuquay-Varina has implemented a uniform rate structure for water consumption charges inside and outside corporate limits. The minimum base water rate increases based on meter size (i.e., larger meters are charged a higher minimum base rate). Water users pay a rate per 1,000 gallons consumed beyond the minimum base rate. Therefore, customers are charged for the water consumed based on actual metered use. The rate structure applies to base water meters and irrigation meters. Per the Town's Code of Ordinances Part 5, Chapter 1, Article B, water users outside of corporate limits are assessed rates double of the corporate limit rate. The Town of Fuquay-Varina's rate structure does not inhibit water conservation. Per Sections 2 of this EIS, the Town of Fuquay-Varina exhibits some of the lowest total per capita water use rates in the Cape Fear River basin.

4.1.2 Leak Detection

In July 2018, the Town of Fuquay-Varina initiated a conversion of the Town's monthly drive-by Automated Meter Reading (AMR) system to an advanced meter reading system, or Advanced Metering Infrastructure (AMI) system. The AMI system provides hourly reading through a fixed radio network. The Town of Fuquay-Varina has approximately 250 miles of water line, over half of which is greater than 20 years old. The AMI system provides Town of Fuquay-Varina staff real-time usage information to enhance and promote water conservation, reduce water leaks in the system, and improve operational efficiency.

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Town staff receive leak alerts from the AMI system that staff investigates daily. The conversion to the AMI system provides 720 water meter readings in each billing cycle in lieu of the one monthly reading currently collected with the existing AMR technology. Therefore, the Town of Fuquay-Varina's customers are more informed about water use in the monthly water bill. The AMI system will assist with minimization and control of spikes in water use, which will ultimately help control the maximum month and maximum day demand and associated peaking factors.

5. Population

5.1 Historic Population

Population data for the Town was obtained from several sources and is summarized in Table 4. Historic data was collected from the Town's Local Water Supply Plans (LWSP), the Office of State Budget and Management (OSBM), and the American Community Survey (ACS) from the U.S. Census Bureau. The Town's 2023 population is estimated at 43,500 people per the Town's LWSP. The population in the service area grew at an annual rate ranging from 3.8 percent to 8.3 percent since 2009 based on a five-year moving average. A five-year moving average was used to smooth out the year-over-year variability in growth. The majority of the Town's growth has occurred in the last 15 years, so a five-year moving average was selected to describe the annual growth in lieu of another metric (i.e., a ten-year moving average). The OSBM and ACS data reported a slightly lower population than the LWSP population between 2016 and 2018. Figure 1 illustrates the historic population data based on the Town's LWSP.

Table 4 also summarizes the number of residential (non-irrigation) accounts and the calculation of people per account. The average number of people per residential dwelling in the Town's service area was estimated by dividing the population estimate by the number of residential housing units. The average of the data from 1997 to 2023 is 2.36 people per account. The Town's residential people per account is slightly lower than the national average of 2.6 as reported by Vickers (2001) and 2.62 reported by the U.S. Census Bureau (2021).

Table 4: Summary of Historic Population and Residential Accounts

Year	Population from Local Water Supply Plan	Annual Growth Rate (5-year Moving Average)	Annual Growth Rate	Population from Office of State Budget and Management [2]	Population from American Community Survey [3]	Number of Residential Accounts [4]	People per Account [5]
1997	6,249	----	5.5%	----	----	2,089	2.99
1998	7,066 [1]	----	13.1%	----	----	----	----
1999	7,883 [1]	----	11.6%	----	----	----	----
2000	8,701 [1]	----	10.4%	----	----	----	----
2001	9,518 [1]	----	9.4%	----	----	----	----
2002	10,335	10.6%	8.6%	----	----	4,454	2.32
2003	11,397 [1]	10.0%	10.3%	----	----	----	----
2004	12,460 [1]	9.6%	9.3%	----	----	----	----
2005	13,522 [1]	9.2%	8.5%	----	----	----	----
2006	14,584	8.9%	7.9%	----	----	6,201	2.35

Table 4: Summary of Historic Population and Residential Accounts

Year	Population from Local Water Supply Plan	Annual Growth Rate (5-year Moving Average)	Annual Growth Rate	Population from Office of State Budget and Management [2]	Population from American Community Survey [3]	Number of Residential Accounts [4]	People per Account [5]
2007	14,723 [1]	7.4%	0.95%	----	----	----	----
2008	14,861 [1]	5.5%	0.94%	----	----	----	----
2009	15,000	3.8%	0.93%	----	----	7,747	1.94
2010	17,937	6.1%	19.6%	18,109	16,152	7,800	2.30
2011	18,600	5.2%	3.7%	18,643	17,074	7,840	2.37
2012	19,674	6.2%	5.8%	19,386	18,143	8,341	2.36
2013	19,804	6.1%	0.66%	19,726	19,164	8,861	2.23
2014	21,653	7.8%	9.3%	21,693	20,246	9,907	2.19
2015	22,920	5.1%	5.9%	22,858	21,399	10,322	2.22
2016	26,105	7.1%	13.9%	24,365	22,722	10,763	2.43
2017	27,600	7.1%	5.7%	25,548	24,373	11,465	2.41
2018	29,450	8.3%	6.7%	26,924	25,932	11,979	2.46
2019	29,200	6.3%	-0.85%	----	----	12,480	2.34
2020	33,000	7.7%	13.0%	34,604	----	13,675	2.41
2021	34,152	5.6%	3.5%	----	----	14,419	2.37
2022	39,468	7.6%	15.6%	----	----	15,060	2.62
2023	43,481	10.6%	10.2%	----	----	19,396	2.24

[1] Linear interpolation of population data.
[2] Population recorded using a fiscal year starting July 1.
[3] U.S. Census Bureau data as of April 2020.
[4] Town of Fuquay-Varina Local Water Supply Plans.
[5] Calculation based on Town of Fuquay-Varina Local Water Supply Plan population projections and number of residential accounts.

5.2 Population Projections

Growth in Wake County and the Piedmont region has been significant due to several factors. The I-540 interchange has been in the planning process since the mid-1990s. The first stretch of I-540 opened in 1999 and the Triangle Expressway Southeast Extension (i.e., between the Town of Holly Springs and the Town of Garner) is under construction after approximately 15 years of delay. More significantly to the growth pressure is the recent economic development drive by the North Carolina Department of Commerce and the Economic Development Partnership of North Carolina (EDPNC) to attract industry to North Carolina. Founded as a non-profit in 2014, EDPNC is funded both by a contract with the North Carolina Department of Commerce and by private investment to provide economic development services. EDPNC, in partnership with the North Carolina Department of Commerce, has been highly successful in attracting new industry to the Piedmont region.

The Town of Fuquay-Varina is a secondary recipient of this growth. The Town has not gained new industry but is instead planning around the effects of residential and commercial growth to support surrounding communities' industrial growth. Furthermore, communities in the Triangle Region have been

identified as best places in the United States to live and work, which has in part resulted in growth in the Piedmont region. Per the Town of Fuquay-Varina's Planning Department, annual population growth in the Town has been consistent over the last several years. In response to this growth, the Town has also seen a change in the mix of residential and commercial development over the last several years. The Town expects this change in land use to continue per the Town's Community Vision Land Use Plan.

The population projections documented in the Town of Fuquay Varina's LWSPs reflect the activity in the region given the uncertainties with the timing of NCDOT road projects and other economic development activities. The Town of Fuquay-Varina has adjusted population projections in the annual LWSPs as warranted by activity in the region. Table 5 provides a summary of the population projections as reported in the Town of Fuquay-Varina's LWSPs compared to the historic population. The following are observations with respect to the historic population compared to the population projections in the LWSPs:

- The 2010 population projection as reported in a 1989 Diehl and Phillips Comprehensive Water and Wastewater Facility study, the 2006 LWSP, and the 2009 LWSP was 19,184 people compared to the 2010 historic population of 17,937 people.
- The 2020 population projection as reported in the 2010 LWSP was 27,662 people compared to the historic 2020 population of 33,000 people.
- The 2020 population projection as reported in the 2016 LWSP was 31,105 people compared to the historic 2020 population of 33,000 people.
- The 2030 population projection as reported in the 2002 LWPS was 43,724 people as compared to a population projection of 51,530 people as reported in the 2023 LWSP.

Hazen and Sawyer updated the Town of Fuquay-Varina's population projections to support the proposed request for an interbasin transfer. The Town commissioned Hazen in early 2019 to begin the planning process. The population projections as reported in the Town of Fuquay-Varina's 2020 to 2023 LWSPs reflect the updated planning estimates for the Town's proposed interbasin transfer project.

ACS Block Group data was used to establish the growth areas in the municipal limits and extra-territorial jurisdiction (ETJ) (e.g., service area). The Wake County parcel data was linked to meter consumption (e.g., billing data) to filter existing accounts to residential homes and year built. The ACS Block Group data was also cross-referenced with Wake County tax parcel data to geospatially determine the number of filtered parcels and filtered parcels with accounts in each Block Group. The fraction of metered parcels was multiplied by the Block Group population to determine a served population. It was assumed that residential homes with metered connections (2019 consumption data) were connected by 2013 if built prior to 2013. An even distribution of persons per household was assumed in each Block Group. This analysis resulted in a 2018 served population of 27,700 people compared to the historic population estimate of 29,450 people, a reasonable 6 percent difference. The unserved population in the service area was determined to be 17,500 people. The unserved population is on private well systems.

The North Carolina Capital Areas Metropolitan Planning Organization (CAMPO) Traffic Analysis Zone (TAZ) data was used to estimate the build-out population in the Town's service area. The TAZ data was used to assess build-out population, provide an additional benchmark for the current population, and estimate the percent of current and future population served in the Cape Fear and the Neuse River basins. The most recent 2018 CAMPO data was used. The 2018 TAZ data starts with a baseline year of

2013 and projects population and employment out to 2045. The 2013 baseline year for TAZ was updated to 2018 using the ACS Block Group data. The dwelling units per acre was converted to population using the Triangle J Council of Governments (TJCOG) assumption of 2.9 persons per household for single family residences and 2.1 persons per household for multi-family residences. The calculations also assume that the Town will connect homes on private well systems (i.e., unserved population) at a rate of 1 percent per year.

Table 5: Population Projections as Reported in Town of Fuquay-Varina's Local Water Supply Plans Compared to Historic Population

Local Water Supply Plan Year	Historic Population	Population Projection As Reported for a Local Water Supply Planning Year						
		2010	2020	2030	2040	2050	2060	2070
1989 Study [1]	----	19,148	21,405	----	----	----	----	----
1997 LWSP	6,249	18,268	38,942	----	----	----	----	----
2002 LWSP	10,335	14,510	25,188	43,724	----	----	----	----
2006 LWSP	14,584	19,184	30,684	42,184	53,684	65,184	----	----
2009 LWSP	15,000	19,184	30,684	42,184	53,684	65,184	----	----
2010 LWSP	17,937	17,937	27,662	42,162	59,662	77,162	94,662	----
2011 LWSP	18,600	----	27,662	42,162	59,662	77,162	94,662	----
2012 LWSP	19,674	----	27,662	42,162	59,662	77,162	94,662	----
2013 LWSP	19,804	----	27,662	42,162	59,662	77,162	94,662	----
2014 LWSP	21,653	----	27,662	42,162	59,662	77,162	94,662	----
2015 LWSP	22,920	----	27,662	42,162	59,662	77,162	94,662	----
2016 LWSP	26,105	----	31,105	43,605	56,105	68,605	73,733	----
2017 LWSP	27,600	----	31,105	43,605	56,105	68,605	73,733	----
2018 LWSP	29,450	----	32,395	45,350	58,960	70,750	77,830	----
2019 LWSP	29,200	----	32,395	45,350	58,960	70,750	77,830	----
2020 LWSP [2]	33,000	----	33,000	51,530	70,290	89,050	108,000	126,000
2021 LWSP [2]	34,152	----	----	51,530	70,290	89,050	108,000	126,000
2022 LWSP [2]	39,468	----	----	51,530	70,290	89,050	108,000	126,000
2023 LWSP [2]	43,481	----	----	51,530	70,290	89,050	108,000	126,000

[1] *Diehl and Philips (1989).*

[2] *The Town of Fuquay-Varina's LWSP reflects IBT planning projections.*

Table 6 provides a summary of TAZ population projections from 2025 to 2045 and build-out in both the ETJ and served areas. The population projections within the ETJ include the served and unserved areas. The Town's near-term development data was compared to the 2025 TAZ projection data as a cross-check for reasonableness. The Town maintains proposed, approved, or under construction development data in GIS for single and multi-family lots. The Town's GIS development layer results in an additional 25,750 people that are estimated to be served by the Town in the next 5 to 7 years, which closely correlates to the anticipated 2025 TAZ population estimate. The build-out population is estimated to be approximately 135,000 people in the Neuse and Cape Fear River basins. The TAZ data does not provide an estimate of the timing of build-out population. The percent of population served in the Neuse and Cape Fear River basins at build-out is approximately 62 percent and 38 percent, respectively. The ratio of

anticipated growth in the Cape Fear and Neuse River basins is fairly consistent throughout the planning period. Exhibit 4 provides an illustration of the TAZ dwelling unit data in the service area at build-out.

Table 6: Summary of TAZ Population Projections and Estimate of Build-out Population

Year	Population Projections in ETJ (Served and Unserved Population)			Population Projections in Served Area				
	Neuse	Cape Fear	Total	Neuse	Cape Fear	Total	% Served in Neuse	% Served in Cape Fear
2013	26,031	11,514	37,545	12,994	8,320	21,314	61.0%	39.0%
2014	27,414	12,686	40,100	13,867	9,347	23,214	59.7%	40.3%
2015	28,330	13,737	42,067	14,617	10,394	25,011	58.4%	41.6%
2016	28,957	13,160	42,117	15,245	9,959	25,204	60.5%	39.5%
2017	29,781	13,362	43,143	14,897	10,702	25,599	58.2%	41.8%
2018	31,193	13,930	45,123	17,157	10,496	27,653	62.0%	38.0%
2025 [1]	46,604	24,367	70,971	34,515	21,405	55,200	61.2%	38.8%
2035	63,624	34,935	98,559	52,603	32,234	83,400	61.3%	38.7%
2045	80,627	45,540	126,167	69,959	42,926	111,624	61.3%	38.7%
Build-out population [2, 3]	83,686	51,080	134,766	83,686	51,080	134,800	62.1%	37.9%

[1] The difference between the 2018 and the 2025 population is approximately equal to the Town's near-term active development.

[2] The timing of build-out population per TAZ is unknown.

[3] The build-out population is the same for the ETJ and served area, as it is assumed that all of the population would be served at build-out in either scenario.

Several projection methods were used to evaluate the Town's population out to 2055. The population projections were developed using several statistical techniques on the historic data set. The population data suggests that the historic growth follows an exponential pattern. A low-growth, best-fit growth, and high-growth population projections were developed to illustrate the range of possible population growth scenarios over the 30-year planning period. The statistical best-fit growth curve resulted in a 2055 population scenario of 360,000 people, which is double the TAZ build-out population estimate. Population projections were then prepared using an annual growth rate to match the average number of accounts per year since 2015. This method resulted in a population estimate of 160,000 people in 2055. A linear best fit method resulted in a 2055 served population estimate of 98,400 people. The linear best fit method is commensurate with the Town's expectations for growth based on the Community Vision Land Use Plan. Additionally, a portion of this future served population estimate includes population in the service area on private wells. The Town anticipates that 20 to 25 private wells per year will be converted to Town services over the planning period.

The selected population estimate using the linear fit method is summarized in Table 7. Figure 2 provides an illustration of the statistically developed population curves in addition to the TAZ population estimates. The 2055 population estimate using the linear fit method is 38 percent less than the build-out population of approximately 135,000.

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Table 7: Summary of Population Projections in Town of Fuquay-Varina Service Area

Year	IBT Planning Population Projection [1]	IBT Planning Annual Percent Increase
2020	33,000	----
2025	42,150	4.7%
2030	51,530	3.8%
2035	60,910	3.2%
2040	70,290	2.7%
2045	79,670	2.4%
2050	89,050	2.2%
2055	98,430	1.9%

[1] *Population projection using linear best fit statistical method.*

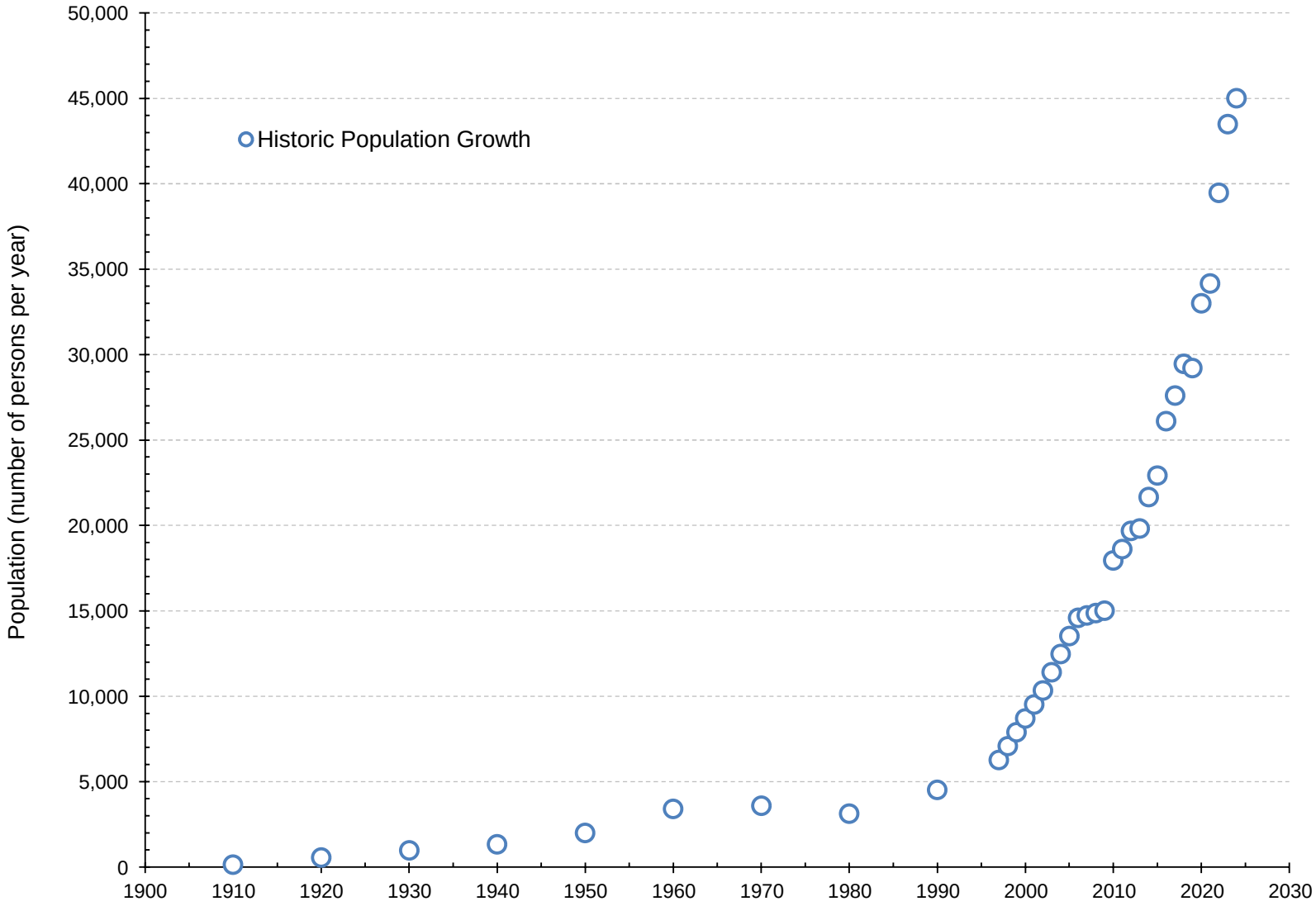

Figure 1: Historic Population for Town of Fuquay-Varina based on Local Water Supply Plans

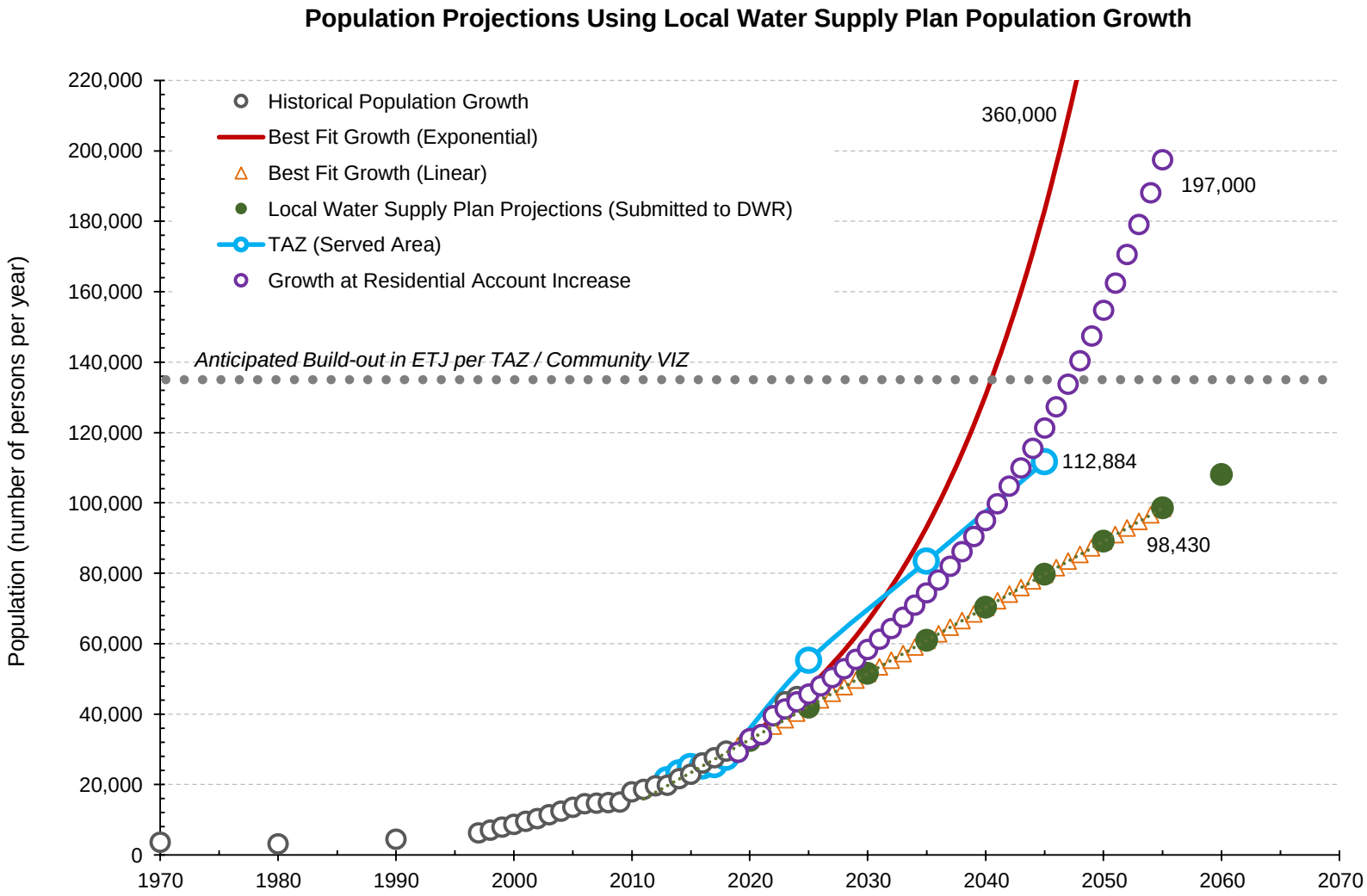

Figure 2: Town of Fuquay-Varina Population Projections

6. Water Demand Analysis

The Town's account data was evaluated to discern trends in water use across the Town's service area. Account data was obtained from the Town's LWSP data. The water use classes evaluated are those reported by the Town to DWR as part of the annual LWSP. The six classes (e.g., residential, commercial, industrial, institutional, system process, and unaccounted-for) may be conceptually divided into revenue water classes (e.g., residential, commercial, industrial, and institutional) and non-revenue classes (e.g., system process, and unaccounted-for).

Table 8 summarizes historic trends to include the number of accounts per use type, percent water use per account type (i.e., residential, commercial, industrial, institutional), percent of demand, and percent annual account increase. Residential accounts, as a percent of the total number of accounts, ranged from 89 to 95 percent. Residential use accounted for approximately two-thirds of the water use in the service area between 2019 and 2022. The service area has seen an average increase in the number of residential accounts at an average of 6.1 percent per year between 2013 and 2022. Commercial accounts have historically comprised approximately 8 percent of the total number of accounts and 16 percent of the total water demand. The growth in residential and commercial accounts illustrates the rapid rate of growth in the Town and is the primary driving force behind the Town's urgency to attain a new and reliable water supply.

6.1 Historic Per Capita Demand

Unit water demand estimates for the Town's service area were evaluated by water use class and then added together to provide an aggregate unit demand (i.e., water use across all water classes divided by population served or a per capita demand metric). Figure 3 graphically illustrates the revenue water classes over time on a per capita basis in gallons per capita per day. Table 9 summarizes the data in tabular format and includes the two non-revenue water classes.

The Town has experienced a general decline in overall per capita demand since 2002 consistent with regional and national trends. Over the latest 10-year period (2013 to 2022), the aggregate per capita usage in the Town's service area was 81.9 gpcd, which represents approximately a 20 to 25 percent reduction from the prior 10-year period between 2003 and 2012 when the aggregate per capita demand was approximately 105 gpcd. The Town is now more efficient (i.e., using less water on an aggregate per capita basis) than most regional peer utilities in the Cape Fear River basin (refer to Table 12).

Table 10 summarizes the total revenue water (billed to customers), the total water purchased, and non-revenue water per capita use metrics for each category. Table 10 also includes an estimate of the percentage of unaccounted-for-water (i.e., non-revenue water) as reported in the Town's LWSP. Unaccounted for water is the percentage of water not billed to customers and include water for firefighting, flushing, water leakage, or theft. The Town's percentage of unaccounted for water has declined from 15.7 percent in 2002 to 9.2 percent in 2022. The national average water loss is 16 percent (Wiant, 2017; EPA, 2013). The Town has not completed a formal water audit but has plans to commission an audit in fiscal year 2025/2026.

The decline in per capita demand in the Town's service area is consistent with declining per capita usage trends observed across other utilities in North Carolina and the U.S. In the mid-1990s, water demand trends began to exhibit patterns that were not typical of historic trends. This phenomenon is attributed primarily to the U.S. Energy Policy Act of 1992, which mandated maximum flow standards for many fixtures including toilets, faucets, and showerheads. Low-cost, high-efficiency plumbing fixtures and appliances became commercially available by 1994 when the Act came into effect and resulted in reduced residential, commercial, and institutional water consumption.

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Table 8: Summary of Historic Residential, Commercial, and Industrial Accounts

Year	Total Accounts	Residential				Commercial				Industrial				Institutional		
		Accounts	% of Accounts	% of Total Demand	% Annual Account Increase	Accounts	% of Accounts	% of Total Demand	% Annual Account Increase	Accounts	% of Accounts	% of Total Demand	% Annual Account Increase	Accounts	% of Accounts	% Annual Account Increase
2006	6,760	6,201	91.7%	52.5%	13.1%	501	7.4%	15.2%	7.7%	9	0.1%	2.0%	4.2%	49	0.7%	4.7%
2009	8,515	7,747	91.0%	87.3%	8.3%	702	8.2%	7.5%	13.4%	8	0.1%	3.2%	-3.7%	58	0.7%	6.1%
2010	8,524	7,800	91.5%	68.5%	0.7%	674	7.9%	13.2%	-4.0%	8	0.1%	1.0%	0.0%	42	0.5%	-27.6%
2011	8,646	7,840	90.7%	50.1%	0.5%	738	8.5%	8.4%	9.5%	12	0.1%	1.2%	50.0%	56	0.6%	33.3%
2012	9,130	8,341	91.4%	68.8%	6.4%	742	8.1%	16.9%	0.5%	7	0.1%	0.8%	-41.7%	40	0.4%	-28.6%
2013	9,922	8,861	89.3%	66.9%	6.2%	1,008	10.2%	15.5%	35.8%	9	0.1%	1.1%	28.6%	44	0.4%	10.0%
2014	10,794	9,907	91.8%	64.9%	11.8%	833	7.7%	16.0%	-17.4%	10	0.1%	3.4%	11.1%	44	0.4%	0.0%
2015	11,212	10,322	92.1%	69.0%	4.2%	836	7.5%	16.5%	0.4%	10	0.1%	1.2%	0.0%	44	0.4%	0.0%
2016	11,692	10,763	92.1%	66.1%	4.3%	875	7.5%	16.3%	4.7%	10	0.1%	1.4%	0.0%	44	0.4%	0.0%
2017	12,421	11,465	92.3%	67.8%	6.5%	904	7.3%	17.2%	3.3%	10	0.1%	1.2%	0.0%	42	0.3%	-4.5%
2018	12,933	11,979	92.6%	67.0%	4.5%	900	7.0%	17.1%	-0.4%	10	0.1%	1.1%	0.0%	44	0.3%	4.8%
2019	13,526	12,480	92.3%	65.7%	4.2%	985	7.3%	16.9%	9.4%	10	0.1%	3.9%	0.0%	51	0.4%	15.9%
2020	14,931	13,675	91.6%	68.1%	9.6%	1,195	8.0%	15.7%	21.3%	13	0.1%	1.0%	30.0%	48	0.3%	-5.9%
2021	15,697	14,419	91.9%	65.7%	5.4%	1,211	7.7%	14.6%	1.3%	17	0.1%	1.0%	30.8%	50	0.3%	4.2%
2022	15,909	15,060	94.7%	63.8%	4.4%	792	5.0%	14.7%	-34.6%	17	0.1%	9.4%	0.0%	40	0.3%	-20.0%
Average (2013 – 2022)			**92.1%**	**66.5%**	**6.1%**	**----**	**7.5%**	**16.1%**	**2.4%**	**----**	**0.1%**	**2.4%**	**10.1%**	**----**	**0.35%**	**0.45%**

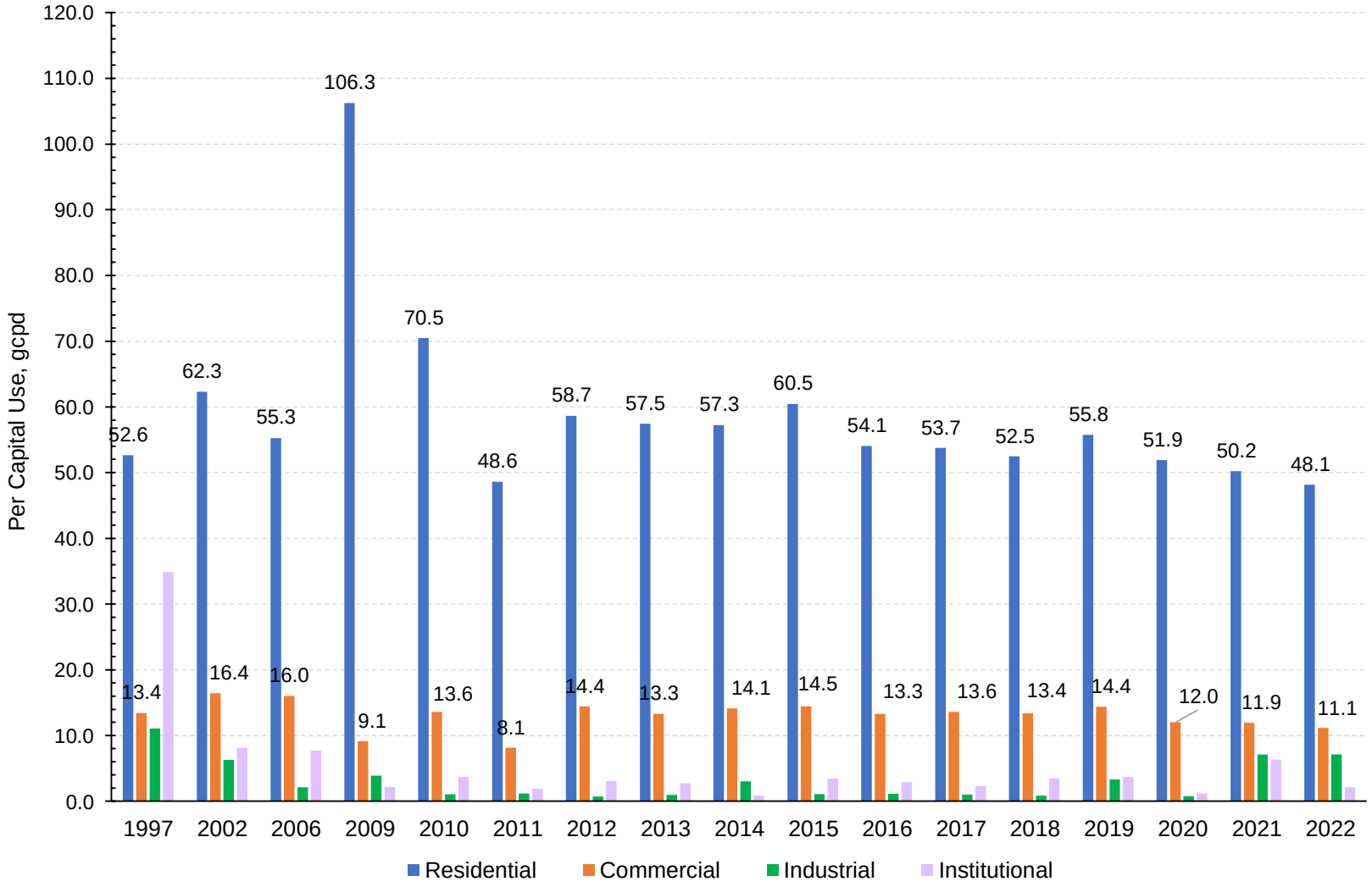

Figure 3: Historic Residential, Commercial, Industrial, and Institutional Per Capita Use

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Table 9: Summary of Water Use by Class and Year

Year	Population	Residential		Commercial		Industrial		Institutional		Process		Unaccounted for Water	
		Water Demand, mgd	Per Capita Demand, gpcd	Water Demand, mgd	Per Capita Demand, gpcd	Water Demand, mgd	Per Capita Demand, gpcd	Water Demand, mgd	Per Capita Demand, gpcd	Water Demand, mgd	Per Capita Demand, gpcd	Water Demand, mgd	Per Capita Demand, gpcd
2006	14,584	0.806	55.3	0.234	16.0	0.031	2.1	0.112	7.7	0.001	0.1	0.352	24.1
2009	15,000	1.594	106.3	0.137	9.1	0.058	3.9	0.032	2.1	0.001	0.1	0.004	0.3
2010	17,937	1.264	70.5	0.244	13.6	0.019	1.1	0.066	3.7	0.010	0.6	0.243	13.5
2011	18,600	0.904	48.6	0.151	8.1	0.022	1.2	0.035	1.9	0.500	26.9	0.192	10.3
2012	19,674	1.154	58.7	0.284	14.4	0.014	0.7	0.060	3.0	0.010	0.5	0.155	7.9
2013	19,804	1.138	57.5	0.264	13.3	0.019	1.0	0.054	2.7	0.000	0.0	0.227	11.5
2014	21,653	1.240	57.3	0.306	14.1	0.065	3.0	0.018	0.8	0.000	0.0	0.283	13.1
2015	22,920	1.386	60.5	0.332	14.5	0.025	1.1	0.079	3.4	0.010	0.4	0.176	7.7
2016	26,105	1.411	54.1	0.348	13.3	0.029	1.1	0.076	2.9	0.010	0.4	0.262	10.0
2017	27,600	1.483	53.7	0.376	13.6	0.027	1.0	0.063	2.3	0.100	3.6	0.137	5.0
2018	29,450	1.545	52.5	0.395	13.4	0.025	0.8	0.102	3.5	0.100	3.4	0.139	4.7
2019	29,200	1.629	55.8	0.420	14.4	0.097	3.3	0.107	3.7	0.100	3.4	0.125	4.3
2020	33,000	1.713	51.9	0.396	12.0	0.025	0.8	0.039	1.2	0.100	3.0	0.244	7.4
2021	34,152	1.714	50.2	0.407	11.9	0.243	7.1	0.216	6.3	0.010	0.3	0.201	5.9
2022	39,468	1.900	48.1	0.439	11.1	0.280	7.1	0.084	2.1	0.030	0.8	0.244	6.2
Average (2013 – 2022)			**54.1**		**13.2**		**2.6**		**2.9**		**1.5**		**7.6**

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Table 10: Summary of Total Water Billed and Purchased Water Per Capita Demand

Year	Total Revenue Water, mgd [1]	Per Capita Water Demand (Revenue), gpcd [1]	Total Water Purchased, mgd [1]	Per Capita Water Demand (Purchased), gpcd [1]	Non-Revenue Water (Process and Unaccounted-for Water), % [1]	Non-Revenue Water (Process and Unaccounted-for Water), gpcd [1]
2006	1.183	81.1	1.536	105.3	23.0%	24.2
2009	1.821	121.4	1.826	121.7	0.3%	0.3
2010	1.593	88.8	1.846	102.9	13.7%	14.1
2011	1.112	59.8	1.804	97.0	38.4%	37.2
2012	1.512	76.9	1.677	85.3	9.9%	8.4
2013	1.475	74.5	1.702	85.9	13.3%	11.5
2014	1.629	75.2	1.912	88.3	14.8%	13.1
2015	1.822	79.5	2.008	87.6	9.3%	8.1
2016	1.864	71.4	2.136	81.8	12.7%	10.4
2017	1.949	70.6	2.186	79.2	10.8%	8.6
2018	2.067	70.2	2.306	78.3	10.4%	8.1
2019	2.253	77.2	2.478	84.9	9.1%	7.7
2020	2.173	65.8	2.517	76.3	13.7%	10.4
2021	2.580	75.5	2.791	81.7	7.6%	6.2
2022	2.703	68.5	2.977	75.4	9.2%	6.9
Average (2013 – 2022)	**2.05**	**72.8**	**2.30**	**81.9**	**11.1%**	**9.1**

[1] *Per Town of Fuquay-Varina Local Water Supply Plans.*

6.2 Residential Per Capita Demand Analysis – Home Age

Water conservation efforts in the region play a large role in the development of future per capita water demand projections with the increased efficiency of indoor plumbing fixtures and appliances (AWWA, 2011). As more homes are renovated or as new construction is built to newer building codes, water use on a per capita basis should decline. Over time, the volume of more efficient plumbing fixtures and appliances will have an impact on average day use and overall per capita demand. Water use per meter may also be dependent on the year in which the home was built. Typically, homes from the 1970s may not have undergone extensive renovations and may exhibit a higher residential meter demand (USGS, 2017). Homes from the 1950s and 1960s have a higher probability of renovation and therefore may exhibit a lower residential meter demand. Newer homes would be expected to exhibit lower residential meter demands due to the newer plumbing codes and more water efficient appliances. Typically, the difference between current and future per meter water use represents the anticipated decline in overall residential water demand.

Table 11 summarizes the single-family residential annual, summer, and winter water demand per meter by age of home. The single-family residential meter demand over the period of record ranges from 106 to 156 gallon per day (gpd) per meter based on 2019 billing records. Annual average water use prior to 1999 ranged from 111 gpd/meter to 129 gpd/meter. Annual average water use post 2000 ranged between 149 and 156 gpd/meter. The total annual average water use is 145 gpd/meter. The accounts without record information were not factored into the analysis. The summer and winter residential water demand per meter did not yield substantial differences in water use prior to 1999. Post-2000, approximately 14 to 22 gpd/meter more water is used in the summer months and 12 to 18 gpd/meter less water is used in the winter months.

The age of homes analysis was inconclusive as to how much per capita demand could be saved from home renovations and appliance updates. The majority of the growth in the Town is post-2000 construction, and therefore subject to newer building codes for increased efficiency. The homes constructed prior to 1989 comprise less than 20 percent of the total number of accounts.

The Town’s single family account use was also compared to a survey of annual water use per single family residential account by the Water Research Foundation (2016c). The survey consisted of 26 utilities, of which 23 utilities provided full data sets for analysis. A random sampling approach was used to select the households for the survey. The WRF research included an analysis of billed consumption. The average single family residential metered use per day was 241.1 gpd/meter compared to the Town’s average of 145 gpd/meter. The maximum and minimum account use from the Water Research Foundation Study was reported as 479.5 and 120.5 gpd/meter, respectively. The Town’s residential metered use is not excessive compared to the random sampling of surveyed utilities.

Table 11: Single-Family Residential Meter Demand by Age of Home Construction

Account Records for Year of Home Construction	Number of Single Family Accounts [1, 2]	Single-Family Residential Meter Use (gpd/meter) – Annual [3]	Single-Family Residential Meter Use (gpd/meter) – Summer [4]	Single-Family Residential Meter Use (gpd/meter) – Winter [5]
No Record	133	124	208	83
< 1950	293	118	126	113
Homes constructed between 1950 – 1959	293	106	111	101
Homes constructed between 1960 – 1969	208	117	122	114
Homes constructed between 1970 – 1979	97	111	111	112
Homes constructed between 1980 – 1989	372	122	124	121
Homes constructed between 1990 – 1999	1,322	129	136	123
Homes constructed between 2000 – 2009	3,668	156	170	144
Homes constructed between 2010 – 2019	4,350	149	169	128
Total	10,598 (Total)	145 (Average)	----	----

[1] *Single-family residential meters per 2019 billing data. Data was edited to remove extreme high and low data, lots with no houses or under construction, and negative billing values.*

[2] *Excludes irrigation meters.*

[3] *Residential meter use is an average of the 2019 billing data.*

[4] *Summer months defined as April to September.*

[5] *Winter months defined as October to March.*

6.3 Comparison of Cape Fear and Neuse River Basin Per Capita Use

Table 12 provides a summary of total per capita use for utilities in the Cape Fear and Neuse River basins based on approved 2022 LWSPs. The Town of Fuquay-Varina's total per capita use is generally less than other communities in the Cape Fear and Neuse River basins with a difference ranging from 3.2 gpcd more than Holly Springs to 79 gpcd less than Burlington. Out of the utilities compared, only the Town of Holly Springs demonstrated a total per capita use comparable to the Town of Fuquay-Varina. The 2022 per capita use for Raleigh Water and Cary-Apex was 90.4 and 95.3 gpcd, respectively. Other utilities in the state range from 72 to over 150 gpcd. The average domestic per capita use from a nationwide Water Research Foundation survey was 96 gpcd (2016c). Per a USGS study in 2017, domestic water use by state per a USGS analysis ranged from 35 to 184 gpcd, with the national average at 82 gpcd (USGS, 2017). The Town's per capita use is comparable to national per capital use trends and less than, or comparable to, regional per capita use trends.

Table 12: Summary of Total Per Capita Use Data for North Carolina Utilities in the Cape Fear and Neuse River Basins

Utility	River Basin [1]	Data of Approved Local Water Supply Plan	Residential Per Capital Use, gpcd [2, 3]	Total Per Capita Use, gpcd [2, 4]
Raleigh Water	Neuse	2022 LWSP	51.3	90.4
Cary-Apex	Neuse and Cape Fear	2022 LWSP	49.1	95.3
Holly Springs	Neuse and Cape Fear	2022 LWSP	45.5	72.2
Harnett County	Cape Fear	2022 LWSP	49.1	96.1
Johnston County	Neuse	2022 LWSP	53.5	90.0
City of Durham	Cape Fear	2022 LWSP	42.5	93.9
City of Sanford	Cape Fear	2022 LWSP	41.6	135.7
Fayetteville PWC	Cape Fear	2021 LSWP	53.2	125.1
City of Greensboro	Cape Fear	2022 LWSP	52.3	108.5
City of Burlington	Cape Fear	2022 LWSP	50.2	154.1
City of High Point	Cape Fear	2022 LWSP	48.9	114.6
Town of Fuquay-Varina	Neuse and Cape Fear	2022 LWSP	48.1	75.4
Cape Fear Utility Authority	Cape Fear	2022 LWSP	58.7	101.8

[1] Hydrologic river basin boundaries as defined in 1991 by Session Law 712 (General Statute § 143-215 22G).

[2] Data extracted from approved 2022 Local Water Supply Plans.

[3] The residential per capita use is the residential service area demand divided by the year-round service area population.

[4] The total per capita use is the total service area demand (i.e., all revenue and non-revenue water use classes) divided by the year-round service area population.

6.4 Future Per Capita Demand

Projecting future water use for the Town involves multiplying the expected population by an expected rate of water use. The Town's historic 10-year average unit demand across all water classes divided by population served (i.e., aggregate per capita demand) from 2013 through 2022 was 81.9 gpcd. The per capita use rate of approximately 82 gpcd is a starting point for determining an appropriate water utilization planning target for meeting the Town's expected growth. To assure a reliable supply over the next 30 years, the rate of use assumption for the Town was rounded up to 85 gpcd. The planning unit demand must account for the wider range of conditions that may occur over the 30-year IBT certificate period. These extenuating conditions may include periods of hot dry weather or more typical non-revenue water ratios as the Town's distribution system ages. Appendix A contains additional analyses of these factors.

6.5 Maximum Month and Maximum Day Peaking Factors

Maximum month and maximum day peaking factors were selected based on the Town's 2019 to 2022 water meter data. A maximum day peaking factor of 1.5 was selected based on the 2022 water meter data. A maximum month peaking factor of 1.18 was selected based on the 2019 to 2022 data. Table 13 provides a summary of the maximum month and day peaking factors for the Town.

Table 13: Summary of Maximum Month and Maximum Day Peaking Factors for Fuquay-Varina

Month	Fuquay-Varina, Maximum Month Peaking Factor				Fuquay-Varina, Maximum Day Peaking Factor			
	2019	2020	2021	2022	2019	2020	2021	2022
January	1.09	1.21	1.13	1.10	1.58	1.69	1.90	1.85
February	1.05	1.08	1.18	1.02	1.62	1.72	1.88	1.78
March	1.62	1.11	1.15	1.19	1.65	1.63	1.89	1.78
April	1.48	----	1.19	1.15	1.66	----	1.57	1.59
May	1.46	1.43	1.29	1.26	1.32	1.49	1.38	1.50
June	1.24	1.22	1.21	1.19	1.29	1.31	1.43	1.19
July	1.24	1.22	1.14	1.25	1.38	1.47	1.42	1.27
August	1.15	1.19	1.16	1.19	1.58	1.60	1.37	1.29
September	1.23	1.14	1.39	1.14	1.66	1.65	1.39	1.33
October	1.69	1.24	1.18	1.06	2.31	1.68	1.54	1.51
November	1.45	1.12	1.07	1.13	2.63	1.81	1.68	1.67
December	1.08	1.08	1.07	1.18	2.11	1.89	1.76	1.66
Average	1.31	1.18	1.18	1.16	1.73	1.63	1.60	1.54

6.6 Water Demand Projections

Table 14 provides a summary of the annual average, average day in a maximum month, and maximum day water demand. The annual average water demand projections assume 85 gpcd applied to the linear best fit population estimate over the planning period. Approximately 9.9 mgd of water will be needed by the Town in 2055 on a maximum month basis. Maximum month water demands were calculated to assess the average day water demand in a maximum month to meet the requirements of General Statute § 143 215.22L. Per General Statute § 143 215.22L, an interbasin transfer certificate is required if a daily average water demand of 2 mgd in a calendar month (i.e., maximum month) or 3 mgd in one day (i.e., maximum day) is exceeded.

Table 15 provides a summary of the average day in a maximum month water demand by river basin, water supply contract amounts with the associated expiration years, and the projected water supply shortfall. The water supply shortfall was calculated as the difference between the Town's current total contract amounts less the total average day water demand in a maximum month. Without provisions for additional water supply capacity, the Town is projected to have a water supply shortfall beginning in 2031. Additional water supply is needed to satisfy the projected water demand in the Town's service area.

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Table 14: Summary of Annual Average, Maximum Month, and Maximum Day Water Demand Projections

Year	Population [1]	Annual Average Water Demand, mgd [2]	Average Water Demand Day in a Maximum Month, mgd [3]	Maximum Day Water Demand, mgd [4]
2025	42,150	3.6	4.2	5.4
2030	51,530	4.4	5.2	6.6
2035	60,910	5.2	6.1	7.8
2040	70,290	6.0	7.1	9.0
2045	79,670	6.8	8.0	10.2
2050	89,050	7.6	8.9	11.4
2055	98,430	8.4	9.9	12.6

[1] Population projections from linear best fit regression method used for the 2022 Local Water Supply Plan.

[2] Assumes a per capita use of 85 gpcd over the planning period.

[3] Maximum month peaking factor of 1.18. Maximum month water demands were calculated to assess the average day water demand in maximum month to meet the intent of General Statute § 143 215.22L.

[4] Maximum day peaking factor of 1.5.

Table 15: Summary of Average Day in the Maximum Month Water Demand, Wholesale Water Supply Contracts, and Projected Water Supply Deficit

Year	Average Day Water Demand in a Maximum Month			Current Water Supply Contract Amounts via Interlocal Agreements			Projected Water Supply Shortfall Indicated by Value in ( ), mgd [D + E + F - A]
	Total, mgd [A]	Neuse Basin, mgd [B]	Cape Fear Basin, mgd [C]	Raleigh Water (Neuse), mgd [D]	Johnston County (Neuse), mgd [E]	Harnett County (Cape Fear), mgd [F]	
2025	4.2	2.61	1.62	1.75	1.5	2	1.0 [2]
2030	5.2	3.19	1.98	1.75	1.5	2	0.08 [2]
2035	6.1	3.79	2.32	1.75	1.5	2	(0.86)
2036	6.3	3.90	2.39	0	1.5	2	(2.8)
2040	7.1	4.37	2.68	0	1.5	2	(3.6)
2041	7.2	4.49	2.75	0	1.5	2	(3.7)
2045	8.0	4.95	3.04	0	1.5	2	(4.5)
2049	8.7	5.42	3.32	0	1.5	2	(5.2)
2050	8.9	5.54	3.40	0	0	2	(6.9)
2055	9.9	6.15	3.73	0	0	2	(7.9)

[1] The projected water supply shortfall is the Town's total contract amount less the average day water demand in a maximum month.

[2] Amount does not include additional 2 mgd from Harnett County via the ILA signed in 2022.

7. Interbasin Transfer Projections

The interbasin transfer projections reflect the water demand in the Neuse less water supply from the Neuse River basin. Tables 16 and 17 provide a summary of average day in a maximum month and maximum day water demand projections, respectively. The basin distribution, water demand per basin, and anticipated water supply amounts are also included in Tables 16 and 17. The basin distribution percentages are supported by the TAZ population analysis, so a corresponding water demand per basin can be calculated. The water supply is delineated by river basin for both maximum month and maximum day. Per the Town of Fuquay-Varina's discussions with Raleigh Water and Johnston County staff, the Town anticipates water supply purchases from Raleigh Water and Johnston County will end in 2035 and 2049, respectively. Post 2049, all of the Town's water supply will originate from the Cape Fear River basin (2-03). The average day transfer in a maximum month in 2055 is anticipated to be 6.17 mgd. The maximum day transfer amount is anticipated to be 7.83 mgd. By 2055, approximately 13 mgd of water supply will be required to support peak day needs in the Town of Fuquay-Varina's service area.

7.1 Consumptive Water Loss

Consumptive water loss is defined as the amount of water withdrawn from a surface water without recycling of the water (i.e., a return) to the source or origin (Congressional Research Service, 2005). A few examples of consumptive loss activities include agricultural use, household use, lawn watering, household wastewater to a septic system, firefighting, and transmission main flushing. The water that is not returned to a centralized wastewater treatment plant, or "consumed," is the difference between the monthly average wastewater flow and the monthly average water use. Consumptive loss is typically applied as a percentage over the service area.

Table 18 provides a summary of the monthly consumptive loss percentages in the Town's service area from 2002 to 2023. The median consumptive loss over the period of record is approximately 17.5 percent (i.e., 17.5 percent of water supplied to the service area is not returned to a centralized wastewater treatment plant). There are 512 non-vacant parcels that are located in the Cape Fear hydrologic boundary. Water is supplied from the Cape Fear River and returned to the Cape Fear River via the North Harnett Regional WWTP. However, these 512 non-vacant parcels are legislatively located in the Neuse River basin per General Statute § 143-215.22L. Therefore, the only transfer for these parcels is the consumptive loss from these homes. The Town's medium consumptive loss percentage was applied to these non-vacant parcels and added into the interbasin transfer calculation.

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Table 16: Summary of Average Day in a Maximum Month Water Demand, Water Supply Contract Amounts, and Interbasin Transfer

Year	Total Projected Demand, Average Day in a Maximum Month, mgd	Basin Distribution [1]		Water Demand in Basin, mgd [2]		Water Supply Source By Seller, mgd				Total Water Supply in Basin, mgd		Interbasin Transfer, Cape Fear to Neuse, mgd [4, 5]
		Neuse	Cape Fear	Neuse	Cape Fear	Raleigh (Neuse) [3]	Johnston County (Neuse) [3]	Harnett County (Cape Fear) [3]	Sanford (Cape Fear)	Neuse	Cape Fear	
2023	3.5	62.0%	38.0%	2.18	1.33	1.75	1.5	2	0	3.25	2	0.00
2025	4.2	61.7%	38.3%	2.61	1.62	1.75	1.5	2	6	3.25	8	0.00
2030	5.2	61.7%	38.3%	3.19	1.98	1.75	1.5	2	6	3.25	8	0.00
2035	6.1	62.0%	38.0%	3.79	2.32	1.75	1.5	2	6	3.25	8	0.56
2036	6.3	62.0%	38.0%	3.90	2.39	0	1.5	2	6	1.5	8	2.42
2040	7.1	62.0%	38.0%	4.37	2.68	0	1.5	2	6	1.5	8	2.89
2041	7.2	62.0%	38.0%	4.49	2.75	0	1.5	2	6	1.5	8	3.01
2045	8.0	62.0%	38.0%	4.95	3.04	0	1.5	2	8	1.5	10	3.47
2049	8.7	62.0%	38.0%	5.42	3.32	0	1.5	2	8	1.5	10	3.94
2050	8.9	62.0%	38.0%	5.54	3.40	0	0	2	10	0	12	5.55
2055	9.9	62.3%	37.7%	6.15	3.73	0	0	2	11	0	13	6.17

[1] Basin distribution based on TAZ build-out population analysis.

[2] Water demand in Town's service area.

[3] Water supply source currently in contract via temporary lease agreement (Interlocal Agreement).

[4] Water demand in Neuse less water supply from Neuse basin.

[5] A consumptive loss factor was applied to non-vacant parcels located in the Cape Fear River basin per hydrologic boundary line but are included in the Neuse River basin per the regulatory interbasin boundary line.

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Table 17: Summary of Maximum Day Water Demand, Water Supply Contract Amounts, and Interbasin Transfer

Year	Total Projected Maximum Day Demand, mgd	Basin Distribution [1]		Water Demand in Basin, mgd [2]		Water Supply Source By Seller, mgd				Total Water Supply in Basin, mgd		Interbasin Transfer, Cape Fear to Neuse, mgd [4, 5]
		Neuse	Cape Fear	Neuse	Cape Fear	Raleigh (Neuse) [3]	Johnston County (Neuse) [3]	Harnett County (Cape Fear) [3]	Sanford (Cape Fear)	Neuse	Cape Fear	
2023	4.5	62.0%	38.0%	2.77	1.69	1.75	1.5	2	0	3.25	2	0.0
2025	5.4	61.7%	38.3%	3.32	2.06	1.75	1.5	2	6	3.25	8	0.08
2030	6.6	61.7%	38.3%	4.06	2.51	1.75	1.5	2	6	3.25	8	0.82
2035	7.8	62.0%	38.0%	4.82	2.95	1.75	1.5	2	6	3.25	8	1.58
2036	8.0	62.0%	38.0%	4.96	3.04	0	1.5	2	6	1.5	8	3.48
2040	9.0	62.0%	38.0%	5.56	3.41	0	1.5	2	6	1.5	8	4.07
2041	9.2	62.0%	38.0%	5.71	3.50	0	1.5	2	6	1.5	8	4.22
2045	10.2	62.0%	38.0%	6.30	3.86	0	1.5	2	8	1.5	10	4.81
2049	11.1	62.0%	38.0%	6.89	4.23	0	1.5	2	8	1.5	10	5.41
2050	11.4	62.0%	38.0%	7.04	4.32	0	0	2	10	0	12	7.05
2055	12.5	62.3%	37.7%	7.81	4.74	0	0	2	11	0	13	7.83

[1] *Basin distribution based on TAZ build-out population analysis.*

[2] *Water demand in Town's service area.*

[3] *Water supply source currently in contract via temporary lease agreement (Interlocal Agreement).*

[4] *Water demand in Neuse less water supply from Neuse basin.*

[5] *A consumptive loss factor was applied to non-vacant parcels located in the Cape Fear River basin per hydrologic boundary line but are included in the Neuse River basin per the regulatory interbasin boundary line.*

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Table 18: Summary of Consumptive Water Loss Data

Month [1, 2, 3]	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009
Jan	----	----	----	----	3.4%	----	----	----	----	----	----	13.1%	----	----
Feb	----	----	----	----	8.0%	----	----	----	----	----	----	20.4%	----	17.5%
Mar	----	----	----	----	----	----	1.4%	--	--	1.9%	----	----	----	----
Apr	4.5%	10.6%	12.0%	----	----	3.6%	----	----	----	----	5.6%	13.4%	24.5%	19.6%
May	----	22.6%	10.1%	29.3%	13.6%	10.1%	1.2%	0.8%	7.6%	12.3%	17.7%	8.8%	4.8%	68.2%
Jun	23.2%	37.4%	14.3%	22.9%	16.4%	18.5%	29.4%	32.6%	35.9%	----	29.8%	19.4%	29.7%	45.6%
Jul	23.8%	11.5%	17.3%	27.1%	----	25.7%	28.1%	24.2%	35.0%	----	36.1%	44.0%	42.5%	28.2%
Aug	29.6%	20.8%	----	25.6%	----	21.0%	33.9%	35.1%	16.0%	15.2%	26.0%	32.2%	31.4%	36.7%
Sep	31.7%	----	----	33.5%	----	13.8%	20.5%	31.9%	3.7%	8.2%	24.0%	21.8%	5.1%	28.1%
Oct	10.6%	18.4%	2.6%	21.2%	----	13.4%	7.3%	4.6%	15.0%	17.5%	14.7%	30.5%	21.2%	31.7%
Nov	0.2%	9.5%	----	7.6%	----	2.5%	----	----	13.0%	16.1%	17.0%	8.2%	6.1%	4.6%
Dec	----	----	----	----	----	----	8.9%	----	----	----	12.8%	----	32.0%	0.2%
Median, 2002 – 2023					17.5%									

[1] Consumptive water loss is the percent of wastewater discharged to the amount of water supplied.

[2] Consumptive loss is calculated based on monthly average water use and discharged wastewater values.

[3] Values less than 0% were removed from the calculation, as these values are indicative of wet weather (i.e., more water discharged than supplied).

8. Summary

The Town intends to invest in water supply treatment capacity in partnership with the City of Sanford (e.g., TriRiver Water). The City of Sanford is planning an expansion of their water treatment facility to meet the City of Sanford's service area and partner's needs. The Town of Fuquay-Varina has recognized a need to secure a permanent water supply source in lieu of a continuation of ten to fifteen year temporary interlocal lease agreements with wholesale suppliers. The City of Sanford is looking for partners to invest in the facility at a time when such a partnership is advantageous to the Town of Fuquay-Varina. A purchase of water treatment plant capacity from a neighboring community will ensure that the Town of Fuquay-Varina will have a reliable and secure source of water well into the future.

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Appendix A – Consideration of Future Unit Demands

Despite steady growth in total water use, the Town's water use intensity (per capita usage), like many communities across the region, has declined over the past two decades (Dieter, 2018). This is illustrated in Figure 3 and Table 10 in Section 6. These trends have been driven by several factors including regulation, evolving environmental awareness, and increased water prices. The Federal Energy Policy Act of 1992 played a large role in spurring the overall decline as it required U.S. markets to offer water efficient toilets, showerheads, and faucets and more recently extended to high-efficiency clothes washers and dishwashers. During the same period there has been widespread adoption of water-conserving habits (e.g. shorter showers and less frequent lawn watering) driven by public education campaigns, drought messaging, and a general rise in environmentally-minded values. Finally, water utilities have in many cases moved toward full-cost pricing, which has led to an increase in water rates that also encourage more efficient water usage. Nevertheless, these factors have likely achieved most of their potential for improving water efficiency and conservation. The evidence suggests the rate of decline in per capita water demands has been less in recent years and per capita water use is flattening.

The Town of Fuquay-Varina must provide a reliable and resilient water supply to its customers under all conditions. These conditions may include hotter, drier weather than observed over the 2013 to 2022 period and/or a modest increase in non-revenue water. Analyses of weather variability and non-revenue water are provided as supporting evidence for the selection of 85 gpcd as the rate of use for planning over the 30-year IBT certificate period.

Weather Variability

One limitation to using the 2013 to 2022 period for planning unit demand is that during this period the Town did not experience any particularly extreme combination of heat and dryness. Hot temperatures and dry weather tend to drive an increase in water demand. If the region's potential for these weather extremes are ignored, the Town risks underestimating the water need. Despite generally increasing temperatures relative to historical norms, there were not any extended periods of drought in the 10-year period from 2013 to 2022 comparable to those experienced during the late 1990s and early 2000s.

The Town's annual unit demand was correlated with temperature and precipitation to estimate unit demands if such conditions were to recur. The revenue water classes were evaluated in aggregate. Non-revenue water use classes (e.g., process water and unaccounted-for-water) were excluded from this particular analysis as these water use categories are less likely to be highly correlated with hot, dry weather. The revenue water categories are residential, commercial, industrial, and institutional as described in Section 6.1.

To estimate demand response with respect to annual weather variability, weather data for the region was collected over a 30-year period from 1994 to 2023. A 30-year period is long enough to smooth out short-term fluctuations and anomalies providing a stable and reliable average. This record length is recommended by the World Meteorological Organization (WMO) and the National Oceanic and Atmospheric Administration (NOAA). Both temperature and precipitation patterns influence water use and have long been known to have a significant influence on variability in outdoor water use (Chang, 2014). Data for the growing seasons from April through November of each year were obtained from nearby

National Weather Service Cooperative Observer Program (COOP) stations and Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS) stations. The correlation between growing season temperature, rainfall and water use were then analyzed using regression analysis to discern how temperature and rainfall affect the Town's water use.

The regression models were developed using 2010 to 2023 revenue category unit demands to assess the range of influence weather has on the Town's water demand. The year 2010 was the last year with a more extreme combination of hot and dry weather in the record. Therefore, the regression model was "trained" using data back to 2010. However, unit usage has declined since 2010 independently of weather effects. To address this shift, the unit demands between 2010 and 2023 were "detrended" (i.e., a regression trend line through the detrended unit demands has a slope of zero) to remove the effects of other factors on water use. The detrended unit demands were pivoted (detrended) to have an average equivalent to the 2019 to 2023 period (i.e., the last 5 years in the record). The unadjusted and detrended unit demands for the revenue water categories are illustrated in Figure A-1. Both unadjusted and detrended unit demands have an average of 71.9 gpcd for the 2019 to 2023 period. The unit demand for 2011 was excluded from the analysis because the demand breakdown appears anomalous. The reported residential demand in 2011 was abnormally low whereas the non-revenue consumption was especially high (38 percent of total demand). The 2011 data suggests that there was an error in metering or tabulating total water use that year. Refer to Tables 9 and 10 to review the 2011 data anomaly.

Temperature alone proved to be weakly correlated with the Town's unit demand with an R-squared (R^2) value of 0.06. R^2 measures the proportion of the variance in the dependent variable (unit demand) that is explained by the model. This means that seasonal fluctuations in temperature only explain 6 percent of the year-to-year variation in demand over the 2010 to 2023 period (excluding 2011).

Aggregate precipitation over a full growing season was moderately correlated with the Town's annual unit demand, having an R^2 value of 0.24. However, aggregate precipitation over a growing season is not an ideal predictor of unit demand because the total seasonal precipitation may obscure the impact that dry periods during the growing season have on water demand. In other words, the temporal distribution of rainfall throughout the growing season is important, and in some cases more so, than the total amount of precipitation. To address this shortcoming, a water stress model was developed to capture the influence that dry periods have on water use.

Water Stress Model

The water stress model scored each day within a growing season (April through November) based on an algorithm using the precipitation records for that day and the prior 9 days (i.e., 10-days in total). Days with the greatest water stress received a score of 2. Days with moderate stress scored 1 and days with low or no water stress scored zero points.

The algorithm specifically works as follows:

1. Each day in the record receives a score of 0, 1, or 2 with higher numbers indicating greater stress.
2. The score for any day involves an analysis of precipitation on that day and over the prior 9 days.

3. To receive a score of 1 or 2, the sum of precipitation in first five days, or second five days must be less than 0.15-inches, which would cause some degree of water stress.
4. If the entire 10-day period meets the criteria in #3 and has a total 10-day precipitation less than 0.2-inches, it received a score of 2.
5. If the entire 10-day period meets the criteria in #3 and has a total 10-day precipitation less than 0.5-inches, it received a score of 1.
6. All other days received a score of 0.

Each growing season received a water stress score that was the sum of each day's score (0, 1, or 2). The water stress scores for each April through November season varied from 50 (2003 and 2020) to 214 (2007), with a mean of 112 and a standard deviation of 40.1. The annual water stress scores are summarized in Table A-1.

A regression analysis was then developed using the total water stress during the growing season and the Town's annual unit demand. Data for the years 2010 to 2023 were used to develop the regression model. For the regression analysis, the z-score of the season's water stress score was used rather than the water stress total itself. A z-score is a way to describe how unusual or typical a particular value is compared to the rest of the data. Specifically, the z-score indicates how many standard deviations the value is above or below the average (e.g., mean). For example, a z-score of +2 means the value is two standard deviations higher than average, while a z-score of -1 means it is one standard deviation lower than the average. The z-score helps identify whether a certain year's water use is likely to be higher or lower compared to long-term trends.

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Table A-1: Unit Demand and Weather Parameters

Year	Actual Unit Demand [1]	Detrended Unit Demand	April to November Average Daily High Temperature, °F	April to November Total Precipitation, inches	Annual Water Stress Score	Water Stress z-score
1994	----	----	78.95	30.7	124	0.307
1995	----	----	78.57	47.6	101	-0.267
1996	----	----	77.45	44.0	69	-1.065
1997	----	----	77.41	29.8	138	0.656
1998	----	----	80.61	24.5	155	1.080
1999	----	----	79.49	36.7	154	1.055
2000	----	----	78.76	32.4	125	0.332
2001	----	----	80.00	30.6	150	0.956
2002	----	----	80.20	29.7	176	1.604
2003	----	----	78.33	41.2	50	-1.540
2004	----	----	78.71	36.2	96	-0.392
2005	----	----	79.60	28.2	130	0.457
2006	----	----	78.57	42.6	63	-1.215
2007	----	----	80.99	26.3	214	2.553
2008	----	----	78.22	32.7	77	-0.866
2009	----	----	78.22	29.1	89	-0.566
2010	88.8	82.9	81.52	33.3	179	1.679
2011	59.8 [2]	56.1	80.38	25.8	78	-0.841
2012	76.9	72.6	78.26	26.2	109	-0.067
2013	74.5	70.8	76.87	41.3	90	-0.541
2014	75.2	71.9	77.88	39.0	92	-0.492
2015	79.5	76.5	79.18	35.9	105	-0.167
2016	71.4	69.1	79.75	31.4	127	0.382
2017	70.6	68.8	79.74	33.9	98	-0.342
2018	70.2	68.8	79.03	45.5	62	-1.240
2019	77.2	76.2	80.39	33.6	109	-0.067
2020	65.8	65.4	78.76	55.3	50	-1.540
2021	75.5	75.5	79.32	28.7	139	0.681
2022	68.5	68.9	79.98	33.4	77	-0.866
2023	72.2	73.2	78.76	37.8	125	0.332

[1] Unit demand for revenue categories only (residential, commercial, industrial, and institutional) and excludes process water and unaccounted-for-water.

[2] Revenue water is anomalously low whereas process water (e.g., a non-revenue category) was reported as 0.5 mgd, which is 5 to 50 times higher than other reporting years.

Table A-1 summarizes the key inputs for the analysis with the detrended unit demand and the z-score for water stress being the dependent and independent variables in the regression, respectively. The z-score is a statistical measure that indicates how many standard deviations a particular value in the dataset is from the mean. The z-score formula is:

Equation (1): $z = (x - \mu)/\sigma$, where μ is the mean for the dataset and σ is the standard deviation

This model demonstrated an improved correlation with the Town's unit demand, having an R^2 value of 0.68. The quality of the model fit with the unit demand data is shown visually in Figure A-2. The coefficient for the water stress z-score was 4.49 gpcd per standard deviation and the intercept was 73.1 gpcd. The interpretation is that for each standard deviation increase in the dry score added up over the growing season, the Town's unit demand for revenue water classes would be expected to rise by 4.49 gpcd. The opposite is true for a reduction in water stress from the average. The model's formula for estimating the Town's unit demand in any year is given by Equation 2:

Equation (2): Revenue water unit demand (in gpcd) = 4.493 x [Water stress z-score] + 73.14

To evaluate the regression model further, and the utility of the water stress model, the coefficient's p-value is reported. A p-value helps determine whether a relationship seen in the data is likely to be real or just due to random chance. In the context of a linear regression, a low p-value (e.g., typically less than 0.05) means there's strong evidence that the variable being tested is actually related to the outcome and not just a coincidence. A high p-value suggests the relationship might not be meaningful. The p-value helps us decide which patterns in the data are likely to be statistically significant. The p-value for the water stress parameter for this model was 0.00048, indicating that this metric is statistically correlated with the Town's water use.

To test if the z-score coefficient was driven principally by the data early in the training period, a similar model was developed using only the 2018 to 2023 data. The retrained model excluded the 2010 data point (e.g., the extreme hot and dry year) but incurred fewer complications with changing water behavior (e.g., improving efficiency) over the longer 2010 to 2023 period. Despite excluding the 2010 data point, this model resulted in a very similar coefficient of 4.34 gpcd and intercept of 73.3 gpcd. The R^2 value of the water stress coefficient increased to 0.83 and the p-value of the coefficient remains a highly respectable 0.011. The increase in the R^2 is not surprising since there are fewer confounding factors over the shorter period.

Using Equation 2, the z-scores for water stress were put into the model for the entire 30-year period from 1994 to 2023, which forms the "climate normal." The result is illustrated in Figure A-3. This model suggests that over a similar 30-year weather period and with water use behavior that matches observations from 2019 through 2023, the Town could expect revenue water unit demands to range from a low of 66.2 gpcd to a high of 84.6 gpcd. The 84.6 gpcd for the revenue category is predicted during a repeat of 2007, which was a historically hot and dry year. When the 2019 to 2023 average annual non-revenue water categories of process water and unaccounted-for-water (i.e., 6.7 gpcd per Table 10) are added to the revenue water range suggested by the model, the model suggests Town may expect aggregate annual unit demands to vary from 72.9 gpcd to as much as 91.3 gpcd. This range serves as a guide for the purpose of planning to meet future needs.

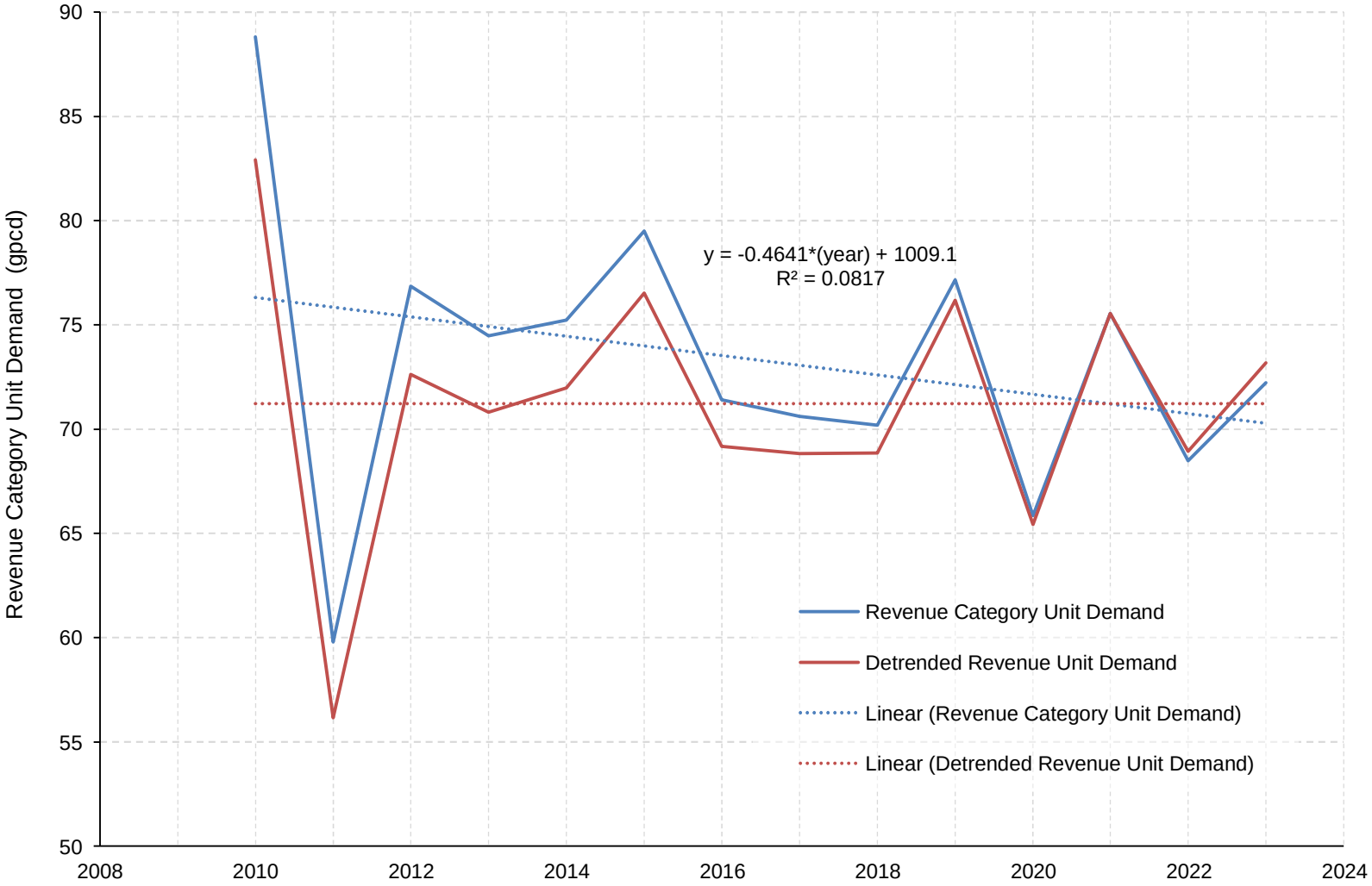


Figure A-1: Detrended Unit Water Demands

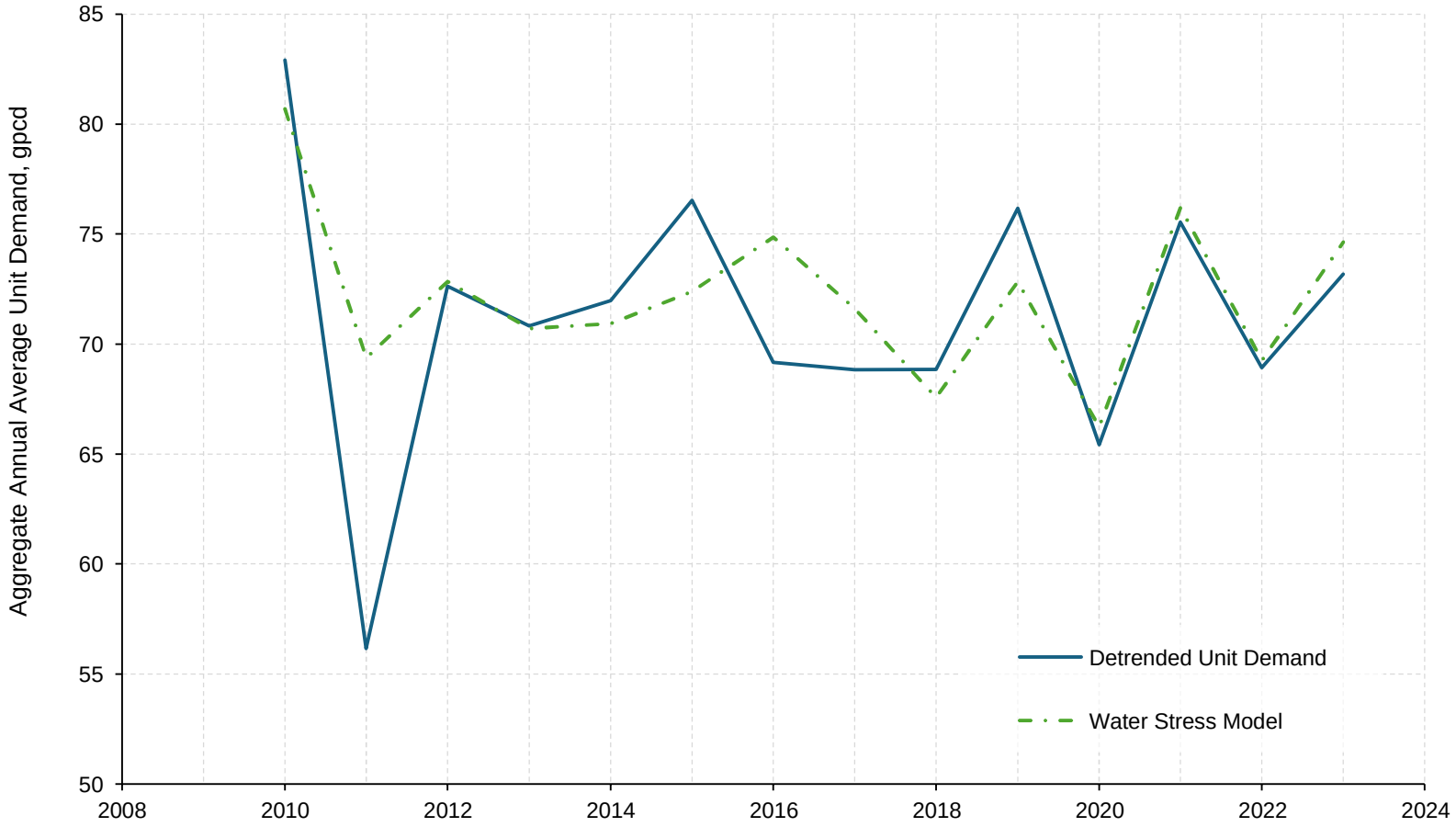


Figure A-2: Water Stress Model Prediction versus Detrended Revenue Category Unit Demand

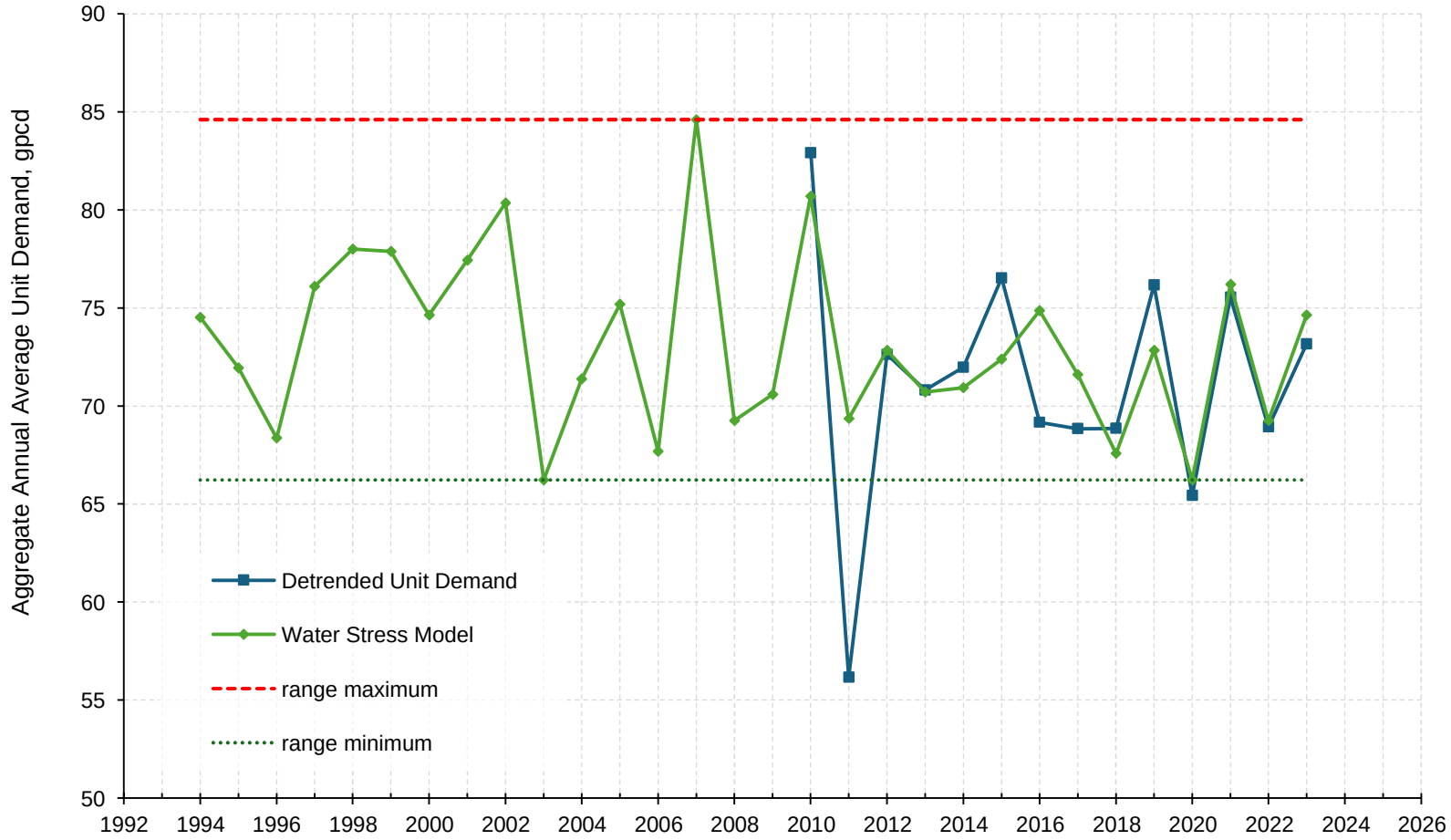


Figure A-3: Water Stress Model Predictions Extended Back to 1994

Precipitation Data

Daily precipitation records were sourced from the weather record repository at https://xmacis.rcc-acis.org/. No single nearby station contained a complete sequence from 1994 through 2023 without missing records. A complete record was synthesized from the data available from multiple stations. The following five station records were used:

1. Holly Springs 3.6 SSE
2. Holly Springs 2.0 ESE
3. Garner [Coop 313238; GARN7 NWS]
4. Sanford 8NE
5. Apex [Coop 310212; APXN7 NWS]

When multiple records were available, the precipitation estimate was based on the distance from the Town of Fuquay-Varina which is arranged in the aforementioned order. If neither Holly Springs stations had records and both the Garner and Sanford stations did have records, the average of the reported precipitation for the two stations was used.

Z-score

The z-score of the season's water stress score was used in the regression analysis rather than the water stress total. A z-score is a way to describe how unusual or typical a particular value is compared to the rest of the data. Specifically, the z-score represents how many standard deviations the value is above or below the average (mean). For example, a z-score of +2 means the value is two standard deviations higher than average, while a z-score of –1 means one standard deviation lower than average. The z-score helps identify whether a certain year's water use is likely to be higher or lower compared to long-term trends. The z-score formula is:

Equation (1): $z = (x - \mu)/\sigma$

where μ is the mean for the dataset

and σ is the standard deviation

The reason for use of the z-score in the regression analysis is that it makes the resulting formula more intuitive. Using Equation 2 as an example, the predictive formula for the Town's unit demand resulting from the regression analysis on the detrended 2010 to 2023 unit demands is:

Equation (2): Revenue water unit demand (in gpcd) = 4.493 x [Water stress z-score] + 73.14

So, in an average weather year where the z-score is zero, the Town's revenue unit demand is predicted to be 73.14 gpcd (i.e. the intercept represents and average year). If the non-revenue demand matches the most recent 5-year average then the total aggregate unit demand would be 79.8 gpcd. In a year where the z-score is +1, the revenue part of unit demand is predicted to be 77.63 gpcd (73.14 + 4.49) and the total unit demand would be 84.3 gpcd (i.e., assuming an average non-revenue component).

If the annual water stress score was used without converting it to a z-score first, the formula for revenue water unit demand would be as follows:

Equation (3): Revenue water unit demand (in gpcd) = 0.112119 x [Annual Water Stress Total] + 60.62

Equation 3 is somewhat less intuitive but gives the same predictive results and has the same R^2 value (0.68) and same p-value for the water stress variable (0.00048). In this case, the intercept (60.62 gpcd) describes the revenue water demand that would be predicted in a year when the water stress metric is zero, which is highly improbable. However, the annual water stress metric from Table A-1 may be used and the results are the same as for Equation 2 using the z-score of the water stress metric.

Mandatory Conservation

This analysis describes how the Town's unit demands were adjusted to anticipate more extreme weather years. Table A-2 summarizes model predicted revenue water use under typical weather conditions (i.e., the mean of the 30-year climate record from 1994 to 2023) as well as the high and low extremes predicted by the model. It is assumed that the non-revenue water would remain at the 5-year average, although it is anticipated that the non-revenue water value will also fluctuate.

Within the 30-year weather record for the regression modeling, the Town would have experienced the highest unit demand in 2007 (e.g., Figure A-3 and the water stress score summarized in Table A-1). From August to the end of 2007 (and into 2008) most public water supply systems in the Triangle area were under mandatory water use restrictions. For future planning, it was assumed the Town would implement the Water Shortage Response Plan (WSRP) during similar drought periods and mandate water use restrictions for customers. It is assumed that the Town could achieve an average 15 percent reduction in water demand from August through December during a repeat of the 2007 drought. This reduction is illustrated in Figure A-4 where mandatory restrictions start in August, much like they were in many Triangle communities in 2007. The annual average unit demand is reduced from a unit demand without water conservation at 91 gpcd to a unit use of 85 gpcd with water conservation.

Table A-2: Summary of Total Per Capita Use Demand Compared to Weather Regression Model Prediction

Parameter	Average Year Per Capita Water Use, gpcd	Wet year Per Capita Use Regression Model Prediction, gpcd	Dry year Per Capita Use Weather Regression Model Prediction, gpcd	Dry year Per Capita with Assumed Conservation
Revenue water [1]	73.1 [1]	66.2 [1]	84.6 [1]	78.4
Non-revenue water	6.7 [2]	6.7 [2]	6.7 [2]	6.7 [2]
Total per capita use	79.8	72.9	91.3	85.1

[1] Model prediction for revenue unit water use (e.g., residential, commercial, institutional, and industrial).

[2] Town average non-revenue water (e.g., process and unaccounted for water) between 2019 and 2023.

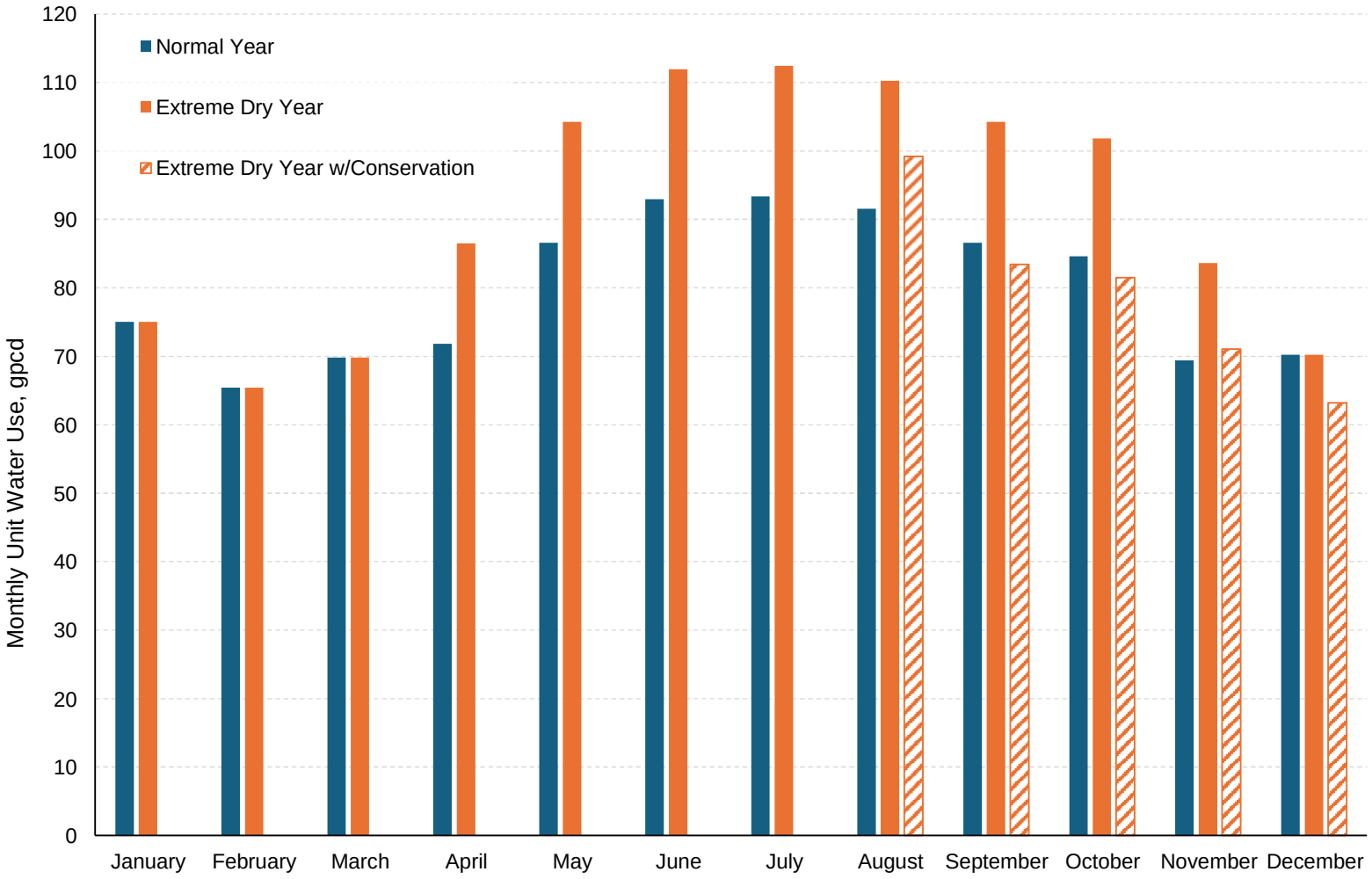


Figure A-4: Monthly unit demand under normal, extreme dry, and extreme dry w/ mandatory conservation conditions

Non-Revenue Water Analysis

Another potential reason the Town would have future water needs greater than observed during the 2013 to 2022 time period is water loss from the distribution network. Currently, the average pipe age in the distribution system is approximately 20 years per conversation with Town staff. A water distribution age of 20 years is relatively young by the standards of pipe infrastructure design lifetime. As a water network ages, it is anticipated that the amount of water loss in will increase. The Town's infrastructure is young and growing rapidly, which contributes to a relatively low level of water loss.

One approach to demonstrate the Town's current low level of water loss is through the non-revenue water categories water systems report to DWR as part of their annual local water supply plans. The non-revenue categories are process water and unaccounted-for-water. Since the process water category includes both losses at water treatment facilities as well as system flushing in the distribution system, the Town's losses were compared only to other systems in the region without water plants. Systems with water plants would be expected to have additional losses from in-plant process water. The comparison was also narrowed further to systems that serve more than 5,000 persons as there are many smaller systems whose distribution networks and resources to maintain their systems may not be comparable to the Town's. Finally, the losses were normalized on a per capita basis.

Figure A-5 illustrates the per capita sum of process water and unaccounted-for water for the period from 2014 to 2023. The data demonstrates that the Town's water loss is consistently among the lowest across the Town's peer group. The Town's closest peer, the Town of Holly Springs, is similar in terms of number of connections, location, demographics. The Town of Holly Springs also has a low sum of process water and unaccounted-for water. Compared to the Town's peers with older distribution systems, the Town of Fuquay-Varina's sum of process water and unaccounted-for water is significantly lower.

Figure A-6 illustrates the Town's data compared to a broader group of peer utilities without treatment plants but not limited by population served. The Town of Fuquay-Varina's water loss is still low compared to this broader data set. As the Town's water system ages, it is anticipated that the non-revenue water consumption will increase as the system ages and will not be as low as over the last 10-year period.

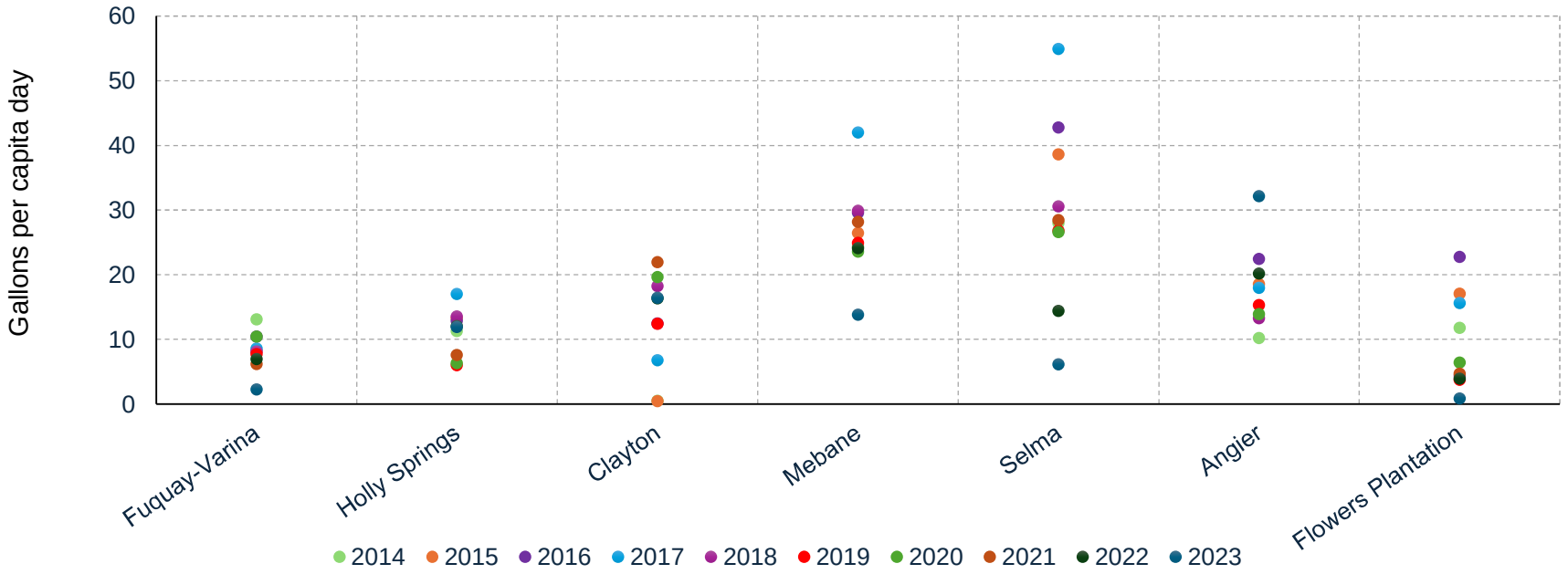


Figure A-5: Sum of Process and Unaccounted-for Water by Utility as Reported to DWR (2014 to 2023)

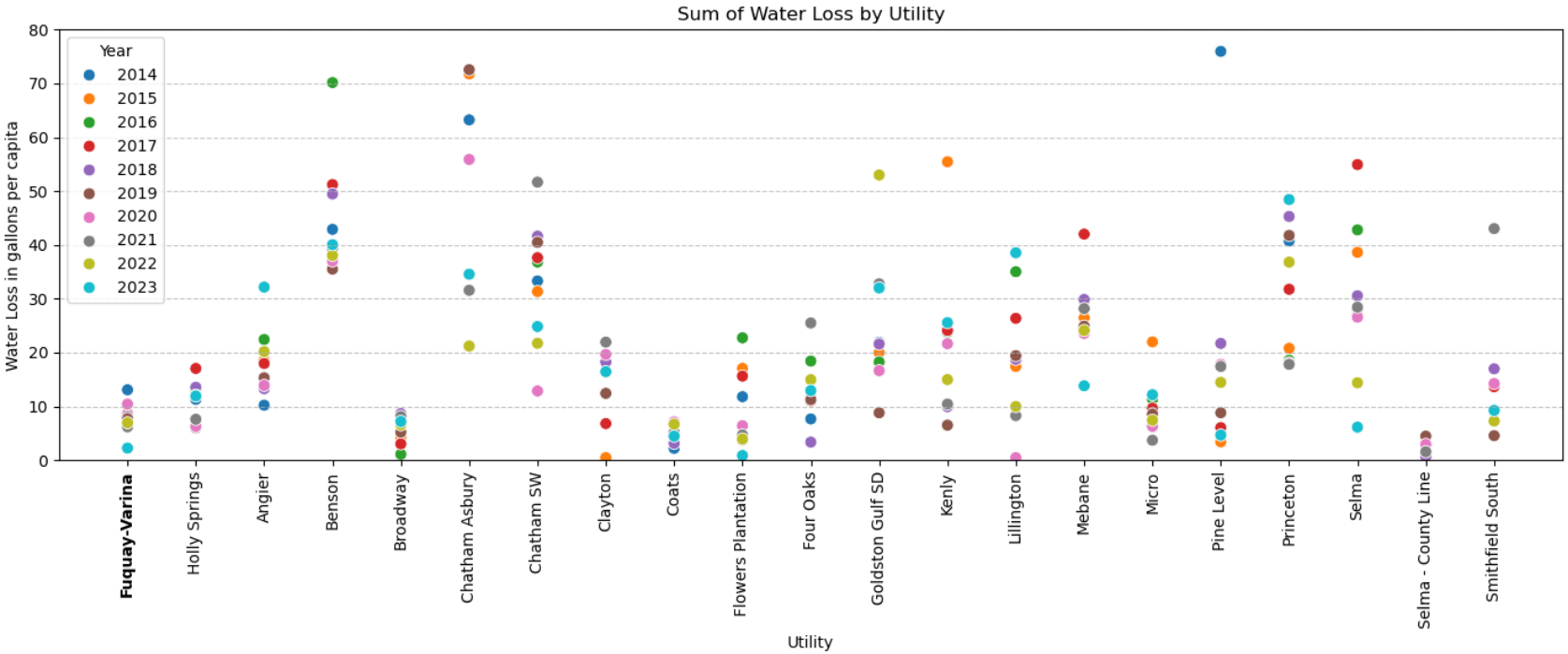


Figure A-6: Sum of Process and Unaccounted-for Water by Utility 2014 to 2023 (Broader Peer Comparison)

Legend

- Fuquay-Varina Water Service Area
- IBT Boundary
- County Boundary
- Major Water Body
- Major River/Stream
- Primary Road
- Municipal Boundary
- Urban Services Area
- ETJ

CARY
APEX
RALEIGH
GARNER
CLAYTON
HOLLY SPRINGS
FUQUAY VARINA
ANGIER
10-1:
Neuse River Basin
2-3:
Cape Fear River Basin
WAKE COUNTY
CHATHAM COUNTY
LEE COUNTY
HARNETT COUNTY
JOHNSTON COUNTY
1
55
70
401
42
40
50
210

N
W E
S

SCALE
1 inch = 2 miles
0 1 2
Miles

FUQUAY-VARINA
north carolina

Hazen

Exhibit 1: Town of Fuquay-Varina Service Area
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River

Legend

- Harnett County Water Line
- Fuquay-Varina Water Line
- Wells
- Parcels Connected to Water
- River Basin Boundary
- IBT Boundary
- County Boundary
- Major Water Body
- Major River/Stream
- Primary Road
- Urban Services Area
- Municipal Boundary
- ETJ

2-3:
Cape Fear River Basin

10-1:
Neuse River Basin

Basal Creek

Middle Creek

Black Creek

HARNETT COUNTY

WAKE COUNTY

JOHNSTON COUNTY

55

401

42

50

70

40

210

N

W

E

S

SCALE

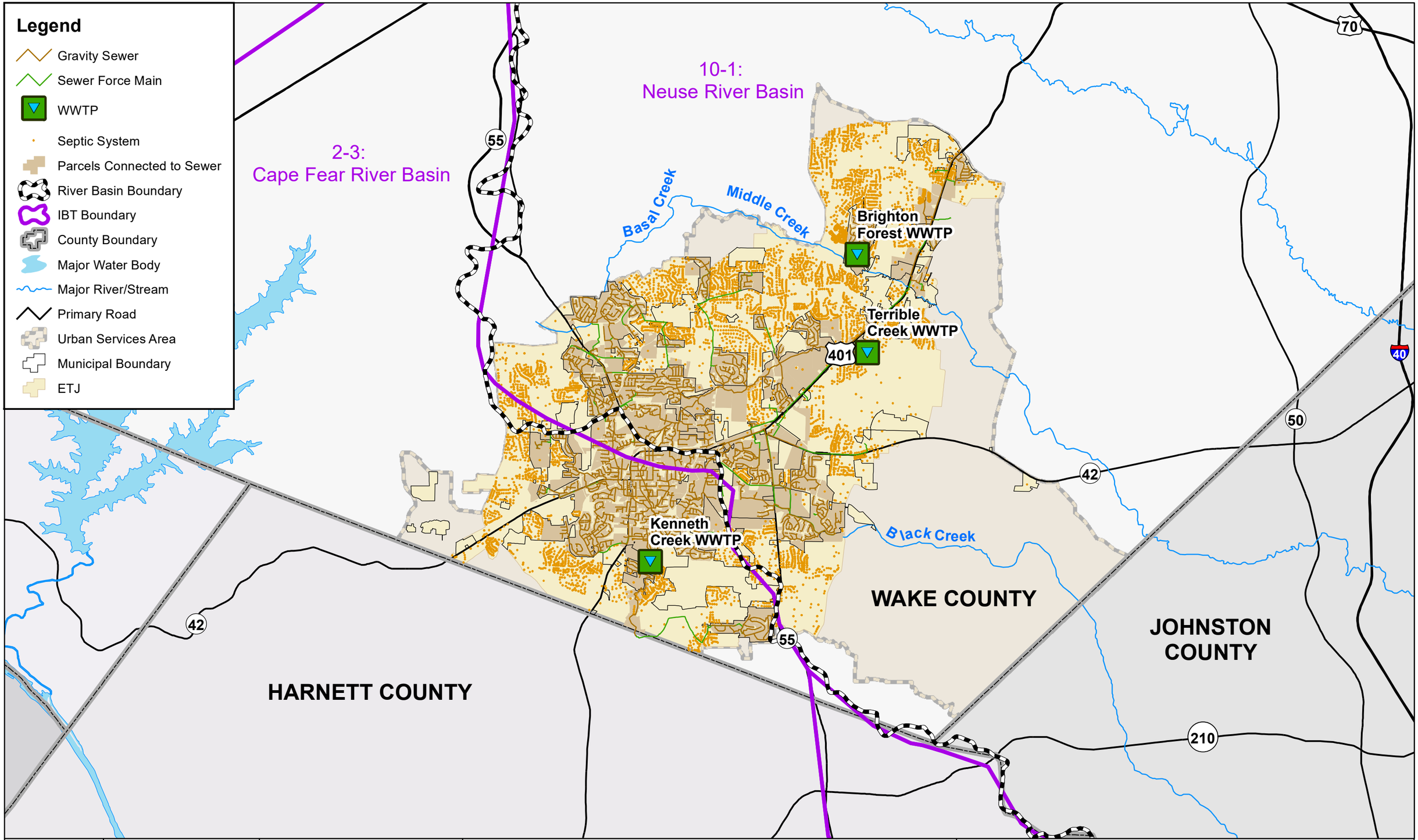
1 inch = 1.5 miles

0 0.5 1 1.5 Miles

FUQUAY-VARINA
north carolina

Hazen

Exhibit 2: Water Infrastructure for the
Town of Fuquay-Varina
Interbasin Transfer for Water Supply
from Cape Fear River to Neuse River



N
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SCALE
1 inch = 1.5 miles
0 0.5 1 1.5
Miles

FUQUAY-VARINA
north carolina

Hazen

Exhibit 3: Wastewater Infrastructure for the Town of Fuquay-Varina Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

Legend

- Urban Services Area
- Municipal Limits
- ETJ
- Extended IBT Boundary

TAZ - Additional DU/Acre BOP

- 0.00 - 0.55
- 0.56 - 1.63
- 1.64 - 2.85
- 2.86 - 4.10
- 4.11 - 10.40

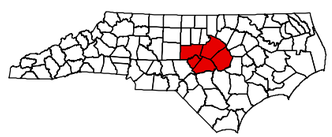
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

N W E S

SCALE

1 inch = 1.5 miles

0 0.5 1 1.5 Miles



FUQUAY-VARINA north carolina

Hazen

Exhibit 4: TAZ Dwelling Unit Density at Build-Out Interbasin Transfer for Water Supply from Cape Fear River to Neuse River

Appendix C: Miscellaneous Documentation

Letter of Intent from Harnett County, Wastewater Capacity in North Harnett Regional WWTP

FUQUAY-VARINA
north carolina

May 21, 2021

Mr. Steve Ward, Director
Harnett Regional Water
PO Box 1119
700 McKinney Parkway
Lillington, NC 27546

Re: Letter of Intent - NHRWWTP Treatment Capacity

Dear Mr. Ward,

In response to your April 23, 2021 letter, and under the Agreement dated November 9, 2000, this notice is to confirm the Town of Fuquay-Varina's decision to participate in the expansion of the North Harnett Regional Wastewater Treatment Plant (NHRWWTP).

Currently, the Town is contracted with Harnett County to receive 2.6 MGD of treatment capacity from the NHRWWTP. This notice is to affirm the Town's request to increase our capacity by 3.4 MGD for a total of 6.0 MGD of treatment capacity. Following the November 9, 2000 Agreement, this written notice serves as the Town's statement regarding our decision to participate in the facility expansion. Upon completing this project's preliminary engineering reports, on the condition that additional treatment capacity may be available for allocation, the Town would like to discuss securing additional treatment capacity beyond its 4.0 MGD entitled treatment capacity allotment.

We look forward to working with Harnett Regional Water on this very important project. In the future, please coordinate this project's activities with Jim Seymour, Assistant Town Manager (Development Services), jseymour@fuquay-varina.org | (919) 567-3919.

Sincerely,

Adam Mitchell
Town Manager

Cc: Jim Seymour, Asst. Town Manager
Jay Meyers, Public Utility Director
James Adcock, Town Attorney

Town of Fuquay-Varina NPDES Permit for Terrible Creek WWTP

DocuSign Envelope ID: 31015C24-3975-4249-B27B-BACBE001E043

ROY COOPER
Governor
DIONNE DELLI-GATTI
Secretary
S. DANIEL SMITH
Director

NORTH CAROLINA
Environmental Quality

June 9, 2021

Mr. Chris Grimes, Utilities Operations Manager
Town of Fuquay-Varina
401 Old Honeycutt Road
Fuquay-Varina, NC 27526

Subject: Final NPDES Permit Renewal
Permit NC0066516
Terrible Creek WWTP
Wake County
Facility Class IV
SIC Code 4952

Dear Mr. Grimes:

Division personnel have reviewed and approved your application for renewal of the subject permit. Accordingly, we are forwarding the attached NPDES permit. This permit is issued pursuant to the requirements of North Carolina General Statute 143-215.1 and the Memorandum of Agreement between North Carolina and the U.S. Environmental Protection Agency dated October 15, 2007 (or as subsequently amended).

Please note that the receiving stream is listed as impaired for **benthos** on the North Carolina **2018** 303(d) Impaired Waters List. Addressing impaired waters is a high priority with the Division, and instream data will continue to be evaluated. If there is noncompliance with permitted effluent limits and stream impairment can be attributed to your facility, then mitigative measures may be required.

The following change was made to the draft permit sent to you on March 9, 2021:

- The description of solids dewatering facility in the component list has been modified as two (2) 3-belt filter presses with gravity thickening ability.
- The 7Q10 for the receiving stream is zero while 30Q2 is greater than zero. Per 15A NCAC 02B .0206 (d), for the expanded discharges of 6 MGD, oxygen consuming waste shall be set as BOD_5 = 5 mg/l, NH_3-N = 2 mg/l, and DO = 6 mg/l. As a result, the winter BOD_5 limits have been corrected to 5 mg/l as monthly average and 7.5 mg/l as weekly average, and the daily average of DO has been corrected from 5 mg/l to 6 mg/l [See A. (2.)].
- Footnote 12 has been added to A. (1.) in the permit to indicate the Permittee can request reduction in monitoring frequencies to twice per week with three years of satisfactory data (presently there are 34-month data available and two additional satisfactory consecutive months will be required) per the Monitoring Frequency Reduction Review Guidance for exceptionally performing facilities. This change will be considered as minor modification since there is a permit condition.

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- The years for performing the Effluent Pollutant Scans have been updated to 2023,2024, and 2025 [See A. (7.)].

The final permit maintains the following significant changes identified in the letter sent on March 9, 2021:

- Upon completion of facility expansion in 2018, the Terrible Creek WWTP entered the 3.0 MGD flow tier. As such, effluent limitations and monitoring requirements for the 1.0 MGD flow tier have been removed from the permit.
- The component list of the Terrible Creek WWTP has been updated.
- The Terrible Creek WWTP is receiving wastewater from one Categorical Industrial User. As a result, the monitoring requirement for effluent and instream conductivity has been added to the permit.
- Given that the facility utilizes only ultraviolet for disinfection and no chlorine is present on the site as backup disinfection, the total residual chlorine (TRC) limit and monitoring requirement have been removed from the permit at both the 3.0 and the 6.0 MGD flow tiers.
- Based on the reasonable potential analysis (RPA) showing reasonable potential to violate state water quality standards, a monthly average limit of 15.7 µg/L and a daily maximum limit of 22.4 µg/L for total copper at both the 3.0 and the 6.0 MGD have been added to the permit with a requirement that samples be taken monthly [See A. (1.) and A. (2.)].
- The facility reported Selenium at less than detection, with a detection level < 2 µg/L. DWR's laboratory identifies the target Practical Quantification Limits (PQLs) for Selenium as 1 µg/L. 15A NCAC 2B .0505 (e) (4) requires that all test procedures must produce detection and reporting levels that are below the permit discharge requirements and all data generated must be reported to the approved detection level or lower reporting level of the procedure. If no approved methods are determined capable of achieving detection and reporting levels below permit discharge requirements, then the approved method with the lowest detection and reporting level must be used. The facility must use sufficiently sensitive test methods for all pollutants, including when performing Effluent Pollutant Scans.
- Based on Mercury TMDL evaluation showing mercury values reported at levels > 1 ng/L and since the permitted flow is greater than 2 MGD, Special Condition A. (8.) Mercury Minimization Plan has been added to the permit. Results of the MMP shall be summarized and submitted with the next permit renewal. The annual monitoring requirement for Mercury has been removed at both the 3.0 and the 6.0 MGD.
- The NC 2007-2014 Water Quality Standard (WQS) Triennial Review was approved by the NC Environmental Management Committee (EMC) on November 13, 2014. The US EPA subsequently approved the WQS revisions on April 6, 2016 with some exceptions. The NC Division of Water Resources NPDES Permitting Unit is required to implement the new dissolved metal standards in all permits public noticed after April 6, 2016. The new standards for most metals include acute standards. Further, the freshwater standards for several metals are expressed as the dissolved form of the metals, and seven metals have hardness-dependent equations. As a result, the NPDES Permitting Unit will need site-specific effluent hardness data and instream hardness data, upstream of the discharge, for each facility monitoring these metals in order to calculate permit limitations. However, since the summer 7Q10 of the receiving stream is zero, upstream hardness sampling is not necessary. Only effluent hardness has been added to the permit at a monitoring frequency of quarterly [See A. (1.) and A. (2.)].

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- Some of the wording has changed and an email address for electronic submittal of toxicity testing results has been added in Special Condition A. (6.), Chronic Toxicity Permit Limit. Please review each paragraph carefully.
- Special Condition A. (7.) has been modified to include the specific three years in which the Effluent Pollutant Scan shall be performed (2023, 2024, 2025), and to allow for electronic submittal. In addition, at the end of the Special Condition, 2nd Species Toxicity Testing Requirements for municipal permit renewals per Federal Regulations [40 CFR 122.21 (j)(5)] have been added.
- A notation was made concerning the Electronic Reporting Rule – NPDES Electronic Reporting Rule – Phase 2 Extension. EPA extended the Phase 2 deadline to December 21, 2025. The current compliance date, effective January 4, 2021, was extended as a final regulation change published in the November 2, 2020 Federal Register.
- Federal regulations require electronic submittal of all discharge monitoring reports (DMRs) and program reports. The requirement to continue reporting discharge monitoring data electronically using the NC DWR's Electronic Discharge Monitoring Report (eDMR) internet application has been added to your NPDES permit [See Special Condition A. (9.)].
- Parameter codes have been added to the Effluent Limitations and Monitoring Requirements [See A. (1.) and A. (2.)] and the Effluent Pollutant Scan [See A. (7.)].
- Regulatory citations have been added to the permit.

If any parts, measurement frequencies or sampling requirements contained in this permit are unacceptable to you, you have the right to an adjudicatory hearing upon written request within thirty (30) days following receipt of this letter. This request must be in the form of a written petition, conforming to Chapter 150B of the North Carolina General Statutes, and filed with the Office of Administrative Hearings (6714 Mail Service Center, Raleigh, North Carolina 27699-6714). Unless such demand is made, this decision shall be final and binding.

Please note that this permit is not transferable except after notice to the Division. The Division may require modification or revocation and reissuance of the permit. This permit does not affect the legal requirements to obtain other permits which may be required by the Division of Water Resources or any other Federal, State, or Local governmental regulations.

If you have any questions concerning this permit, please contact Min Xiao, PE at (919) 707-3644 or via email at Min.Xiao@ncdenr.gov.

Sincerely,

DocuSigned by:
Michael Montebello
C464531431644FE...

for S. Daniel Smith, Director
Division of Water Resources, NCDEQ

Hardcopy: NPDES Files
Ecopy: US EPA Region 4
DWR/Raleigh Regional Office/Water Quality/Scott Vinson
DWR/Operator Certification Program/Maureen Kinney
DWR/Ecosystems Branch/Mark Vander Borgh
DWR/Aquatic Toxicology Branch/Zach Thomas, Cindy Moore

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STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF WATER RESOURCES

PERMIT

TO DISCHARGE WASTEWATER UNDER THE

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of North Carolina General Statute 143-215.1, other lawful standards and regulations promulgated and adopted by the North Carolina Environmental Management Commission, and the Federal Water Pollution Control Act, as amended,

Town of Fuquay-Varina

is hereby authorized to discharge wastewater from a facility located at the

Terrible Creek WWTP
5812 Hill Top Road
East of Fuquay-Varina
Wake County

to receiving waters designated as Terrible Creek in the Neuse River Basin in accordance with effluent limitations, monitoring requirements, and other conditions set forth in Parts I, II, III and IV hereof.

This permit shall become effective July 1, 2021.

This permit and authorization to discharge shall expire at midnight on April 30, 2026.

Signed this day June 9, 2021.

DocuSigned by:
Michael Montebello
C464531431644FE...

for S. Daniel Smith, Director
Division of Water Resources
By Authority of the Environmental Management Commission

DocuSign Envelope ID: 31015C24-3975-4249-B27B-BACBE001E043

SUPPLEMENT TO PERMIT COVER SHEET

All previous NPDES Permits issued to this facility, whether for operation or discharge are hereby revoked, and as of this issuance, any previously issued permit bearing this number is no longer effective. Therefore, the exclusive authority to operate and discharge from this facility arises under the permit conditions, requirements, terms, and provisions included herein.

The **Town of Fuquay-Varina** is hereby authorized to:

1. Continue to operate a 3.0 MGD wastewater treatment facility consisting of the following components:

   - Influent pump station
   - Mechanical coarse bar screen
   - Mechanical step bar screens
   - Manual bar rack
   - Grit removal
   - Flow distribution box
   - Two (2) 5-stage conventional BNR basins
   - Two (2) secondary clarifiers
   - RAS pump station
   - Two (2) ultrascreen disc filters
   - UV disinfection
   - Effluent flow measurement
   - WAS pump station
   - One (1) aerated sludge holding tank
   - Two (2) 3-belt filter presses with gravity thickening ability
   - Stand-by power

   This facility is located at Terrible Creek Wastewater Treatment Plant, 5812 Hill Top Road, east of Fuquay-Varina in Wake County. Terrible WWTP is currently rated a Class IV facility.

2. After receiving an Authorization to Construct from the Division for expansion and submission of an engineer's certification, construct and operate a wastewater treatment facility with a design capacity of 6.0 MGD.

3. Discharge from said treatment works at the location specified on the attached map into Terrible Creek, which is classified C-NSW waters in the Neuse River Basin.

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Part I

A. (1.) EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS (3.0 MGD)
[15A NCAC 02B .0400 et seq., 02B .0500 et seq.]
Grade IV Biological Water Pollution Control System [15A NCAC 08G .0302]

a. During the period beginning upon the effective date and lasting until expansion above 3.0 MGD or expiration, the Permittee is authorized to discharge treated wastewater through Outfall 001. Such discharges shall be limited and monitored[1] by the Permittee as specified below:

EFFLUENT CHARACTERISTICS	*Parameter Code*	DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS		
		Monthly Average	Weekly Average	Daily Maximum	Measurement Frequency	Sample Type	Sample Location[2]
Flow	*50050*	3.0 MGD			Continuous	Recording	Influent or Effluent
Total Monthly Flow (MG)	*82220*	Monitor and Report			Monthly	Recorded or Calculated	Effluent
BOD, 5-day, 20°C (Summer)[3,4,12]	*CO310*	5.0 mg/L	7.5 mg/L		Daily	Composite	Influent & Effluent
BOD, 5-day, 20°C (Winter)[3,4,12]	*CO310*	10.0 mg/L	15.0 mg/L		Daily	Composite	Influent & Effluent
Total Suspended Solids[3,12]	*CO530*	30.0 mg/L	45.0 mg/L		Daily	Composite	Influent & Effluent
NH_3 as N (Summer)[4]	*CO610*	1.0 mg/L	3.0 mg/L		Daily	Composite	Effluent
NH_3 as N (Winter)[4]	*CO610*	2.0 mg/L	6.0 mg/L		Daily	Composite	Effluent
Dissolved Oxygen	*00300*	Daily average ≥ 5.0 mg/L			Daily	Grab	Effluent
Fecal Coliform[12]	*31616*	200/100mL	400/100mL		Daily	Grab	Effluent
pH	*00400*	Between 6.0 and 9.0 s.u.			Daily	Grab	Effluent
Temperature	*00010*	Monitor and Report			Daily	Grab	Effluent
Conductivity	*00094*	Monitor and Report			Daily	Grab	Effluent
Total Phosphorus[5]	*CO665*	2.0 mg/L (Quarterly Average)[5]			Weekly	Composite	Effluent
TKN (mg/L)[6]	*00625*	Monitor and Report			Weekly	Composite	Effluent
$NO_2 + NO_3$ (mg/L)[6]	*00630*	Monitor and Report			Weekly	Composite	Effluent
TN (mg/L)[6]	*CO660*	Monitor and Report			Weekly	Composite	Effluent
Total Nitrogen Load[7]	*QY600*	Monitor and Report (pounds/month)			Monthly	Calculated	Effluent
		68,489 pounds per year			Annually	Calculated	Effluent
Total Copper	*01042*	15.7 µg/L		22.4 µg/L	Monthly	Composite	Effluent
Total Zinc	*01092*	Monitor and Report			Quarterly	Composite	Effluent
Chronic Toxicity[8]	*TGP3B*	Monitor and Report			Quarterly	Composite	Effluent
Temperature	*00010*	Monitor and Report			Footnote 9	Grab	U, D
Conductivity	*00094*	Monitor and Report			Footnote 9	Grab	U, D
Dissolved Oxygen	*00300*	Monitor and Report			Footnote 9	Grab	U, D
Fecal Coliform	*31616*	Monitor and Report			Footnote 9	Grab	U, D
Total Hardness [as $CaCO_3$] (mg/L)[10]	*00900*	Monitor and Report			Quarterly	Composite	Effluent
Effluent Pollutant Scan	*NC01*	Monitor and Report			Footnote 11	Footnote 11	Effluent

All footnotes are listed on the following page.

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Footnotes:

1. The permittee shall submit discharge monitoring reports electronically using the NC DWR's eDMR application system [see A. (9.)].
2. U: Upstream at least 100 feet from the outfall. D: Downstream at NCSR 2751.
3. The monthly average effluent BOD_5 and Total Suspended Solids concentrations shall not exceed 15% of the respective influent value (85% removal).
4. Summer is defined as the period from April 1 through October 31, while winter is defined as November 1 through March 31.
5. The quarterly average for total phosphorus shall be the average of composite samples collected weekly during the calendar quarter (January-March, April-June, July-September, October-December).
6. For a given wastewater sample, TN = TKN + NO_3-N + NO_2-N, where TN is Total Nitrogen, TKN is Total Kjeldahl Nitrogen, and NO_3-N and NO_2-N are Nitrate and Nitrite Nitrogen, respectively.
7. This is the mass quantity of Total Nitrogen discharged in a given period of time. See condition A. (3.). Compliance with this limit shall be determined in accordance with Special Condition A. (4.) of this permit.
8. Chronic Toxicity (Ceriodaphnia) P/F at 90% with testing in March, June, September and December (see condition A. (6.)).
9. Sample collected three times per week during June 1 through September 30 and once per week October 1 through May 31. Monitoring for upstream and downstream are provisionally waived based upon membership in the Lower Neuse River Basin Association (LNBA). If at anytime during the term of this permit, membership in the LNBA is terminated, the Division shall be notified immediately, and in-stream monitoring shall immediately be conducted as stipulated in this permit.
10. Effluent hardness sampling should be performed in conjunction with testing for hardness dependent metals (cadmium, copper, lead, nickel, silver, and zinc).
11. The Permittee shall perform three Effluent Pollutant Scans during the term of this permit [see A. (7.)].
12. The Permittee can request reduction in monitoring frequencies to twice per week with three years of satisfactory data (presently there are 34-month data available and two additional satisfactory consecutive months will be required) per the Monitoring Frequency Reduction Review Guidance for exceptionally performing facilities.

b. There shall be no discharge of floating solids or visible foam in other than trace amounts.

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A. (2.) EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS (6.0 MGD)

[15A NCAC 02B .0400 et seq., 02B .0500 et seq.]

Grade IV Biological Water Pollution Control System [15A NCAC 08G .0302]

a. During the period beginning upon expansion above 3.0 MGD and lasting until expiration, the Permittee is authorized to discharge treated wastewater through outfall 001. Such discharges shall be limited and monitored[1] by the Permittee.

EFFLUENT CHARACTERISTICS		DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS		
Parameter Code		Monthly Average	Weekly Average	Daily Maximum	Measurement Frequency	Sample Type	Sample Location[2]
Flow[12]	*50050*	6.0 MGD			Continuous	Recording	Influent or Effluent
Total Monthly Flow (MG)	*82220*	Monitor and Report			Monthly	Recorded or Calculated	Effluent
BOD, 5-day, 20°C[3]	*CO310*	5.0 mg/L	7.5 mg/L		Daily	Composite	Influent & Effluent
Total Suspended Solids[3]	*CO530*	30.0 mg/L	45.0 mg/L		Daily	Composite	Influent & Effluent
NH_3 as N (Summer)[4]	*CO610*	1.0 mg/L	3.0 mg/L		Daily	Composite	Effluent
NH_3 as N (Winter)[4]	*CO610*	2.0 mg/L	6.0 mg/L		Daily	Composite	Effluent
Dissolved Oxygen	*00300*	Daily average ≥ 6.0 mg/L			Daily	Grab	Effluent
Fecal Coliform	*31616*	200/100mL	400/100mL		Daily	Grab	Effluent
pH	*00400*	Between 6.0 and 9.0 s.u.			Daily	Grab	Effluent
Temperature	*00010*	Monitor and Report			Daily	Grab	Effluent
Conductivity	*00094*	Monitor and Report			Daily	Grab	Effluent
Total Phosphorus[5]	*CO665*	2.0 mg/L (Quarterly Average)[5]			Weekly	Composite	Effluent
TKN (mg/L)[6]	*00625*	Monitor and Report			Weekly	Composite	Effluent
NO_2 + NO_3 (mg/L)[6]	*00630*	Monitor and Report			Weekly	Composite	Effluent
TN (mg/L) [6]	*CO660*	Monitor and Report			Weekly	Composite	Effluent
Total Nitrogen Load[7]	*QY600*	Monitor and Report (pounds/month)			Monthly	Calculated	Effluent
		68,489 pounds per year			Annually	Calculated	Effluent
Total Copper	*01042*	15.7 µg/L		22.4 µg/L	Monthly	Composite	Effluent
Total Zinc	*01092*	Monitor and Report			Quarterly	Composite	Effluent
Chronic Toxicity[8]	*TGP3B*	Monitor and Report			Quarterly	Composite	Effluent
Temperature	*00010*	Monitor and Report			Footnote 9	Grab	U, D
Conductivity	*00094*	Monitor and Report			Footnote 9	Grab	U, D
Dissolved Oxygen	*00300*	Monitor and Report			Footnote 9	Grab	U, D
Fecal Coliform	*31616*	Monitor and Report			Footnote 9	Grab	U, D
Total Hardness [as $CaCO_3$] (mg/L) [10]	*00900*	Monitor and Report			Quarterly	Composite	Effluent
Effluent Pollutant Scan	*NC01*	Monitor and Report			Footnote 11	Footnote 11	Effluent

All footnotes are listed on the following page.

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Footnotes:

1. The permittee shall submit discharge monitoring reports electronically using the NC DWR's eDMR application system [see A. (9.)].
2. U: Upstream at least 100 feet from the outfall. D: Downstream at NCSR 2751.
3. The monthly average effluent BOD_5 and Total Suspended Solids concentrations shall not exceed 15% of the respective influent value (85% removal).
4. Summer is defined as the period from April 1 through October 31, while winter is defined as November 1 through March 31.
5. The quarterly average for total phosphorus shall be the average of composite samples collected weekly during the calendar quarter (January-March, April-June, July-September, October-December).
6. For a given wastewater sample, TN = TKN + NO_3-N + NO_2-N, where TN is Total Nitrogen, TKN is Total Kjeldahl Nitrogen, and NO_3-N and NO_2-N are Nitrate and Nitrite Nitrogen, respectively.
7. This is the mass quantity of Total Nitrogen discharged in a given period of time. See condition A. (3.). Compliance with this limit shall be determined in accordance with Special Condition A. (4.) of this permit.
8. Chronic Toxicity (Ceriodaphnia) P/F at 90% with testing in March, June, September and December (see condition A. (6.)).
9. Sample collected three times per week during June 1 through September 30 and once per week October 1 through May 31. Monitoring for upstream and downstream are provisionally waived based upon membership in the Lower Neuse River Basin Association (LNBA). If at anytime during the term of this permit, membership in the LNBA is terminated, the Division shall be notified immediately, and in-stream monitoring shall immediately be conducted as stipulated in this permit.
10. Effluent hardness sampling should be performed in conjunction with testing for hardness dependent metals (cadmium, copper, lead, nickel, silver, and zinc).
11. The Permittee shall perform three Effluent Pollutant Scans during the term of this permit [see A. (7.)].
12. In accordance with 15A NCAC 02H .0124, reliability measures for facilities with a design capacity equal to or greater than 5 MGD, continuous operation, 24 hours, seven days per week, are required to have at least one certified operator on each shift, unless the applicant can show the requirement is unwarranted for a particular case.

b. There shall be no discharge of floating solids or visible foam in other than trace amounts.

A. (3.) CALCULATION OF TOTAL NITROGEN LOADS [G.S. 143-215.1(b)]

a. The permittee shall calculate monthly and annual TN Loads as follows:

i. Monthly TN Load (lb/mo) = TN x TMF x 8.34

where:

TN = the average Total Nitrogen concentration (mg/L) of the composite samples collected during the month

TMF = the Total Monthly Flow of wastewater discharged during the month (MG/mo)

8.34 = conversion factor, from (mg/L x MG) to pounds

ii. Annual TN Load (lb/yr) = Sum of the 12 Monthly TN Loads for the calendar year

b. The permittee shall report monthly Total Nitrogen results (mg/L and lb/mo) in the discharge monitoring report for that month and shall report each year's annual results (lb/yr) in the December report for that year.

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A. (4.) ANNUAL LIMITS FOR TOTAL NITROGEN [G.S. 143-215.1(b)]

a. Total Nitrogen (TN) allocations and TN Load limits for NPDES dischargers in the Neuse River basin apply on a calendar year basis.

b. For any given calendar year, the permittee shall be in compliance with the annual TN Load limit in this Permit if:

   i. the permittee's annual TN discharge is less than or equal to its TN Load limit, or
   ii. the permittee is a co-permittee member of a compliance association.

c. If the permittee is not a co-permittee member of a compliance association and the permittee's cumulative annual TN discharge exceeds the effective TN Load limit in this permit at any point during the calendar year, the permittee is in violation of its TN Load limit, and each day of a continuing violation shall constitute a separate violation.

d. The TN Load limit in this Permit (if any) may be modified as the result of allowable changes in the permittee's TN allocation.

   i. Allowable changes include those resulting from purchase of TN allocation from the Wetlands Restoration Fund; purchase, sale, trade, or lease of allocation between the permittee and other dischargers; regionalization; and other transactions approved by the Division.

   ii. The permittee may request a modification of the TN Load limit in this Permit to reflect allowable changes in its TN allocation. Upon receipt of timely and proper application, the Division will modify the permit as appropriate and in accordance with state and federal program requirements.

   iii. Changes in TN limits become effective on January 1 of the year following permit modification. The Division must receive application no later than August 31 for changes proposed for the following calendar year.

   iv. Application shall be sent to:

   NCDWR / NPDES Programs
   Attn: Neuse River Basin Coordinator
   1617 Mail Service Center
   Raleigh, NC 27699-1617

e. If the permittee is a member and co-permittee of an approved compliance association, its TN discharge during that year is governed by that association's group NPDES permit and the TN limits therein.

   i. The permittee shall be considered a Co-permittee Member for any given calendar year in which it is identified as such in Appendix A of the association's group NPDES permit.

   ii. Association roster(s) and members' TN allocations will be updated annually and in accordance with state and federal program requirements.

   iii. If the permittee intends to join or leave a compliance association, the Division must be notified of the proposed action in accordance with the procedures defined in the association's NPDES permit.

      (A) Upon receipt of timely and proper notification, the Division will modify the permit as appropriate and in accordance with state and federal program requirements.

      (B) Membership changes in a compliance association become effective on January 1 of the year following modification of the association's permit.

f. The TN monitoring and reporting requirements in this Permit remain in effect until expiration of this Permit and are not affected by the permittee's membership in a compliance association.

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A. (5.) TOTAL NITROGEN ALLOCATIONS [G.S. 143-215.1(b)]

a. The following table lists the Total Nitrogen (TN) allocations assigned to, acquired by, or transferred to or from the permittee in accordance with the Neuse River nutrient strategy (15A NCAC 02B .0700) and the status of each as of permit issuance. These allocations are not enforceable limits nor do they supersede any TN limit(s) established elsewhere in this permit or in the NPDES permit of a compliance association of which the permittee is a Co-Permittee Member.

Table 1. TN Allocations

ALLOCATION TYPE	SOURCE	DATE	ALLOCATION AMOUNT (lb/yr)[1]		STATUS
			Estuary	Discharge	
Base Allocation	Assigned by Rule [2]	12/7/97; 4/1/03	33,790	67,579	Active
Supplemental Allocation	Connection of Southside MHP (NC0030724)	?	253	506	Active
Supplemental Allocation	Connection of Wake Technical C.C. (NC0025631)	?	202	404	Active
		TOTAL	34,244	68,489	Active

Footnotes:

1. Transport Factor = 50%. Values are displayed to the nearest pound per year.
2. 15A NCAC 02B .0713 (formerly 02B .0234)

b. Any addition, deletion, or modification of the listed allocations (other than typographical errors) or any change to Active status of any reserve allocations shall be considered a major modification of this permit and shall be subject to the public review process afforded such modifications under state and federal rules.

A. (6.) CHRONIC TOXICITY PERMIT LIMIT (QUARTERLY) [15A NCAC 02B.0200]

The effluent discharge shall at no time exhibit observable inhibition of reproduction or significant mortality to ***Ceriodaphnia dubia*** at an effluent concentration of **90%**.

The permit holder shall perform at a minimum, **quarterly** monitoring using test procedures outlined in the "North Carolina *Ceriodaphnia* Chronic Effluent Bioassay Procedure," (Revised December 2010, or subsequent versions) or "North Carolina Phase II Chronic Whole Effluent Toxicity Test Procedure" (Revised December 2010, or subsequent versions). The tests will be performed **during the months of March, June, September, and December.** These months signify the first month of each three-month toxicity testing quarter assigned to the facility. Effluent sampling for this testing must be obtained during representative effluent discharge and shall be performed at the NPDES permitted final effluent discharge below all treatment processes.

If the test procedure performed as the first test of any single quarter results in a failure or ChV below the permit limit, then multiple-concentration testing shall be performed at a minimum, in each of the two following months as described in "North Carolina Phase II Chronic Whole Effluent Toxicity Test Procedure" (Revised-December 2010, or subsequent versions).

All toxicity testing results required as part of this permit condition will be entered on the Effluent Discharge Monitoring Form (**MR-1**) for the months in which tests were performed, using the parameter code **TGP3B** for the pass/fail results and **THP3B** for the Chronic Value. Additionally, DWR Form **AT-3** (original) is to be sent to the following address:

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North Carolina Division of Water Resources
Water Sciences Section/Aquatic Toxicology Branch
1621 Mail Service Center
Raleigh, NC 27699-1621

Or, results can be sent to the email, ATForms.ATB@ncdenr.gov.

Completed Aquatic Toxicity Test Forms shall be filed with the Water Sciences Section no later than 30 days after the end of the reporting period for which the report is made.

Test data shall be complete, accurate, include all supporting chemical/physical measurements and all concentration/response data, and be certified by laboratory supervisor and ORC or approved designate signature. Total residual chlorine of the effluent toxicity sample must be measured and reported if chlorine is employed for disinfection of the waste stream.

Should there be no discharge of flow from the facility during a month in which toxicity monitoring is required, the permittee will complete the information located at the top of the aquatic toxicity (AT) test form indicating the facility name, permit number, pipe number, county, and the month/year of the report with the notation of "No Flow" in the comment area of the form. The report shall be submitted to the Water Sciences Section at the address cited above.

Should the permittee fail to monitor during a month in which toxicity monitoring is required, monitoring will be required during the following month. Assessment of toxicity compliance is based on the toxicity testing quarter, which is the three-month time interval that begins on the first day of the month in which toxicity testing is required by this permit and continues until the final day of the third month.

Should any test data from this monitoring requirement or tests performed by the North Carolina Division of Water Resources indicate potential impacts to the receiving stream, this permit may be re-opened and modified to include alternate monitoring requirements or limits.

NOTE: Failure to achieve test conditions as specified in the cited document, such as minimum control organism survival, minimum control organism reproduction, and appropriate environmental controls, shall constitute an **invalid test** and will require immediate follow-up testing to be completed no later than the last day of the month following the month of the initial monitoring.

A. (7.) EFFLUENT POLLUTANT SCAN (Municipal POTWs) [G.S. 143-215.1(b)]

The Permittee shall perform a total of three (3) Effluent Pollutant Scans for all parameters listed below. **One scan must be performed in each of the following years: 2023, 2024, and 2025**. Analytical methods shall be in accordance with 40 CFR Part 136 and shall be sufficiently sensitive to determine whether parameters are present in concentrations greater than applicable standards and criteria. Samples should be collected with one quarterly toxicity test each year, and must represent seasonal variation [i.e., do not sample in the same quarter every year]. Unless otherwise indicated, metals shall be analyzed as "total recoverable."

Ammonia (as N)	CO610	Trans-1,2-dichloroethylene	34546	Bis (2-chloroethyl) ether	34273
Chlorine (total residual, TRC)	50060	1,1-dichloroethylene	34501	Bis (2-chloroisopropyl) ether	34283
Dissolved oxygen	00300	1,2-dichloropropane	CO541	Bis (2-ethylhexyl) phthalate	CO100
Nitrate / Nitrite	00630	1,3-dichloropropylene	77163	4-bromophenyl phenyl ether	34636
Kjeldahl nitrogen	00625	Ethylbenzene	34371	Butyl benzyl phthalate	34292
Oil and grease	00556	Methyl bromide	34413	2-chloronaphthalene	34581
Phosphorus	CO665	Methyl chloride	34418	4-chlorophenyl phenyl ether	34641
Total dissolved solids	70295	Methylene chloride	34423	Chrysene	34320

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Hardness	00900	1,1,2,2-tetrachloroethane	81549	Di-n-butyl phthalate	39110
Antimony	01097	Tetrachloroethylene	34475	Di-n-octyl phthalate	34596
Arsenic	01002	Toluene	34010	Dibenzo(a,h)anthracene	34556
Beryllium	01012	1,1,1-trichloroethane	34506	1,2-dichlorobenzene	34536
Cadmium	01027	1,1,2-trichloroethane	34511	1,3-dichlorobenzene	34566
Chromium	CO034	Trichloroethylene	39180	1,4-dichlorobenzene	34571
Copper	01042	Vinyl chloride	39175	3,3-dichlorobenzidine	34631
Lead	*01051*	***Acid-extractable compounds:***		Diethyl phthalate	34336
Mercury (Method 1631E)	COMER	P-chloro-m-cresol	34452	Dimethyl phthalate	34341
Nickel	01067	2-chlorophenol	34586	2,4-dinitrotoluene	34611
Selenium	01147	2,4-dichlorophenol	34601	2,6-dinitrotoluene	CO626
Silver	01077	2,4-dimethylphenol	34606	1,2-diphenylhydrazine	34346
Thallium	01059	4,6-dinitro-o-cresol	34657	Fluoranthene	CO376
Zinc	01092	2,4-dinitrophenol	34616	Fluorene	34381
Cyanide	00720	2-nitrophenol	34591	Hexachlorobenzene	CO700
Total phenolic compounds	32730	4-nitrophenol	34646	Hexachlorobutadiene	CO702
Volatile organic compounds:		Pentachlorophenol	39032	Hexachlorocyclo-pentadiene	34386
Acrolein	34210	Phenol	34694	Hexachloroethane	34396
Acrylonitrile	34215	2,4,6-trichlorophenol	34621	Indeno(1,2,3-cd)pyrene	34403
Benzene	34030	***Base-neutral compounds:***		Isophorone	34408
Bromoform	32104	Acenaphthene	34205	Naphthalene	34696
Carbon tetrachloride	32102	Acenaphthylene	34200	Nitrobenzene	34447
Chlorobenzene	34301	Anthracene	CO220	N-nitrosodi-n-propylamine	34428
Chlorodibromomethane	34306	Benzidine	39120	N-nitrosodimethylamine	34438
Chloroethane	85811	Benzo(a)anthracene	CO526	N-nitrosodiphenylamine	34433
2-chloroethyl vinyl ether	34576	Benzo(a)pyrene	34247	Phenanthrene	34461
Chloroform	32106	3,4 benzofluoranthene	34230	Pyrene	34469
Dichlorobromomethane	32101	Benzo(ghi)perylene	34521	1,2,4-trichlorobenzene	CO551
1,1-dichloroethane	34496	Benzo(k)fluoranthene	34242		
1,2-dichloroethane	32103	Bis (2-chloroethoxy) methane	34278		

Reporting. Test results shall be reported electronically using the Division's eDMR system or on DWR Form DMR-PPA-1(or on a form approved by the Director) by December 31st of each designated sampling year. The Permittee must at least report completion of the test in the eDMR system by entering "1" or "Y" for parameter code NC01 - Annual Pollutant Scan. If utilizing the DWR Form submit to the following address:

NC DEQ / DWR / NPDES Files, 1617 Mail Service Center, Raleigh, North Carolina 27699-1617.

Or the form may be uploaded at: https://edocs.deq.nc.gov/Forms/NPDES_WW-EDMR-Supplemental-Form

Additional Toxicity Testing Requirements for Municipal Permit Renewal. Please note that Municipal facilities that are subject to the Effluent Pollutant Scan requirements listed above are also subject to additional toxicity testing requirements specified in Federal Regulation 40 CFR 122.21(j)(5). The US EPA requires four (4) toxicity tests for a test organism other than the test species currently required in this permit. The multiple species tests should be conducted either quarterly for a 12-month period prior to submittal of the permit renewal application, or four tests performed at least annually in the four and one half year period prior to the application. These tests shall be performed for acute or chronic toxicity, whichever is specified in this permit. The multiple species toxicity test results shall be filed with the Aquatic Toxicology Branch at the following address:

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North Carolina Division of Water Resources
Water Sciences Section/Aquatic Toxicology Branch
1621 Mail Service Center
Raleigh, North Carolina 27699-1621

Or, results can be sent to the email: ATForms.ATB@ncdenr.gov.

Contact the Division's Aquatic Toxicology Branch at 919-743-8401 for guidance on conducting the additional toxicity tests and reporting requirements. Results should also be summarized in Part E (Toxicity Testing Data) of EPA Municipal Application Form 2A, when submitting the permit renewal application to the NPDES Permitting Unit.

A. (8.) MERCURY MINIMIZATION PLAN [G.S. 143-215.1(b)]

The Permittee shall develop and implement a Mercury Minimization Plan (MMP) during this permit term. The MMP shall be developed within 180 days of the NPDES Permit Effective Date, and shall be available for inspection on-site. A sample MMP was developed through a stakeholder review process and has been placed on the Division website for guidance (http://deq.nc.gov/about/divisions/water-resources/water-resources-permits/wastewater-branch/npdes-wastewater-permits, under NC Model Mercury Minimization Plan). The MMP should place emphasis on identification of mercury contributors and goals for reduction. Results shall be summarized and submitted with the next permit renewal. Performance of the Mercury Minimization Plan will meet the requirements of the TMDL (Total Maximum Daily Load) for mercury approved by USEPA on October 12, 2012, unless and until a Waste Load Allocation specific to this facility is developed and this NPDES permit is amended to require further actions to address the Waste Load Allocation.

A. (9.) ELECTRONIC REPORTING - DISCHARGE MONITORING REPORTS [G.S. 143-215.1 (b)]

Federal regulations require electronic submittal of all discharge monitoring reports (DMRs) and program reports. The final NPDES Electronic Reporting Rule was adopted and became effective on December 21, 2015.

NOTE: This special condition supplements or supersedes the following sections within Part II of this permit (*Standard Conditions for NPDES Permits*):

- Section B. (11.) Signatory Requirements
- Section D. (2.) Reporting
- Section D. (6.) Records Retention
- Section E. (5.) Monitoring Reports

1. <u>Reporting Requirements [Supersedes Section D. (2.) and Section E. (5.) (a)]</u>

The permittee shall report discharge monitoring data electronically using the NC DWR's Electronic Discharge Monitoring Report (eDMR) internet application.

Monitoring results obtained during the previous month(s) shall be summarized for each month and submitted monthly electronically using eDMR. The eDMR system allows permitted facilities to enter

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monitoring data and submit DMRs electronically using the internet. The eDMR system may be accessed at: https://deq.nc.gov/about/divisions/water-resources/edmr.

If a permittee is unable to use the eDMR system due to a demonstrated hardship or due to the facility being physically located in an area where less than 10 percent of the households have broadband access, then a temporary waiver from the NPDES electronic reporting requirements may be granted and discharge monitoring data may be submitted on paper DMR forms (MR 1, 1.1, 2, 3) or alternative forms approved by the Director. Duplicate signed copies shall be submitted to the following address:

NC DEQ / Division of Water Resources / Water Quality Permitting Section
ATTENTION: Central Files
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

See "How to Request a Waiver from Electronic Reporting" section below.

Regardless of the submission method, the first DMR is due on the last day of the month following the issuance of the permit or in the case of a new facility, on the last day of the month following the commencement of discharge.

Starting on **December 21, 2025**, the permittee must electronically report the following compliance monitoring data and reports, when applicable:

- Sewer Overflow/Bypass Event Reports;
- Pretreatment Program Annual Reports; and
- Clean Water Act (CWA) Section 316(b) Annual Reports.

The permittee may seek an electronic reporting waiver from the Division (see "How to Request a Waiver from Electronic Reporting" section below).

2. Electronic Submissions

In accordance with 40 CFR 122.41(l)(9), the permittee must identify the initial recipient at the time of each electronic submission. The permittee should use the EPA's website resources to identify the initial recipient for the electronic submission.

Initial recipient of electronic NPDES information from NPDES-regulated facilities means the entity (EPA or the state authorized by EPA to implement the NPDES program) that is the designated entity for receiving electronic NPDES data [see 40 CFR 127.2(b)].

EPA plans to establish a website that will also link to the appropriate electronic reporting tool for each type of electronic submission and for each state. Instructions on how to access and use the appropriate electronic reporting tool will be available as well. Information on EPA's NPDES Electronic Reporting Rule is found at:

https://www.federalregister.gov/documents/2015/10/22/2015-24954/national-pollutant-discharge-elimination-system-npdes-electronic-reporting-rule

Electronic submissions must start by the dates listed in the "Reporting Requirements" section above.

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3. How to Request a Waiver from Electronic Reporting

The permittee may seek a temporary electronic reporting waiver from the Division. To obtain an electronic reporting waiver, a permittee must first submit an electronic reporting waiver request to the Division. Requests for temporary electronic reporting waivers must be submitted in writing to the Division for written approval at least sixty (60) days prior to the date the facility would be required under this permit to begin submitting monitoring data and reports. The duration of a temporary waiver shall not exceed 5 years and shall thereupon expire. At such time, monitoring data and reports shall be submitted electronically to the Division unless the permittee re-applies for and is granted a new temporary electronic reporting waiver by the Division. Approved electronic reporting waivers are not transferrable. Only permittees with an approved reporting waiver request may submit monitoring data and reports on paper to the Division for the period that the approved reporting waiver request is effective.

Information on eDMR and the application for a temporary electronic reporting waiver are found on the following web page:

http://deq.nc.gov/about/divisions/water-resources/edmr

4. Signatory Requirements [Supplements Section B. (11.) (b) and Supersedes Section B. (11.) (d)]

All eDMRs submitted to the permit issuing authority shall be signed by a person described in Part II, Section B. (11.)(a) or by a duly authorized representative of that person as described in Part II, Section B. (11.)(b). A person, and not a position, must be delegated signatory authority for eDMR reporting purposes.

For eDMR submissions, the person signing and submitting the DMR must obtain an eDMR user account and login credentials to access the eDMR system. For more information on North Carolina's eDMR system, registering for eDMR and obtaining an eDMR user account, please visit the following web page:

http://deq.nc.gov/about/divisions/water-resources/edmr

Certification. Any person submitting an electronic DMR using the state's eDMR system shall make the following certification [40 CFR 122.22]. NO OTHER STATEMENTS OF CERTIFICATION WILL BE ACCEPTED:

"*I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.*"

5. Records Retention [Supplements Section D. (6.)]

The permittee shall retain records of all Discharge Monitoring Reports, including eDMR submissions. These records or copies shall be maintained for a period of at least 3 years from the date of the report. This period may be extended by request of the Director at any time [40 CFR 122.41].

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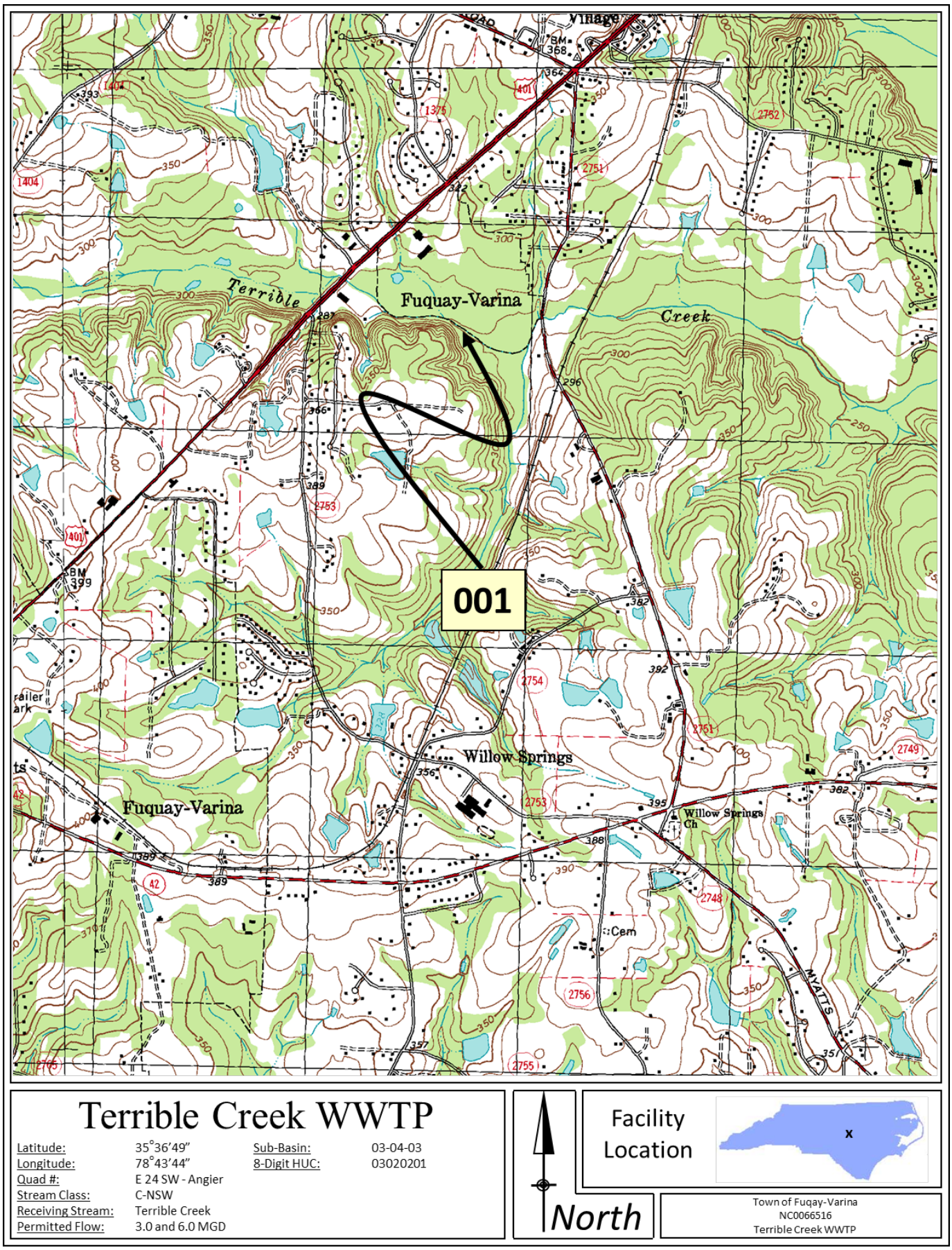

Terrible Creek WWTP

Latitude:	35°36'49"	Sub-Basin:	03-04-03
Longitude:	78°43'44"	8-Digit HUC:	03020201
Quad #:	E 24 SW - Angier		
Stream Class:	C-NSW		
Receiving Stream:	Terrible Creek		
Permitted Flow:	3.0 and 6.0 MGD		

North

Facility Location

Town of Fuquay-Varina
NC0066516
Terrible Creek WWTP

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PART II
STANDARD CONDITIONS FOR NPDES PERMITS

Section A. Definitions

2/Month
Samples are collected twice per month with at least ten calendar days between sampling events. These samples shall be representative of the wastewater discharged during the sample period.

3/Week
Samples are collected three times per week on three separate calendar days. These samples shall be representative of the wastewater discharged during the sample period.

Act or "the Act"
The Federal Water Pollution Control Act, also known as the Clean Water Act (CWA), as amended, 33 USC 1251, et. seq.

Annual Average
The arithmetic mean of all "daily discharges" of a pollutant measured during the calendar year. In the case of fecal coliform, the geometric mean of such discharges.

Arithmetic Mean
The summation of the individual values divided by the number of individual values.

Bypass
The known diversion of waste streams from any portion of a treatment facility including the collection system, which is not a designed or established or operating mode for the facility.

Calendar Day
The period from midnight of one day until midnight of the next day. However, for purposes of this permit, any consecutive 24-hour period that reasonably represents the calendar day may be used for sampling.

Calendar Week
The period from Sunday through the following Saturday.

Calendar Quarter
One of the following distinct periods: January through March, April through June, July through September, and October through December.

Composite Sample
A sample collected over a 24-hour period by continuous sampling or combining grab samples of at least 100 mL in such a manner as to result in a total sample representative of the wastewater discharge during the sample period. The Director may designate the most appropriate method (specific number and size of aliquots necessary, the time interval between grab samples, etc.) on a case-by-case basis. Samples may be collected manually or automatically. Composite samples may be obtained by the following methods:

(1) Continuous: a single, continuous sample collected over a 24-hour period proportional to the rate of flow.
(2) Constant time/variable volume: a series of grab samples collected at equal time intervals over a 24 hour period of discharge and combined proportional to the rate of flow measured at the time of individual sample collection, or
(3) Variable time/constant volume: a series of grab samples of equal volume collected over a 24 hour period with the time intervals between samples determined by a preset number of gallons passing the sampling point. Flow measurement between sample intervals shall be determined by use of a flow recorder and totalizer, and the preset gallon interval between sample collection fixed at no greater than 1/24 of the expected total daily flow at the treatment system, or

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(4) Constant time/constant volume: a series of grab samples of equal volume collected over a 24-hour period at a constant time interval. Use of this method requires prior approval by the Director. This method may only be used in situations where effluent flow rates vary less than 15 percent. The following restrictions also apply:

- Influent and effluent grab samples shall be of equal size and of no less than 100 milliliters
- Influent samples shall not be collected more than once per hour.
- Permittees with wastewater treatment systems whose detention time < 24 hours shall collect effluent grab samples at intervals of no greater than 20 minutes apart during any 24-hour period.
- Permittees with wastewater treatment systems whose detention time exceeds 24 hours shall collect effluent grab samples at least every six hours; there must be a minimum of four samples during a 24-hour sampling period.

Continuous flow measurement
Flow monitoring that occurs without interruption throughout the operating hours of the facility. Flow shall be monitored continually except for the infrequent times when there may be no flow or for infrequent maintenance activities on the flow device.

Daily Discharge
The discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants measured in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants expressed in other units of measurement, the "daily discharge" is calculated as the average measurement of the pollutant over the day. (40 CFR 122.2; see also "Composite Sample," above.)

Daily Maximum
The highest "daily discharge" during the calendar month.

Daily Sampling
Parameters requiring daily sampling shall be sampled 5 out of every 7 days per week unless otherwise specified in the permit. Sampling shall be conducted on weekdays except where holidays or other disruptions of normal operations prevent weekday sampling. If sampling is required for all seven days of the week for any permit parameter(s), that requirement will be so noted on the Effluent Limitations and Monitoring Page(s).

DWR or "the Division"
The Division of Water Resources, Department of Environmental Quality.

Effluent
Wastewater discharged following all treatment processes from a water pollution control facility or other point source whether treated or untreated.

EMC
The North Carolina Environmental Management Commission

EPA
The United States Environmental Protection Agency

Facility Closure
Cessation of all activities that require coverage under this NPDES permit. Completion of facility closure will allow this permit to be rescinded.

Geometric Mean
The Nth root of the product of the individual values where N = the number of individual values. For purposes of calculating the geometric mean, values of "0" (or "< [detection level]") shall be considered = 1.

Grab Sample
Individual samples of at least 100 mL collected over a period of time not exceeding 15 minutes. Grab samples can be collected manually. Grab samples must be representative of the discharge (or the receiving stream, for instream samples).

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Hazardous Substance
Any substance designated under 40 CFR Part 116 pursuant to Section 311 of the CWA.

Instantaneous flow measurement
The flow measured during the minimum time required for the flow measuring device or method to produce a result in that instance. To the extent practical, instantaneous flow measurements coincide with the collection of any grab samples required for the same sampling period so that together the samples and flow are representative of the discharge during that sampling period.

Monthly Average (concentration limit)
The arithmetic mean of all "daily discharges" of a pollutant measured during the calendar month. In the case of fecal coliform or other bacterial parameters or indicators, the geometric mean of such discharges.

Permit Issuing Authority
The Director of the Division of Water Resources.

Quarterly Average (concentration limit)
The arithmetic mean of all samples taken over a calendar quarter.

Severe property damage
Substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage excludes economic loss caused by delays in production.

Toxic Pollutant:
Any pollutant listed as toxic under Section 307(a)(1) of the CWA.

Upset
An incident beyond the reasonable control of the Permittee causing unintentional and temporary noncompliance with permit effluent limitations and/or monitoring requirements. An upset does not include noncompliance caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

Weekly Average (concentration limit)
The arithmetic mean of all "daily discharges" of a pollutant measured during the calendar week. In the case of fecal coliform or other bacterial parameters or indicators, the geometric mean of such discharges.

Section B. General Conditions

l. Duty to Comply
The Permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the CWA and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application [40 CFR 122.41].

a. The Permittee shall comply with effluent standards or prohibitions established under section 307(a) of the CWA for toxic pollutants and with standards for sewage sludge use or disposal established under section 405(d) of the CWA within the time provided in the regulations that establish these standards or prohibitions or standards for sewage sludge use or disposal, even if the permit has not yet been modified to incorporate the requirement.

b. The CWA provides that any person who violates section[s] 301, 302, 306, 307, 308, 318 or 405 of the Act, or any permit condition or limitation implementing any such sections in a permit issued under section 402, or any requirement imposed in a pretreatment program approved under sections 402(a)(3) or 402(b)(8) of the Act, is subject to a civil penalty not to exceed $37,500 per day for each violation. [33 USC 1319(d) and 40 CFR 122.41(a)(2)]

c. The CWA provides that any person who negligently violates sections 301, 302, 306, 307, 308, 318, or 405 of the Act, or any condition or limitation implementing any of such sections in a permit issued under section 402 of the Act, or any requirement imposed in a pretreatment program approved under section 402(a)(3) or 402(b)(8) of the Act, is subject to criminal penalties of $2,500 to $25,000 per day of violation, or

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imprisonment of not more than 1 year, or both. In the case of a second or subsequent conviction for a negligent violation, a person shall be subject to criminal penalties of not more than $50,000 per day of violation, or by imprisonment of not more than 2 years, or both. [33 USC 1319(c)(1) and 40 CFR 122.41(a)(2)]

d. Any person who knowingly violates such sections, or such conditions or limitations is subject to criminal penalties of $5,000 to $50,000 per day of violation, or imprisonment for not more than 3 years, or both. In the case of a second or subsequent conviction for a knowing violation, a person shall be subject to criminal penalties of not more than $100,000 per day of violation, or imprisonment of not more than 6 years, or both. [33 USC 1319(c)(2) and 40 CFR 122.41(a)(2)]

e. Any person who *knowingly* violates section 301, 302, 303, 306, 307, 308, 318 or 405 of the Act, or any permit condition or limitation implementing any of such sections in a permit issued under section 402 of the Act, and who knows at that time that he thereby places another person in imminent danger of death or serious bodily injury, shall, upon conviction, be subject to a fine of not more than $250,000 or imprisonment of not more than 15 years, or both. In the case of a second or subsequent conviction for a knowing endangerment violation, a person shall be subject to a fine of not more than $500,000 or by imprisonment of not more than 30 years, or both. An organization, as defined in section 309(c)(3)(B)(iii) of the CWA, shall, upon conviction of violating the imminent danger provision, be subject to a fine of not more than $1,000,000 and can be fined up to $2,000,000 for second or subsequent convictions. [40 CFR 122.41(a)(2)]

f. Under state law, a civil penalty of not more than $25,000 per violation may be assessed against any person who violates or fails to act in accordance with the terms, conditions, or requirements of a permit. [North Carolina General Statutes § 143-215.6A]

g. Any person may be assessed an administrative penalty by the Administrator for violating section 301, 302, 306, 307, 308, 318 or 405 of this Act, or any permit condition or limitation implementing any of such sections in a permit issued under section 402 of this Act. Administrative penalties for Class I violations are not to exceed $16,000 per violation, with the maximum amount of any Class I penalty assessed not to exceed $37,500. Penalties for Class II violations are not to exceed $16,000 per day for each day during which the violation continues, with the maximum amount of any Class II penalty not to exceed $177,500. [33 USC 1319(g)(2) and 40 CFR 122.41(a)(3)]

2. Duty to Mitigate
The Permittee shall take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit with a reasonable likelihood of adversely affecting human health or the environment [40 CFR 122.41(d)].

3. Civil and Criminal Liability
Except as provided in permit conditions on "Bypassing" (Part II.C.4), “Upsets” (Part II.C.5) and "Power Failures" (Part II.C.7), nothing in this permit shall be construed to relieve the Permittee from any responsibilities, liabilities, or penalties for noncompliance pursuant to NCGS 143-215.3, 143-215.6 or Section 309 of the Federal Act, 33 USC 1319. Furthermore, the Permittee is responsible for consequential damages, such as fish kills, even though the responsibility for effective compliance may be temporarily suspended.

4. Oil and Hazardous Substance Liability
Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the Permittee from any responsibilities, liabilities, or penalties to which the Permittee is or may be subject to under NCGS 143-215.75 et seq. or Section 311 of the Federal Act, 33 USG 1321. Furthermore, the Permittee is responsible for consequential damages, such as fish kills, even though the responsibility for effective compliance may be temporarily suspended.

5. Property Rights
The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations [40 CFR 122.41(g)].

6. Onshore or Offshore Construction
This permit does not authorize or approve the construction of any onshore or offshore physical structures or facilities or the undertaking of any work in any navigable waters.

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7. Severability
   The provisions of this permit are severable. If any provision of this permit, or the application of any provision of this permit to any circumstances, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby [NCGS 150B-23].

8. Duty to Provide Information
   The Permittee shall furnish to the Permit Issuing Authority, within a reasonable time, any information which the Permit Issuing Authority may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. The Permittee shall also furnish to the Permit Issuing Authority upon request, copies of records required by this permit [40 CFR 122.41(h)].

9. Duty to Reapply
   If the Permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the Permittee must apply for and obtain a new permit [40 CFR 122.41(b)].

10. Expiration of Permit
    The Permittee is not authorized to discharge after the expiration date. In order to receive automatic authorization to discharge beyond the expiration date, the Permittee shall submit such information, forms, and fees as are required by the agency authorized to issue permits no later than 180 days prior to the expiration date unless permission for a later date has been granted by the Director. (The Director shall not grant permission for applications to be submitted later than the expiration date of the existing permit.) [40 CFR 122.21(d)] Any Permittee that has not requested renewal at least 180 days prior to expiration, or any Permittee that does not have a permit after the expiration and has not requested renewal at least 180 days prior to expiration, will subject the Permittee to enforcement procedures as provided in NCGS 143-215.6 and 33 USC 1251 et. seq.

11. Signatory Requirements
    All applications, reports, or information submitted to the Permit Issuing Authority shall be signed and certified [40 CFR 122.41(k)].

    a. All permit applications shall be signed as follows:
       (1) For a corporation: by a responsible corporate officer. For the purpose of this Section, a responsible corporate officer means: (a) a president, secretary, treasurer or vice president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision making functions for the corporation, or (b) the manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures .
       (2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or
       (3) For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official [40 CFR 122.22].

    b. All reports required by the permit and other information requested by the Permit Issuing Authority shall be signed by a person described in paragraph a. above or by a duly authorized representative of that person. A person is a duly authorized representative only if:
       (1) The authorization is made in writing by a person described above;
       (2) The authorization specified either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of plant manager, operator of a well or well field, superintendent, a position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.); and
       (3) The written authorization is submitted to the Permit Issuing Authority [40 CFR 122.22]

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c. Changes to authorization: If an authorization under paragraph (b) of this section is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph (b) of this section must be submitted to the Director prior to or together with any reports, information, or applications to be signed by an authorized representative [40 CFR 122.22]

d. Certification. Any person signing a document under paragraphs a. or b. of this section shall make the following certification [40 CFR 122.22]. NO OTHER STATEMENTS OF CERTIFICATION WILL BE ACCEPTED:

"I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations."

12. Permit Actions
This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the Permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition [40 CFR 122.41(f)].

13. Permit Modification, Revocation and Reissuance, or Termination
The issuance of this permit does not prohibit the permit issuing authority from reopening and modifying the permit, revoking and reissuing the permit, or terminating the permit as allowed by the laws, rules, and regulations contained in Title 40, Code of Federal Regulations, Parts 122 and 123; Title 15A of the North Carolina Administrative Code, Subchapter 02H .0100; and North Carolina General Statute 143.215.1 et. al.

14. Annual Administering and Compliance Monitoring Fee Requirements
The Permittee must pay the annual administering and compliance monitoring fee within thirty days after being billed by the Division. Failure to pay the fee in a timely manner in accordance with 15A NCAC 02H .0105(b)(2) may cause this Division to initiate action to revoke the permit.

Section C. Operation and Maintenance of Pollution Controls

1. Certified Operator
Owners of classified water pollution control systems must designate operators, certified by the Water Pollution Control System Operators Certification Commission (WPCSOCC), of the appropriate type and grade for the system, and, for each classification must [T15A NCAC 08G .0201]:

a. designate one Operator In Responsible Charge (ORC) who possesses a valid certificate of the type and grade at least equivalent to the type and grade of the system;

b. designate one or more Back-up Operator(s) in Responsible Charge (Back-up ORCs) who possesses a valid certificate of the type of the system and no more than one grade less than the grade of the system, with the exception of no backup operator in responsible charge is required for systems whose minimum visitation requirements are twice per year; and

c. submit a signed completed "Water Pollution Control System Operator Designation Form" to the Commission (or to the local health department for owners of subsurface systems) countersigned by the designated certified operators, designating the Operator in Responsible Charge (ORC) and the Back-up Operator in Responsible Charge (Back-up ORC):

(1) 60 calendar days prior to wastewater or residuals being introduced into a new system; or

(2) within 120 calendar days following:

- receiving notification of a change in the classification of the system requiring the designation of a new Operator in Responsible Charge (ORC) and Back-up Operator in Responsible Charge (Back-up ORC) of the proper type and grade; or
- a vacancy in the position of Operator in Responsible Charge (ORC) or Back-up Operator in Responsible Charge (Back-up ORC).

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(3) within seven calendar days of vacancies in both ORC and Back-up ORC positions replacing or designating at least one of the responsibilities.

The ORC of each Class I facility (or the Back-up ORC, when acting as surrogate for the ORC) must:

- Visit the facility as often as is necessary to insure proper operation of the treatment system; the treatment facility must be visited at least weekly
- Comply with all other conditions of 15A NCAC 08G .0204.

The ORC of each Class II, III and IV facility (or the Back-up ORC, when acting as surrogate for the ORC) must:

- Visit the facility as often as is necessary to insure proper operation of the treatment system; the treatment facility must be visited at least five days per week, excluding holidays
- Properly manage and document daily operation and maintenance of the facility
- Comply with all other conditions of 15A NCAC 08G .0204.

2. Proper Operation and Maintenance

The Permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the Permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the Permittee to install and operate backup or auxiliary facilities only when necessary to achieve compliance with the conditions of the permit [40 CFR 122.41(e)].

NOTE: Properly and officially designated operators are fully responsible for all proper operation and maintenance of the facility, and all documentation required thereof, whether acting as a contract operator [subcontractor] or a member of the Permittee's staff.

3. Need to Halt or Reduce not a Defense

It shall not be a defense for a Permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the condition of this permit [40 CFR 122.41(c)].

4. Bypassing of Treatment Facilities

a. Bypass not exceeding limitations [40 CFR 122.41(m)(2)]

The Permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of Paragraphs b. and c. of this section.

b. Notice [40 CFR 122.41(m)(3)]

(1) Anticipated bypass. If the Permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least ten days before the date of the bypass; including an evaluation of the anticipated quality and effect of the bypass.

(2) Unanticipated bypass. The Permittee shall submit notice of an unanticipated bypass as required in Part II.E.6. (24-hour notice).

c. Prohibition of Bypass

(1) Bypass from the treatment facility is prohibited and the Permit Issuing Authority may take enforcement action against a Permittee for bypass, unless:

(A) Bypass was unavoidable to prevent loss of life, personal injury or severe property damage;

(B) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

(C) The Permittee submitted notices as required under Paragraph b. of this section.

(2) Bypass from the collection system is prohibited and the Permit Issuing Authority may take enforcement action against a Permittee for a bypass as provided in any current or future system-wide collection system permit associated with the treatment facility.

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(3) The Permit Issuing Authority may approve an anticipated bypass, after considering its adverse effects, if the Permit Issuing Authority determines that it will meet the three conditions listed above in Paragraph c. (1) of this section.

5. Upsets
   a. Effect of an upset [40 CFR 122.41(n)(2)]: An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of paragraph b. of this condition are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.
   b. Conditions necessary for a demonstration of upset: Any Permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:
      (1) An upset occurred and that the Permittee can identify the cause(s) of the upset;
      (2) The Permittee facility was at the time being properly operated; and
      (3) The Permittee submitted notice of the upset as required in Part II.E.6.(b) of this permit.
      (4) The Permittee complied with any remedial measures required under Part II.B.2. of this permit.
   c. Burden of proof [40 CFR 122.41(n)(4)]: The Permittee seeking to establish the occurrence of an upset has the burden of proof in any enforcement proceeding.

6. Removed Substances
   Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be utilized/disposed of in accordance with NCGS 143-215.1 and in a manner such as to prevent any pollutant from such materials from entering waters of the State or navigable waters of the United States except as permitted by the Commission. The Permittee shall comply with all applicable state and Federal regulations governing the disposal of sewage sludge, including 40 CFR 503, Standards for the Use and Disposal of Sewage Sludge; 40 CFR Part 258, Criteria For Municipal Solid Waste Landfills; and 15A NCAC Subchapter 2T, Waste Not Discharged To Surface Waters. The Permittee shall notify the Permit Issuing Authority of any significant change in its sludge use or disposal practices.

7. Power Failures
   The Permittee is responsible for maintaining adequate safeguards (as required by 15A NCAC 02H .0124) to prevent the discharge of untreated or inadequately treated wastes during electrical power failures either by means of alternate power sources, standby generators or retention of inadequately treated effluent.

Section D. Monitoring and Records

l. Representative Sampling
   Samples collected and measurements taken, as required herein, shall be representative of the permitted discharge. Samples collected at a frequency less than daily shall be taken on a day and time that is representative of the discharge for the period the sample represents. All samples shall be taken at the monitoring points specified in this permit and, unless otherwise specified, before the effluent joins or is diluted by any other wastestream, body of water, or substance. Monitoring points shall not be changed without notification to and the approval of the Permit Issuing Authority [40 CFR 122.41(j)].

2. Reporting
   Monitoring results obtained during the previous month(s) shall be summarized for each month and reported on a monthly Discharge Monitoring Report (DMR) Form (MR 1, 1.1, 2, 3) or alternative forms approved by the Director, postmarked no later than the last calendar day of the month following the completed reporting period.

   The first DMR is due on the last day of the month following the issuance of the permit or in the case of a new facility, on the last day of the month following the commencement of discharge. Duplicate signed copies of these, and all other reports required herein, shall be submitted to the following address:

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NC DEQ / Division of Water Resources / Water Quality Permitting Section
ATTENTION: Central Files
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

3. Flow Measurements
Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to ensure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated and maintained to ensure that the accuracy of the measurements is consistent with the accepted capability of that type of device. Devices selected shall be capable of measuring flows with a maximum deviation of less than 10% from the true discharge rates throughout the range of expected discharge volumes. Flow measurement devices shall be accurately calibrated at a minimum of once per year and maintained to ensure that the accuracy of the measurements is consistent with the accepted capability of that type of device. The Director shall approve the flow measurement device and monitoring location prior to installation.

Once-through condenser cooling water flow monitored by pump logs, or pump hour meters as specified in Part I of this permit and based on the manufacturer's pump curves shall not be subject to this requirement.

4. Test Procedures
Laboratories used for sample analysis must be certified by the Division. Permittees should contact the Division's Laboratory Certification Section (919 733-3908) or visit https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/laboratory-certification-branch for information regarding laboratory certifications.

Facilities whose personnel are conducting testing of field-certified parameters only must hold the appropriate field parameter laboratory certifications.

Test procedures for the analysis of pollutants shall conform to the EMC regulations (published pursuant to NCGS 143-215.63 et. seq.), the Water and Air Quality Reporting Acts, and to regulations published pursuant to Section 304(g), 33 USC 1314, of the CWA (as amended), and 40 CFR 136; or in the case of sludge use or disposal, approved under 40 CFR 136, unless otherwise specified in 40 CFR 503, unless other test procedures have been specified in this permit [40 CFR 122.41].

To meet the intent of the monitoring required by this permit, all test procedures must produce minimum detection and reporting levels that are below the permit discharge requirements and all data generated must be reported down to the minimum detection or lower reporting level of the procedure. If no approved methods are determined capable of achieving minimum detection and reporting levels below permit discharge requirements, then the most sensitive (method with the lowest possible detection and reporting level) approved method must be used.

5. Penalties for Tampering
The CWA provides that any person who falsifies, tampers with, or knowingly renders inaccurate, any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than two years per violation, or by both. If a conviction of a person is for a violation committed after a first conviction of such person under this paragraph, punishment is a fine of not more than $20,000 per day of violation, or by imprisonment of not more than 4 years, or both [40 CFR 122.41].

6. Records Retention
Except for records of monitoring information required by this permit related to the Permittee's sewage sludge use and disposal activities, which shall be retained for a period of at least five years (or longer as required by 40 CFR 503), the Permittee shall retain records of all monitoring information, including:

- all calibration and maintenance records
- all original strip chart recordings for continuous monitoring instrumentation
- copies of all reports required by this permit
- copies of all data used to complete the application for this permit

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These records or copies shall be maintained for a period of at least 3 years from the date of the sample, measurement, report or application. This period may be extended by request of the Director at any time [40 CFR 122.41].

7. Recording Results
For each measurement or sample taken pursuant to the requirements of this permit, the Permittee shall record the following information [40 CFR 122.41]:

   a. The date, exact place, and time of sampling or measurements;
   b. The individual(s) who performed the sampling or measurements;
   c. The date(s) analyses were performed;
   d. The individual(s) who performed the analyses;
   e. The analytical techniques or methods used; and
   f. The results of such analyses.

8. Inspection and Entry
The Permittee shall allow the Director, or an authorized representative (including an authorized contractor acting as a representative of the Director), upon the presentation of credentials and other documents as may be required by law, to;

   a. Enter, at reasonable times, upon the Permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;
   b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
   c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and
   d. Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the CWA, any substances or parameters at any location [40 CFR 122.41(i)].

Section E Reporting Requirements

l. Change in Discharge
All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit.

2. Planned Changes
The Permittee shall give notice to the Director as soon as possible of any planned physical alterations or additions to the permitted facility [40 CFR 122.41(l)]. Notice is required only when:

   a. The alteration or addition to a permitted facility may meet one of the criteria for new sources at 40 CFR 122.29(b); or
   b. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants subject neither to effluent limitations in the permit, nor to notification requirements under 40 CFR 122.42(a)(1); or
   c. The alteration or addition results in a significant change in the Permittee’s sludge use or disposal practices, and such alteration, addition or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan.

3. Anticipated Noncompliance
The Permittee shall give advance notice to the Director of any planned changes to the permitted facility or other activities that might result in noncompliance with the permit [40 CFR 122.41(l)(2)].

4. Transfers
This permit is not transferable to any person without prior written notice to and approval from the Director in accordance with 40 CFR 122.61. The Director may condition approval in accordance with NCGS 143-215.1, in

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particular NCGS 143-215.1(b)(4)b.2., and may require modification or revocation and reissuance of the permit, or a minor modification, to identify the new permittee and incorporate such other requirements as may be necessary under the CWA [40 CFR 122.41(l)(3), 122.61] or state statute.

5. Monitoring Reports
Monitoring results shall be reported at the intervals specified elsewhere in this permit [40 CFR 122.41(l)(4)].
   a. Monitoring results must be reported on a Discharge Monitoring Report (DMR) (See Part II.D.2) or forms provided by the Director for reporting results of monitoring of sludge use or disposal practices.
   b. If the Permittee monitors any pollutant more frequently than required by this permit using test procedures approved under 40 CFR Part 136 and at a sampling location specified in this permit or other appropriate instrument governing the discharge, the results of such monitoring shall be included in the calculation and reporting of the data submitted on the DMR.
6. Twenty-four Hour Reporting
   a. The Permittee shall report to the Director or the appropriate Regional Office any noncompliance that potentially threatens public health or the environment. Any information shall be provided orally within 24 hours from the time the Permittee became aware of the circumstances. A written submission shall also be provided within 5 days of the time the Permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance, and its cause; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance [40 CFR 122.41(l)(6)].
   b. The Director may waive the written report on a case-by-case basis for reports under this section if the oral report has been received within 24 hours.
   c. Occurrences outside normal business hours may also be reported to the Division's Emergency Response personnel at (800) 858-0368 or (919) 733-3300.
7. Other Noncompliance
The Permittee shall report all instances of noncompliance not reported under Part II.E.5 and 6. of this permit at the time monitoring reports are submitted. The reports shall contain the information listed in Part II.E.6. of this permit [40 CFR 122.41(l)(7)].
8. Other Information
Where the Permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Director, it shall promptly submit such facts or information [40 CFR 122.41(l)(8)].
9. Noncompliance Notification
The Permittee shall report by telephone to either the central office or the appropriate regional office of the Division as soon as possible, but in no case more than 24 hours or on the next working day following the occurrence or first knowledge of the occurrence of any of the following:
   a. Any occurrence at the water pollution control facility which results in the discharge of significant amounts of wastes which are abnormal in quantity or characteristic, such as the dumping of the contents of a sludge digester; the known passage of a slug of hazardous substance through the facility; or any other unusual circumstances.
   b. Any process unit failure, due to known or unknown reasons, that render the facility incapable of adequate wastewater treatment such as mechanical or electrical failures of pumps, aerators, compressors, etc.
   c. Any failure of a pumping station, sewer line, or treatment facility resulting in a by-pass without treatment of all or any portion of the influent to such station or facility.

   Persons reporting such occurrences by telephone shall also file a written report within 5 days following first knowledge of the occurrence. Also see reporting requirements for municipalities in Part IV.C.2.c. of this permit.
10. Availability of Reports
Except for data determined to be confidential under NCGS 143-215.3 (a)(2) or Section 308 of the Federal Act, 33 USC 1318, all reports prepared in accordance with the terms shall be available for public inspection at the offices

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of the Division. As required by the Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in NCGS 143-215.1(b)(2) or in Section 309 of the Federal Act.

11. Penalties for Falsification of Reports
The CWA provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance shall, upon conviction, be punished by a fine of not more than $25,000 per violation, or by imprisonment for not more than two years per violation, or by both [40 CFR 122.41].

12. Annual Performance Reports
Permittees who own or operate facilities that primarily collect or treat municipal or domestic wastewater and have an average annual flow greater than 200,000 gallons per day shall provide an annual report to the Permit Issuing Authority and to the users/customers served by the Permittee (NCGS 143-215.1C). The report shall summarize the performance of the collection or treatment system, as well as the extent to which the facility was compliant with applicable Federal or State laws, regulations and rules pertaining to water quality. The report shall be provided no later than sixty days after the end of the calendar or fiscal year, depending upon which annual period is used for evaluation.

The report shall be sent to:

NC DEQ / Division of Water Resources / Water Quality Permitting Section
ATTENTION: Central Files
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

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PART III
OTHER REQUIREMENTS

Section A. Construction

a. The Permittee shall not commence construction of wastewater treatment facilities, nor add to the plant's treatment capacity, nor change the treatment process(es) utilized at the treatment plant unless (1) the Division has issued an Authorization to Construct (AtC) permit or (2) the Permittee is exempted from such AtC permit requirements under Item b. of this Section.

b. In accordance with NCGS 143-215.1(a5) [SL 2011-394], no permit shall be required to enter into a contract for the construction, installation, or alteration of any treatment work or disposal system or to construct, install, or alter any treatment works or disposal system within the State when the system's or work's principle function is to conduct, treat, equalize, neutralize, stabilize, recycle, or dispose of industrial waste or sewage from an industrial facility and the discharge of the industrial waste or sewage is authorized under a permit issued for the discharge of the industrial waste or sewage into the waters of the State. Notwithstanding the above, the permit issued for the discharge may be modified if required by federal regulation.

c. Issuance of an AtC will not occur until Final Plans and Specifications for the proposed construction have been submitted by the Permittee and approved by the Division.

Section B. Groundwater Monitoring

The Permittee shall, upon written notice from the Director, conduct groundwater monitoring as may be required to determine the compliance of this NPDES permitted facility with the current groundwater standards.

Section C. Changes in Discharges of Toxic Substances

The Permittee shall notify the Permit Issuing Authority as soon as it knows or has reason to believe (40 CFR 122.42):

a. That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels";

   (1) One hundred micrograms per liter (100 µg/L);

   (2) Two hundred micrograms per liter (200 µg/L) for acrolein and acrylonitrile; five hundred micrograms per liter (500 µg/L) for 2,4-dinitrophenol and for 2-methyl-4,6-dinitrophenol; and one milligram per liter (1 mg/L) for antimony;

   (3) Five times the maximum concentration value reported for that pollutant in the permit application.

b. That any activity has occurred or will occur which would result in any discharge, on a non-routine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels";

   (1) Five hundred micrograms per liter (500 µg/L);

   (2) One milligram per liter (1 mg/L) for antimony;

   (3) Ten times the maximum concentration value reported for that pollutant in the permit application.

Section D. Facility Closure Requirements

The Permittee must notify the Division at least 90 days prior to the closure of any wastewater treatment system covered by this permit. The Division may require specific measures during deactivation of the system to prevent adverse impacts to waters of the State. This permit cannot be rescinded while any activities requiring this permit continue at the permitted facility.

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PART IV
SPECIAL CONDITIONS FOR MUNICIPAL FACILITIES

Section A. Definitions

In addition to the definitions in Part II of this permit, the following definitions apply to municipal facilities:

Indirect Discharge or Industrial User
Any non-domestic source that discharges wastewater containing pollutants into a POTW regulated under section 307(b), (c) or (d) of the CWA. [40 CFR 403.3 (i) and (j) and 15A NCAC 02H .0903(b)(11)]

Interference
Inhibition or disruption of the POTW treatment processes; operations; or its sludge process, use, or disposal which causes or contributes to a violation of any requirement of the Permittee's (or any satellite POTW's if different from the Permittee) NPDES, collection system, or non-discharge permit or prevents sewage sludge use or disposal in compliance with specified applicable State and Federal statutes, regulations, or permits. [15A NCAC 02H .0903(b)(14)]

Pass Through
A discharge which exits the POTW into waters of the State in quantities or concentrations which, alone or with discharges from other sources, causes a violation, including an increase in the magnitude or duration of a violation, of the Permittee's (or any satellite POTW's, if different from the Permittee) NPDES, collection system, or non-discharge permit. [15A NCAC 02H .0903(b)(23)]

Publicly Owned Treatment Works (POTW)
A treatment works as defined by Section 212 of the CWA, which is owned by a State or local government organization. This definition includes any devices and systems used in the storage, treatment, recycling and reclamation of municipal sewage or industrial wastes of a liquid nature. It also includes the collection system, as defined in 15A NCAC 2T .0402, only if it conveys wastewater to a POTW treatment plant. The term also means the local government organization, or municipality, as defined in section 502(4) of the CWA, which has jurisdiction over indirect discharges to and the discharges from such a treatment works. In this context, the organization may be the owner of the POTW treatment plant or the owner of the collection system into which an indirect discharger discharges. This second type of POTW may be referred to as a "satellite POTW organization." [15A NCAC 02H .0903(b)(26)]

"Significant Industrial User" or "SIU"
An Industrial User that discharges wastewater into a publicly owned treatment works and that [15A NCAC 02H .0903(b)(33)]:

1. Discharges an average of 25,000 gallons per day or more of process wastewater to the POTW (excluding sanitary, noncontact cooling and boiler blowdown wastewaters); or
2. Contributes process wastewater which makes up five percent or more of the NPDES or non-discharge permitted flow limit or organic capacity of the POTW treatment plant. In this context, organic capacity refers to BOD, TSS and ammonia; or
3. Is subject to categorical standards under 40 CFR Part 403.6 and 40 CFR Parts 405-471; or
4. Is designated as such by the Permittee on the basis that the Industrial User has a reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement, or the POTW's effluent limitations and conditions in its NPDES or non-discharge permit, or to limit the POTW's sludge disposal options;
5. Subject to approval under 15A NCAC 02H .0907(b), the Permittee may determine that an Industrial User meeting the criteria in paragraphs 1 or 2 of this definition above has no reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement, the POTW's effluent limitations and conditions in its NPDES or non-discharge permit, or to limit the POTW's sludge disposal options, and thus is not a Significant Industrial User (SIU); or
6. Subject to approval under 15A NCAC 02H .0907(b), the Permittee may determine that an Industrial User meeting the criteria in paragraph 3 of this definition above meets the requirements of 40 CFR Part 403.3(v)(2) and thus is a non-significant categorical Industrial User.

Section B. Publicly Owned Treatment Works (POTWs)

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All POTWs must provide adequate notice to the Director of the following [40 CFR 122.42(b)]:

1. Any new introduction of pollutants into the POTW from an indirect discharger, regardless of the means of transport, which would be subject to section 301 or 306 of CWA if it were directly discharging those pollutants; and
2. Any substantial change in the volume or character of pollutants being introduced by an indirect discharger as influent to that POTW at the time of issuance of the permit.
3. For purposes of this paragraph, adequate notice shall include information on (1) the quality and quantity of effluent introduced into the POTW, and (2) any anticipated impact that may result from the change of the quantity or quality of effluent to be discharged from the POTW.

Section C. Municipal Control of Pollutants from Industrial Users.

1. Effluent limitations are listed in Part I of this permit. Other pollutants attributable to inputs from Industrial Users discharging to the POTW may be present in the Permittee's discharge. At such time as sufficient information becomes available to establish limitations for such pollutants, this permit may be revised to specify effluent limitations for any or all of such other pollutants in accordance with best practicable technology or water quality standards.
2. Prohibited Discharges
   a. The Permittee shall develop and enforce their Pretreatment Program to implement the prohibition against the introduction of pollutants or discharges into the waste treatment system or waste collection system which cause or contribute to Pass Through or Interference as defined in 15A NCAC 02H .0900 and 40 CFR 403. [40 CFR 403.5(a)(1)]
   b. The Permittee shall develop and enforce their Pretreatment Program to implement the prohibitions against the introduction of the following wastes in the waste treatment or waste collection system [40 CFR 403.5(b)]:
      (1) Pollutants which create a fire or explosion hazard in the POTW, including, but not limited to, wastestreams with a closed cup flashpoint of less than 140 degrees Fahrenheit or 60 degrees Centigrade using the test methods specified in 40 CFR 261.21;
      (2) Pollutants which cause corrosive structural damage to the POTW, but in no case discharges with pH lower than 5.0, unless the works is specifically designed to accommodate such discharges;
      (3) Solid or viscous pollutants in amounts which cause obstruction to the flow in the POTW resulting in Interference;
      (4) Any pollutant, including oxygen demanding pollutants (BOD, etc.) released in a Discharge at a flow rate and/or pollutant concentration which will cause Interference with the POTW;
      (5) Heat in amounts which will inhibit biological activity in the POTW resulting in Interference, but in no case heat in such quantities that the temperature at the POTW Treatment Plant exceeds 40°C (104°F) unless the Division, upon request of the POTW, approves alternate temperature limits;
      (6) Petroleum oil, non-biodegradable cutting oil, or products of mineral oil origin in amounts that will cause Interference or Pass Through;
      (7) Pollutants which result in the presence of toxic gases, vapors, or fumes within the POTW in a quantity that may cause acute worker health and safety problems; or
      (8) Any trucked or hauled pollutants, except at discharge points designated by the POTW.
   c. The Permittee shall investigate the source of all discharges into the POTW, including slug loads and other unusual discharges, which have the potential to adversely impact the Permittee's Pretreatment Program and/or the operation of the POTW.

      The Permittee shall report such discharges into the POTW to the Director or the appropriate Regional Office. Any information shall be provided orally within 24 hours from the time the Permittee became aware of the circumstances. A written submission shall also be provided within 5 days of the time the Permittee becomes aware of the circumstances. The written submission shall contain a description of the discharge; the investigation into possible sources; the period of the discharge, including exact dates and times; if the discharge has not ceased, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance,

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3. With regard to the effluent requirements listed in Part I of this permit, it may be necessary for the Permittee to supplement the requirements of the Federal Pretreatment Standards (40 CFR, Part 403) to ensure compliance by the Permittee with all applicable effluent limitations. Such actions by the Permittee may be necessary regarding some or all of the industries discharging to the municipal system.
4. The Permittee shall require any Industrial User (IU) discharging to the POTW to meet Federal Pretreatment Standards developed under Section 307(b) of the Act as amended (which includes categorical standards and specific local limits, best management practices and narrative requirements). Prior to accepting wastewater from any Significant Industrial User (SIU), the Permittee shall either develop and submit to the Division a new Pretreatment Program or, as necessary, a modification of an existing Pretreatment Program, for approval as required under section D below as well as 15A NCAC 02H .0907(a) and (b). [40 CFR 122.44(j)(2)]
5. This permit shall be modified, or alternatively, revoked and reissued, to incorporate or modify an approved POTW Pretreatment Program or to include a compliance schedule for the development of a POTW Pretreatment Program as required under Section 402 (b)(8) of the CWA and implementing regulations or by the requirements of the approved State pretreatment program, as appropriate.

Section D. Pretreatment Programs

Under authority of sections 307 (b) and (c) and 402(b)(8) of the CWA and implementing regulations 40 CFR 403, North Carolina General Statute 143-215.3(14) and implementing regulations 15A NCAC 02H .0900, and in accordance with the approved pretreatment program, all provisions and regulations contained and referenced in the pretreatment program submittal are an enforceable part of this permit. [40 CFR 122.44(j)(2)]

The Permittee shall operate its approved pretreatment program in accordance with Section 402(b)(8) of the CWA, 40 CFR 403, 15A NCAC 02H .0900, and the legal authorities, policies, procedures, and financial provisions contained in its pretreatment program submission and Division approved modifications thereof. Such operation shall include but is not limited to the implementation of the following conditions and requirements. Terms not defined in Part II or Part IV of this permit are as defined in 15A NCAC 02H .0903 and 40 CFR 403.3.

1. Sewer Use Ordinance (SUO)
   The Permittee shall maintain adequate legal authority to implement its approved pretreatment program. [15A NCAC 02H .0903(b)(32), .0905 and .0906(b)(1); 40 CFR 403.8(f)(1) and 403.9(b)(1) and (2)]

2. Industrial Waste Survey (IWS)
   The Permittee shall implement an IWS consisting of the survey of users of the POTW collection system or treatment plant, as required by 40 CFR 403.8(f)(2)(i-iii) and 15A NCAC 02H .0905 [also 40 CFR 122.44(j)(1)], including identification of all Industrial Users that may have an impact on the POTW and the character and amount of pollutants contributed to the POTW by these Industrial Users and identification of those Industrial Users meeting the definition of SIU. Where the Permittee accepts wastewater from one or more satellite POTWs, the IWS for the Permittee shall address all satellite POTW services areas, unless the pretreatment program in those satellite service areas is administered by a separate Permittee with an approved Pretreatment Program. The Permittee shall submit a summary of its IWS activities to the Division at least once every five years, and as required by the Division. The IWS submission shall include a summary of any investigations conducted under paragraph C.2.c. of this Part. [15A NCAC 02H .0903(b)(13), .0905 and .0906(b)(2); 40 CFR 403.8(f)(2) and 403.9]

3. Monitoring Plan
   The Permittee shall implement a Division-approved Monitoring Plan for the collection of facility specific data to be used in a wastewater treatment plant Headworks Analysis (HWA) for the development of specific pretreatment local limits. Effluent data from the Plan shall be reported on the DMRs (as required by Parts II.D and II.E.5.). [15A NCAC 02H .0903(b)(16), .0906(b)(3) and .0905]

4. Headworks Analysis (HWA) and Local Limits
   The Permittee shall obtain Division approval of a HWA at least once every five years, and as required by the Division. Within 180 days of the effective date of this permit (or any subsequent permit modification) the Permittee shall submit to the Division a written technical evaluation of the need to revise local limits (i.e., an updated HWA or documentation of why one is not needed) [40 CFR 122.44]. The Permittee shall develop, in accordance with 40 CFR 403.5(c) and 15A NCAC 02H .0909, specific Local Limits to implement the prohibitions listed in 40 CFR 403.5(a) and (b) and 15A NCAC 02H .0909. Pursuant to 40 CFR 403.5, local limits are

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enforceable Pretreatment Standards as defined by 40 CFR 403.3(1). [15A NCAC 02H .0903(b)(10), .0905, and .0906(b)(4)]

5. Industrial User Pretreatment Permits (IUP) & Allocation Tables
In accordance with NCGS 143-215.1, the Permittee shall issue to all Significant Industrial Users, permits for operation of pretreatment equipment and discharge to the Permittee's collection system or treatment works. These permits shall contain limitations, sampling protocols, reporting requirements, appropriate standard and special conditions, and compliance schedules as necessary for the installation of treatment and control technologies to assure that their wastewater discharge will meet all applicable pretreatment standards and requirements. The Permittee shall maintain a current Allocation Table (AT) which summarizes the results of the HWA and the limits from all IUPs. Permitted IUP loadings for each parameter cannot exceed the treatment capacity of the POTW as determined by the HWA. [15A NCAC 02H .0906(b)(6), .0909, .0916, and .0917; 40 CFR 403.5, 403.8(f)(1)(iii); NCGS 143-215.67(a)]

6. Authorization to Construct (AtC)
The Permittee shall ensure that an Authorization to Construct permit (AtC) is issued to all applicable Industrial Users for the construction or modification of any pretreatment facility. Prior to the issuance of an AtC, the proposed pretreatment facility and treatment process must be evaluated for its capacity to comply with all Industrial User Pretreatment Permit (IUP) limitations. [15A NCAC 02H .0906(b)(7) and .0905; NCGS 143-215.1(a)(8)]

7. POTW Inspection & Monitoring of their IUs
The Permittee shall conduct inspection, surveillance, and monitoring activities as described in its Division approved pretreatment program in order to determine, independent of information supplied by Industrial Users, compliance with applicable pretreatment standards. [15A NCAC 02H .0908(e); 40 CFR 403.8(f)(2)(v)] The Permittee must:

   a. Inspect all Significant Industrial Users (SIUs) at least once per calendar year;
   b. Sample all Significant Industrial Users (SIUs) at least once per calendar year for all SIU permit-limited parameters including flow except as allowed under 15A NCAC .0908(e); and
   c. At least once per year, document an evaluation of any non-significant categorical Industrial User for compliance with the requirements in 40 CFR 403.3(v)(2), and either continue or revoke the designation as non-significant.

8. IU Self Monitoring and Reporting
The Permittee shall require all Industrial Users to comply with the applicable monitoring and reporting requirements outlined in the Division-approved pretreatment program, the industry's pretreatment permit, or in 15A NCAC 02H .0908. [15A NCAC 02H .0906(b)(5) and .0905; 40 CFR 403.8(f)(1)(v) and (2)(iii); 40 CFR 122.44(j)(2) and 40 CFR 403.12]

9. Enforcement Response Plan (ERP)
The Permittee shall enforce and obtain appropriate remedies for violations of all pretreatment standards promulgated pursuant to section 307(b) and (c) of the CWA (40 CFR 405 et. seq.), prohibitive discharge standards as set forth in 40 CFR 403.5 and 15A NCAC 02H .0909, specific local limitations, and other pretreatment requirements. All remedies, enforcement actions and other, shall be consistent with the Enforcement Response Plan (ERP) approved by the Division. [15A NCAC 02H .0903(b)(7), .0906(b)(8) and .0905; 40 CFR 403.8(f)(5)]

10. Pretreatment Annual Reports (PAR)
The Permittee shall report to the Division in accordance with 15A NCAC 02H .0908. In lieu of submitting annual reports, Modified Pretreatment Programs developed under 15A NCAC 02H .0904 (b) may be required to submit a partial annual report or to meet with Division personnel periodically to discuss enforcement of pretreatment requirements and other pretreatment implementation issues.

    For all other active pretreatment programs, the Permittee shall submit two copies of a Pretreatment Annual Report (PAR) describing its pretreatment activities over the previous calendar year to the Division at the following address:

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NC DEQ / Division of Water Resources / Water Quality Permitting Section
Pretreatment, Emergency Response, and Collection Systems (PERCS) Unit
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

These reports shall be submitted by March 1 of each year and shall contain the following:

a. Narrative
A narrative summary detailing actions taken, or proposed, by the Permittee to correct significant non-compliance and to ensure compliance with pretreatment requirements;

b. Pretreatment Program Summary (PPS)
A pretreatment program summary (PPS) on forms or in a format provided by the Division;

c. Significant Non-Compliance Report (SNCR)
A list of Industrial Users (IUs) in significant noncompliance (SNC) with pretreatment requirements, and the nature of the violations on forms or in a format provided by the Division;

d. Industrial Data Summary Forms (IDSF)
Monitoring data from samples collected by both the POTW and the Significant Industrial Users (SIUs). These analytical results must be reported on Industrial Data Summary Forms (IDSF) or on other forms or in a format provided by the Division;

e. Other Information
Copies of the POTW's allocation table, new or modified enforcement compliance schedules, public notice of IUs in SNC, a summary of data or other information related to significant noncompliance determinations for IUs that are not considered SIUs, and any other information, upon request, which in the opinion of the Director is needed to determine compliance with the pretreatment implementation requirements of this permit;

11. Public Notice
The Permittee shall publish annually a list of Industrial Users (IUs) that were in significant noncompliance (SNC) as defined in the Permittee's Division-approved Sewer Use Ordinance with applicable pretreatment requirements and standards during the previous twelve month period. This list shall be published within four months of the applicable twelve-month period. [15A NCAC 02H .0903(b)(34), .0908(b)(5) and .0905 and 40 CFR 403.8(f)(2)(viii)]

12. Record Keeping
The Permittee shall retain for a minimum of three years records of monitoring activities and results, along with support information including general records, water quality records, and records of industrial impact on the POTW and shall retain all other Pretreatment Program records as required by 15A NCAC 02H .0908(f). [15A NCAC 02H .0908(f); 40 CFR 403.12(o)]

13. Pretreatment Program Resources
The Permittee shall maintain adequate funding and qualified personnel to accomplish the objectives of its approved pretreatment program. and retain a written description of those current levels of inspection. [15A NCAC 02H .0906(b)(9) and (10) and .0905; 40 CFR 403.8(f)(3), 403.9(b)(3)]

14. Modification to Pretreatment Programs
Modifications to the approved pretreatment program including but not limited to local limits modifications, POTW monitoring of their Significant Industrial Users (SIUs), and Monitoring Plan modifications, shall be considered a permit modification and shall be governed by 40 CFR 403.18, 15 NCAC 02H .0114 and 15A NCAC 02H .0907.

Town of Fuquay-Varina Communication with Town of Cary RE: Western Wake Regional WRF

Sadler, Mary

From: Michael Wagner <mwagner@fuquay-varina.org>
Sent: Monday, January 30, 2023 10:35 AM
To: Sadler, Mary
Subject: Fw: Fuquay-Varina & Western Wake WRF

Caution! *External email – think before you click*

Mary,

Good morning. Please see the communication below regarding capacity in WWRWRF.

Mike

Michael Wagner
Public Utilities Director
Town of Fuquay-Varina
Office:

1415 Holland Road
Fuquay-Varina, NC 27526
www.fuquay-varina.org
Facebook Instagram Twitter

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From: Jamie Revels <Jamie.Revels@townofcary.org>
Sent: Monday, January 30, 2023 9:44 AM
To: Michael Wagner <mwagner@fuquay-varina.org>
Cc: Michael.Deaton@apexnc.org <michael.deaton@apexnc.org>
Subject: Fuquay-Varina & Western Wake WRF

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Mike,

Good to hear from you. Yes, we've been following your IBT since Jay Meyers was with F-V. As you know, Cary and Apex have a long history with IBT and our IBT was a driving factor in forming our partnership to construct the Western Wake Regional Water Reclamation Facility (WWRWRF) and associated pipelines and pumping facilities. I'm copying our partner, Michael Deaton, Water Resources Director from Apex, on my reply. Cary and Apex are now engaged with a process to master plan for future expansion of the WWRWRF, which we expect to take place sometime in the next 10-years.

When we formed the partnership and constructed the facilities, it was a substantial long-term capital investment for both Cary and Apex. The WWRWRF is still the biggest capital project ever completed by Cary, one in which we are still paying the debt service after nearly 10-years of operation. The regional facility was designed to serve long-term growth and economic development of Western Wake County portions of Cary, Apex, Morrisville, and Wake County's portion of Research Triangle Park.

Under our current partnership, we built sufficient capacity in the trunk lines to meet the long term needs of the Western Wake Partners, knowing that we would eventually need to expand the treatment facility as we grow into the previously built conveyance infrastructure, but there isn't additional capacity within the conveyance system including 11.5 miles of effluent pipeline that is required to reach the Cape Fear River discharge based on current projections. We are working on master planning for the future and an important part of our planning is renewing our population projections. We expect this master planning phase to take a couple of years to complete and then we'll make necessary adjustments as needed to our 20-year CIP for the Western Wake Partner owned facilities.

At this time, I think we're not a viable alternative. Let us know if we can answer any further questions.

Best regards,
Jamie

Jamie Revels, P.E.
Utilities Director
CARY
UTILITIES DEPARTMENT
PO Box 8005 | Cary, NC 27512-8005
400 James Jackson Avenue | Cary, NC 27513-8005
phone: (919) 469-4303 | fax: (919) 469-4304
mobile: (919) 418-7572
Email: jamie.revels@townofcary.org

In keeping with the NC Public Records Law, e-mails, and attachments, may be released to others upon request for inspection and copying.

From: Michael Wagner <mwagner@fuquay-varina.org>
Sent: Friday, January 27, 2023 2:47 PM
To: Jamie Revels <Jamie.Revels@townofcary.org>
Subject: Fuquay-Varina & Western Wake WRF

You don't often get email from mwagner@fuquay-varina.org. Learn why this is important

Jamie,

Good afternoon and happy Friday. I hope this email finds you well.

The Town of Fuquay-Varina is finalizing the draft environmental impact statement for our IBT request of 6 mgd. As a part of our Alternatives Analysis, Hazen needed to identify alternatives to return water to the Cape Fear River Basin. Understanding the impacts on everyone's regional growth and long range planning, the alternative for a partnership and capacity at WWWRF did not present itself as a viable option and feasibility was not undertaken. I am not sure if Jay Meyers previously reached out, but DWR has requested that F-V ask if a partnership and capacity in the Western Wake WRF is a viable alternative at this time?

I hope you have a wonderful weekend.
Thanks,
Mike

Michael Wagner
Public Utilities Director
Town of Fuquay-Varina
Office:

1415 Holland Road
Fuquay-Varina, NC 27526
www.fuquay-varina.org
Facebook Instagram Twitter

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Water Balance for City of Sanford

City of Sanford

Average Day and Maximum Month Water Balance and Interbasin Transfer Estimate

Average Day

Year	Finished Water Production, mgd	Basin Water Demand Distribution		Water Demand in (IBT) Basin (mgd)		Consumptive Loss, mgd (Notes 2, 3, 4)		Wastewater Flow Projections (Note 5, 6, 7, 8), mgd	Total Surface Water Transfer, mgd (Note 9)	Wastewater Distribution	
	Cape Fear (Note 1)	Cape Fear	Deep River	Cape Fear	Deep River	Cape Fear (water lines on septic)	Deep River (water lines on septic)	Deep River		Cape Fear	Deep River
2022	6.33	42.0%	58.0%	2.7	3.7	2.17	1.25	3.8	1.25	24.2%	75.8%
2025	7.01	42.0%	58.0%	2.9	4.1	2.27	1.31	4.1	1.31	24.2%	75.8%
2030	8.13	42.0%	58.0%	3.4	4.7	2.46	1.41	4.8	1.41	24.2%	75.8%
2035	8.60	42.0%	58.0%	3.6	5.0	2.66	1.53	5.6	1.53	24.2%	75.8%
2040	9.08	42.0%	58.0%	3.8	5.3	2.87	1.65	6.5	1.65	24.2%	75.8%
2045	9.55	42.0%	58.0%	4.0	5.5	3.10	1.78	7.5	1.78	24.2%	75.8%
2050	10.11	42.0%	58.0%	4.2	5.9	3.36	1.93	8.7	1.93	24.2%	75.8%
2055	10.50	42.0%	58.0%	4.4	6.1	3.63	2.09	10.1	2.09	24.2%	75.8%

Maximum Month

Year	Finished Water Production, mgd	Basin Water Demand Distribution		Water Demand in (IBT) Basin (mgd)		Consumptive Loss, mgd		Wastewater Flow Projections (Sanford only), mgd	Total Surface Water Transfer, mgd	Wastewater Distribution	
	Cape Fear	Cape Fear	Deep River	Cape Fear	Deep River	Cape Fear (water lines on septic)	Deep River (water lines on septic)	Deep River		Cape Fear	Deep River
2022	7.60	42.0%	58.0%	3.2	4.4	2.60	1.50	4.6	1.50	24.2%	75.8%
2025	8.41	42.0%	58.0%	3.5	4.9	2.73	1.57	4.9	1.57	24.2%	75.8%
2030	9.75	42.0%	58.0%	4.1	5.7	2.95	1.70	5.8	1.70	24.2%	75.8%
2035	10.32	42.0%	58.0%	4.3	6.0	3.19	1.83	6.7	1.83	24.2%	75.8%
2040	10.89	42.0%	58.0%	4.6	6.3	3.45	1.98	7.8	1.98	24.2%	75.8%
2045	11.46	42.0%	58.0%	4.8	6.6	3.73	2.14	9.0	2.14	24.2%	75.8%
2050	12.13	42.0%	58.0%	5.1	7.0	4.03	2.31	10.4	2.31	24.2%	75.8%
2055	12.60	42.0%	58.0%	5.3	7.3	4.35	2.50	12.1	2.50	24.2%	75.8%

NOTES

1 Finished water production data in Sanford service area from 2022 Local Water Supply Plan. Water supply from the Cape Fear River.
2 Consumptive loss is the amount of water lost to groundwater (e.g., septic systems).
3 Number of homes on water and septic *2.67*126 gpcd / 10^6
4 A septic growth rate of 1.57% was assumed based on Local Water Supply Plan data.
5 Wastewater flow projections are for Sanford service area.
6 Wastewater flow projections reflect sewer gallon per capita day rates and infiltration and inflow.
7 Wastewater flow projections calculated using number of people per account x sewer account increase x gpcd
8 The City of Sanford is not subject to an interbasin transfer. The Cork Rule per 15A NCAC 02E .0401(b) is applicable to the City's system:
The discharge point is situated upstream of the withdrawal point such that the water discharged will naturally flow past the withdrawal point.
9 Maximum month water and wastewater flow projections estimated at 1.2 x annual average

Water Balance for Town of Fuquay-Varina

Town of Fuquay-Varina
Average Day and Maximum Month Water Balance and Interbasin Transfer Estimate

Average Day

				[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[E] +[F]	[G] + [H]	[A] - ([E]+[F]) -[C]							
		Basin Water Demand Distribution		Water Demand in (IBT) Basin (mgd)		Consumptive Loss, mgd		Supply by Seller (mgd)				Supply from Each Basin (mgd)			Wastewater Distribution		Wastewater Flow Projections, mgd (Notes 8 and 9)		Septic Discharges on Water Lines, mgd		Well System Wastewate Discharge to Sewer, mgd (Note 11)	
Year	Total Water Purchased, mgd	Neuse	Cape Fear	Neuse (Note 1)	Cape Fear (Note 4)	Neuse (Notes 2 and 3)	Cape Fear (Note 5)	Raleigh (Neuse)	Johnston County (Neuse)	Harnett County (Cape Fear)	Sanford (Cape Fear)	Neuse	Cape Fear	Total Surface Water Transfer, mgd	Neuse	Cape Fear	Neuse (Terrible Creek WWTP)	Cape Fear (North Harnett Regional WWTP)	Neuse (Note 6)	Cape Fear (Note 5)	Septic Systems in Neuse	Septic Systems in Cape Fear
2020	3.0	62.0%	38.0%	1.85	1.13	0.018	0.103	1.75	0.5	2	0	2.25	2	0.00	55.8%	44.3%	1.4	1.4	0.037	0.103	0.025	0.070
2025	3.6	61.7%	38.3%	2.21	1.37	0.018	0.103	1.75	0.5	2	6	2.25	8	0.00	55.8%	44.3%	1.9	2.0	0.037	0.103	0.025	0.070
2030	4.4	61.7%	38.3%	2.70	1.68	0.018	0.103	1.75	0.5	2	6	2.25	8	0.47	55.8%	44.3%	3.1	2.9	0.037	0.103	0.025	0.070
2035	5.2	62.0%	38.0%	3.21	1.97	0.018	0.103	1.75	0.5	2	6	2.25	8	0.98	55.8%	44.3%	4.1	4.1	0.037	0.103	0.025	0.070
2036	5.3	62.0%	38.0%	3.31	2.03	0.018	0.103	0	0.5	2	6	0.5	8	2.83	55.8%	44.3%	4.1	4.2	0.037	0.103	0.025	0.070
2040	6.0	62.0%	38.0%	3.70	2.27	0.018	0.103	0	0.5	2	6	0.5	8	3.22	55.8%	44.3%	4.4	4.6	0.037	0.103	0.025	0.070
2041	6.1	62.0%	38.0%	3.80	2.33	0.018	0.103	0	0.5	2	6	0.5	8	3.32	55.8%	44.3%	4.5	4.7	0.037	0.103	0.025	0.070
2045	6.8	62.0%	38.0%	4.20	2.58	0.018	0.103	0	0.5	2	8	0.5	10	3.71	55.8%	44.3%	4.9	5.0	0.037	0.103	0.025	0.070
2049	7.4	62.0%	38.0%	4.59	2.82	0.018	0.103	0	0.5	2	8	0.5	10	4.11	55.8%	44.3%	5.2	5.5	0.037	0.103	0.025	0.070
2050	7.6	62.0%	38.0%	4.69	2.88	0.018	0.103	0	0	2	10	0	12	4.71	55.8%	44.3%	5.3	5.6	0.037	0.103	0.025	0.070
2055	8.4	62.3%	37.7%	5.21	3.16	0.018	0.103	0	0	2	11	0	13	5.23	55.8%	44.3%	5.9	6.2	0.037	0.103	0.025	0.070

Maximum Month

		Basin Water Demand Distribution		Water Demand in (IBT) Basin (mgd)		Consumptive Loss, mgd		Supply by Seller (mgd)				Supply from Each Basin (mgd)			Wastewater Distribution		Wastewater Flow Projections, mgd (Notes 8, 9, 10)		Septic Discharges on Water Lines, mgd		Well System Wastewate Discharge to Sewer, mgd (Note 11)	
Year	Total Water Purchased, mgd	Neuse	Cape Fear	Neuse (Note 1)	Cape Fear (Note 4)	Neuse (Notes 2 and 3)	Cape Fear (Note 5)	Raleigh (Neuse)	Johnston County (Neuse)	Harnett County (Cape Fear)	Sanford (Cape Fear)	Neuse	Cape Fear	Total Surface Water Transfer, mgd	Neuse	Cape Fear	Neuse (Terrible Creek WWTP)	Cape Fear (North Harnett Regional WWTP)	Neuse (Notes 6, 7, 10)	Cape Fear (Notes 5, 7, 10)	Septic Systems in Neuse	Septic Systems in Cape Fear
2020	3.5	62.0%	38.0%	2.18	1.33	0.018	0.103	1.75	1.5	2	0	3.25	2	0.00	55.8%	44.3%	1.7	1.7	0.044	0.123	0.030	0.084
2025	4.2	61.7%	38.3%	2.61	1.62	0.018	0.103	1.75	1.5	2	6	3.25	8	0.00	55.8%	44.3%	2.3	2.4	0.044	0.123	0.030	0.084
2030	5.2	61.7%	38.3%	3.19	1.98	0.018	0.103	1.75	1.5	2	6	3.25	8	0.00	55.8%	44.3%	3.7	3.5	0.044	0.123	0.030	0.084
2035	6.1	62.0%	38.0%	3.79	2.32	0.018	0.103	1.75	1.5	2	6	3.25	8	0.56	55.8%	44.3%	4.9	4.9	0.044	0.123	0.030	0.084
2036	6.3	62.0%	38.0%	3.90	2.39	0.018	0.103	0	1.5	2	6	1.5	8	2.42	55.8%	44.3%	4.9	5.0	0.044	0.123	0.030	0.084
2040	7.1	62.0%	38.0%	4.37	2.68	0.018	0.103	0	1.5	2	6	1.5	8	2.89	55.8%	44.3%	5.3	5.5	0.044	0.123	0.030	0.084
2041	7.2	62.0%	38.0%	4.49	2.75	0.018	0.103	0	1.5	2	6	1.5	8	3.01	55.8%	44.3%	5.4	5.6	0.044	0.123	0.030	0.084
2045	8.0	62.0%	38.0%	4.95	3.04	0.018	0.103	0	1.5	2	8	1.5	10	3.47	55.8%	44.3%	5.9	6.0	0.044	0.123	0.030	0.084
2049	8.7	62.0%	38.0%	5.42	3.32	0.018	0.103	0	1.5	2	8	1.5	10	3.94	55.8%	44.3%	6.2	6.6	0.044	0.123	0.030	0.084
2050	8.9	62.0%	38.0%	5.54	3.40	0.018	0.103	0	0	2	10	0	12	5.55	55.8%	44.3%	6.4	6.7	0.044	0.123	0.030	0.084
2055	9.9	62.3%	37.7%	6.15	3.73	0.018	0.103	0	0	2	11	0	13	6.17	55.8%	44.3%	7.1	7.4	0.044	0.123	0.030	0.084

NOTES

1 All finished water supplied to the Neuse River Basin is discharged in the Neuse River Basin (with the exception of 512 homes - Notes 2 and 3)
2 512 homes in Cape Fear Basin HUC but in Neuse legislative boundary. Water supplied by CF and WW returned to CF. Only transfer is consumptive loss.
3 512 homes*2.36*85 gpcd / 10^6 * 17.5% consumptive loss factor
4 All finished water supplied to the Cape Fear River Basin is discharged to the Cape Fear River basin.
5 Approximately 438 non-vacant parcels on water lines and septic in Cape Fear. Since this water is returned to the Cape Fear basin, this amount is not a transfer.
6 Approximately 208 non-vacant parcels on water lines and septic in Neuse
7 The number of septic systems on public water lines in the Town's service area is not expected to increase.
8 Wastewater flow projections between the Neuse and the Cape Fear reflect different sewer gallon per capita day rates and infiltration and inflow
9 Wastewater flow projections calculated using number of people per account x sewer account increase x gpcd
10 Maximum month wastewater flow projections estimated at 1.2 x annual average
11 The number of systems on wells and sewer in the Town's service area is not expected to increase.

City of Sanford RSST Results for Carbon Selection

Hazen *Technical Memorandum*

January 16, 2023

To: City of Sanford, North Carolina

From: David Briley, P.E. – Hazen and Sawyer
Jared Hostetler, P.E – Hazen and Sawyer
Yoko Koyama – Hazen and Sawyer

cc: Tom Tant, P.E. – Hazen and Sawyer
Z. Michael Wang, Ph.D., P.E – Hazen and Sawyer
Cory Hopkins, P.E – Hazen and Sawyer
Sara Gibson, P.E – Hazen and Sawyer

Re: City of Sanford, NC – PD--RSSCT Results for Carbon Selection for the Sanford WFF Expansion Project

1.1 Introduction

This Technical Memorandum (TM) documents the bench-scale testing conducted in support of the design of the post-filtration granular activated carbon (GAC) adsorption process for the Sanford Water Filtration Facility Expansion. The primary objective of this round of bench scale testing is to select carbon products and specify manufacturers in the GAC design technical specification.

1.2 Rapid Small Scale Column Testing (RSSCTs)

Rapid small scale column tests (RSSCTs) are widely employed as a lab-scale adsorbent comparison tool capable of screening adsorption performance of GAC in a treatment scenario quickly and at a lower cost compared to pilot testing. RSSCTs utilize short bed depths and ground GAC to expedite breakthrough with less water and materials. The design and operation of RSSCTs are contingent on a proportional diffusivity (PD) adsorption assumption which dictates that the interparticle diffusivity of an adsorbate is proportional to the adsorbent particle size. PD-RSSCTs have demonstrated sufficient performance in poly- and perfluoroalkyl substances (PFAS) removal prediction through numerous literature studies on a variety of PFAS contaminated water types. Three commercial products were compared: Calgon F400, Norit GAC 400, and Evoqua UC1240 LD. The selection of these Calgon and Norit products is based on a machine learning simulation of bed volume to 10% breakthrough (BV10), for which simulation results are shown in Figure 1. In addition to the top-two performing commercial carbon, a relatively new GAC product by Evoqua was also included in the analysis.

Job no 30202-034

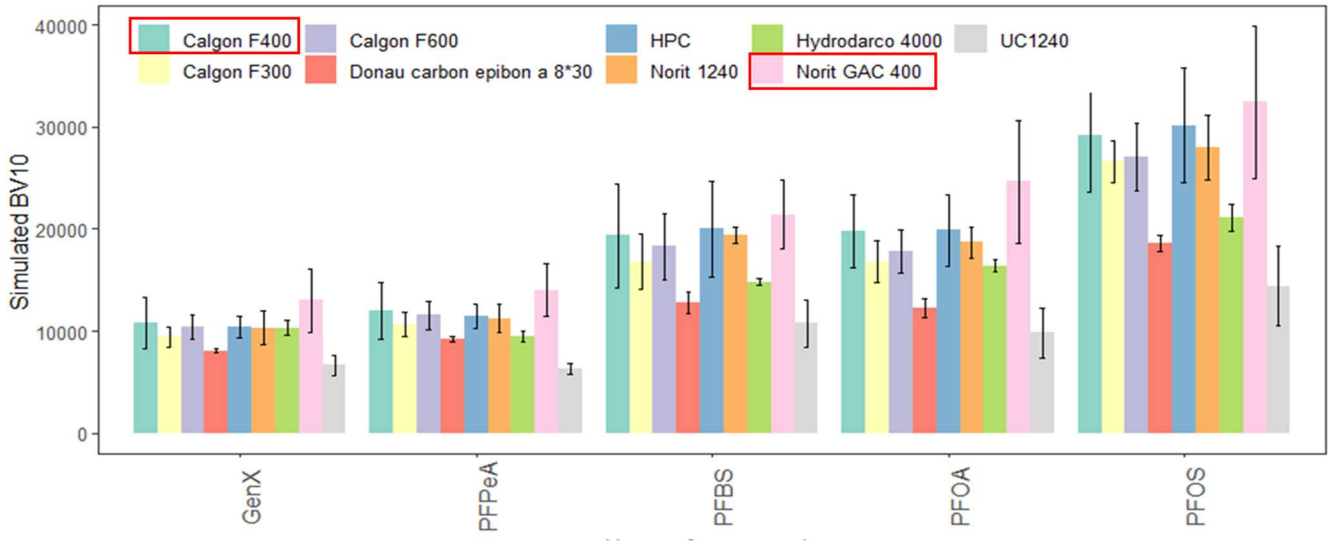

Figure 1: Machine learning prediction of BV10 for multiple PFAS species across multiple GAC products. Note that HPC Super 8x30 by Calgon is not an available commercial product and thus not selected as a candidate carbon product during the RSSCT testing.

1.3 RSSCT Results

1.3.1 PD- RSSCT Results

PD-RSSCTs were conducted by Engineering Performance Solutions lab at a 20-minute simulated empty bed contact time (EBCT) with perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and (perfluorobutanesulfonic acid) PFBS tracked in the effluent as a function of bed volumes (BVs) processed. Selected results from RSSCT experiments are shown in **Figure 2 through Figure 4** below.

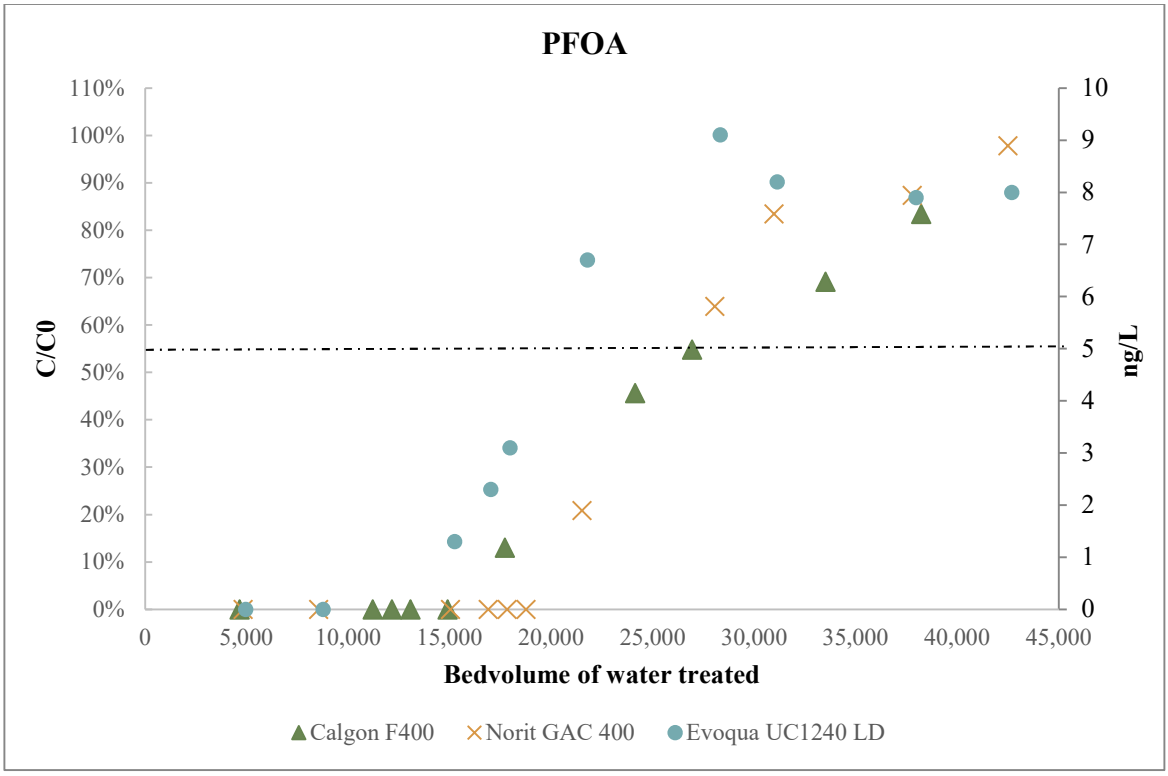

Figure 2: RSSCT-PD Breakthrough Curve for PFOA compounds as a function of bed volumes for 3 commercially available GAC products. Dashed line indicates previously set water quality goal of 5 ng/L.

For PFOA adsorption (Figure 2), Calgon F400 and Norit GAC 400 exhibited similar bed life (~25,000 BVs) at the breakthrough threshold of interest (C/C_0 =52 %). Meanwhile, at the same threshold, Evoqua UC1240 LD's bed life (~20,000 BVs) was about 5,000 BVs shorter than those of the Calgon and Norit products. Hence, the Calgon and Norit products are superior than the Evoqua product in the case of PFOA adsorption.

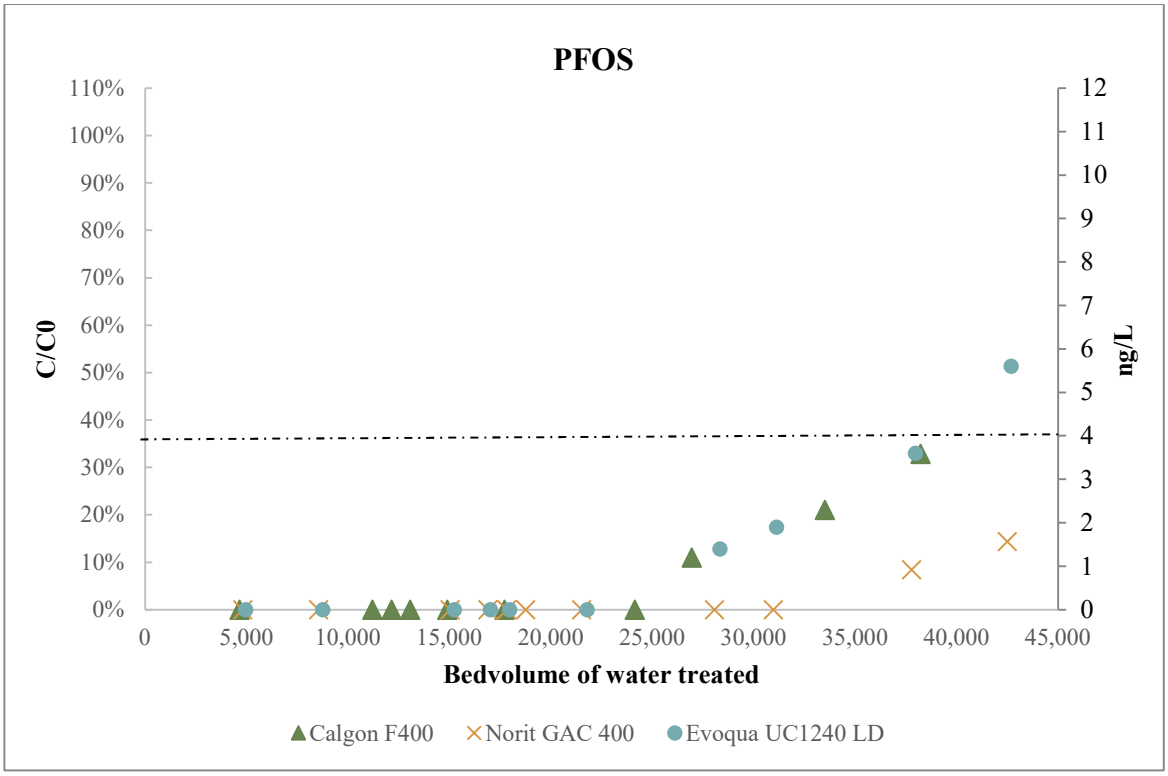

Figure 3: RSSCT-PD Breakthrough Curve for PFOS compounds as a function of bed volumes for 3 commercially available GAC products. Dashed line indicates EPA defined minimum reporting limit (MRL) of 4 ng/L for PFOS.

For PFOS adsorption (Figure 3), Evoqua UC1240LD and Calgon F400 exhibited similar breakthrough behavior for $C/C_0 < 40\%$. Overall, Norit GAC400 broke through later than both the Evoqua and Calgon products in this the tested threshold range, indicating superior adsorption performance.

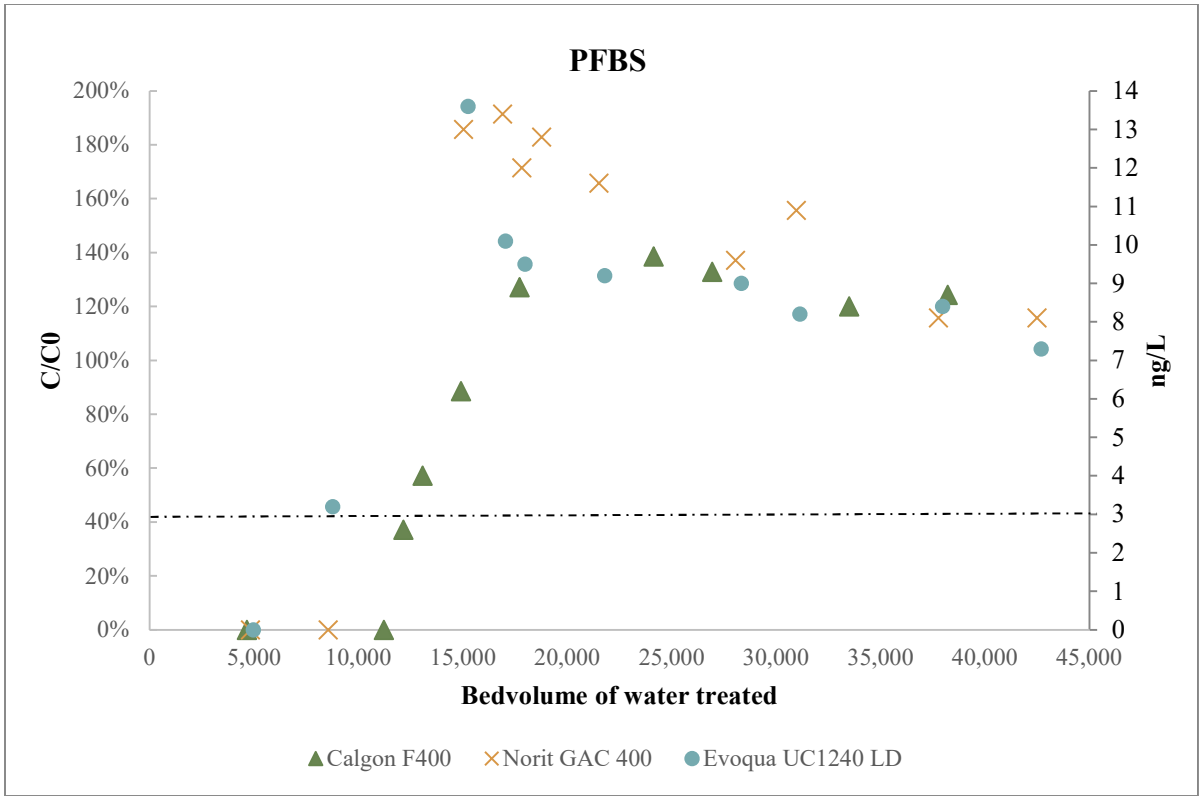

Figure 4: RSSCT-PD Breakthrough Curve for PFBS compounds as a function of bed volumes for 3 commercially available GAC products. Dashed line indicates EPA defined minimum reporting limit (MRL) of 3 ng/L for PFBS.

For PFBS adsorption (Figure 4), since data points are missing between the MRL and C/C_0 = 100% for Evoqua UC1240LD and Norit GAC400, the comparison between the adsorption performance amongst the three GAC products (Calgon F400, Norit GAC400, and Evoqua UC1240LD) could not be drawn.

1.4 Conclusions

The US EPA revised HALs for PFOA in 2022 and published new HALs for PFBS, and Gen-X. The current HALs are 0.004 ng/L for PFOA, and 0.02 ng/L for PFOS. US EPA is also planning to publish draft Maximum Contaminant Levels for these compounds soon. EPA has announced its intention to publish MCLs by the end of 2022 but it is currently expected to in March 2023. Current analytical methods have a much higher MRL (~4 ng/L for PFOA) as compared to the revised HAL. Therefore, the upcoming draft maximum contaminant levels will likely be set closer to the MRL. PFOA will likely dictate the GAC media change out schedule due to its earlier breakthrough than PFOS.

PD-RSSCT results indicate that Calgon and Norit should be the two preferred manufacturers to be listed in the technical specification for the Sanford WFF expansion project. For PFOA, the GAC products from Calgon and Norit have demonstrated later breakthrough than the GAC product from Evoqua. While minimum reporting limit for PFBS and its breakthrough is shown above, it does not serve as the design

basis since the PFBS concentration present within the background matrix at the Sanford Water Filtration Facility is not yet at a concerning level in terms of the EPA HAL (2000 ng/L).

Appendix D: Detailed Summary of Water Conservation Measures in Cape Fear River Basin

Jurisdiction	Ordinance or Reference	Description
Apex	Code of Ordinances, Chapter 12, Division 5 Sec. 12-101, 12-102	• Mandatory year round odd/even watering schedule. (Exemption provided for new landscape in which owners may obtain a 45-day new landscape permit) o Odd numbered addresses may water on Tuesdays, Thursdays, and Saturdays o Even numbered addresses may water on Wednesdays, Fridays, and Sundays. o Hand watering is permitted everyday • No person is allowed to operate and irrigation system in which: o Allows water to fall on impervious surfaces, such as driveways, roads, sidewalks and/or the like. o Allows water to accumulate to the extent that it runs off the property being irrigated and onto public streets or property. • Rain Sensors are required for all automatic irrigation systems. o Rain sensors shall be operated and set so that for every rainfall event the sensors shut off the system after ¼" of rainfall has occurred. They shall also be installed in a position that allows for full rainfall exposure. • Irrigation surcharge is allowed and shall be computed by a multiplier established by the town council. • Damage to the water distribution system, improper connections, and unauthorized use of the system, without first obtaining permission from the town and paying applicable fees is inadmissible. • Stages of conservation measures in response to water shortage: o Year-round odd/even watering o To avoid impact of water shortage the town manager will institute stage 1, 2, 3 and rationing by written declaration: • Stage 1 Water Shortage Condition: (The town shall publicize and request the public to comply with the following conservation measures): o Spray irrigation is limited to once per week. o Hand-watering is permitted every day. Athletic field irrigation is permitted. o No new 45-day landscape permits shall be issued. Permits already issued during a stage 1 declaration would continue to be honored until the 45-day period has expired. o Reuse household water when possible, (within state gray water laws). o Limit vehicle washing to the minimum. o Refrain from washing down outside areas such as sidewalks, patios, etc. o Use shower for bathing rather than bathtub, and limit shower to no more than four minutes. o Limit flushing of toilets by multiple usages. o Refrain from leaving faucets running while shaving or while rinsing dishes. o Limit the use of clothes washers and dishwashers and when used, to operate fully loaded. o Install water-flow restrictive devices in showerheads. o Use disposable and biodegradable dishes. o Install water-saving devices such as bricks, plastics, bottles or commercial units in toilet tanks. o Limit operation of water-cooled air conditioners • Stage 2 Water Shortage Condition (Continue recommendations from Stage 1 and the following measures will be mandatory): o Spray irrigation is not allowed. Hand-watering is permitted. o Filling of newly constructed or drained swimming or wading pools shall require the approval of the public works and utilities director. Makeup water is allowed for maintaining the operation of swimming or wading pools. o No introducing water into any ornamental fountain, pool or pond or other structure making similar use of water. o No using water from public or private fire hydrants for any purposes other than fire suppression or other public emergency. o Watering for dust control or compaction shall require the approval of the public works and utilities director. o No using water for any unnecessary purpose or intentionally wasting water. • Stage 3 Water Shortage Condition (All provisions of Stage 1 and 2 apply and in addition the following are mandatory measures): o Spray irrigation is not allowed. Hand-watering is not allowed. The irrigation of athletic fields is not allowed. o No nonessential use of water for commercial or public use, and the use of single service plates and utensils is encouraged and recommended in restaurants. o No washing down outside areas such as streets, driveways, service station aprons, parking lots, office buildings, exterior of existing or newly constructed homes or apartments, sidewalks, or patios, or use of water for other similar purposes.

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		○ Washing of vehicles is not permitted. • Emergency/Rationing Stage (All provisions above apply in addition to the following mandatory measures): ○ No using water outside of structures for any use other than emergencies involving fire. Fire protection will be maintained, but where possible, tank trucks shall use raw water. ○ All industrial uses of water are prohibited. ○ All other uses of water will be limited to those uses necessary to meet essential health and safety needs of customers. ○ No introducing water into swimming pools.
	Apex Unified Development Ordinance (UDO), Article 8.2.2	• Use of Native or Adaptive plant materials is required to further water conservation and to assure the growth and survival of new plantings.
Asheboro	Code of Ordinances, Title V, Section 50.027	Staged water use restrictions are as follows: • Level I (Voluntary): ○ Watering of lawns, ornamental plants, and gardens should be limited to the hours between 7:00 p.m. and 7:00 a.m. ○ Use of water for wash down of outside areas such as driveways, parking lots, and sidewalks should be curtailed. ○ Faucets should not be left running while shaving, brushing teeth, or washing dishes. ○ The use of clothes and dishwashers should be limited where possible, and these units should be operated with full loads. ○ Washing cars and other vehicles should be curtailed to Saturday and Sundays, and hoses should not be left running while washing. ○ The use of flow restriction and other water saving devices is encouraged. ○ Showers should be used for bathing, and showers should be limited to four minutes or less. ○ Filling of pools should be deferred or limited to hours between 7:00 p.m. and 7:00 a.m. • Level II (Mandatory). ○ The watering of lawns, ornamental plants, and gardens shall be limited to the hours between 7:00 p.m. and 7:00 a.m. ○ The watering of lawns, ornamental plants, and gardens shall not be done except by handheld containers (buckets, jugs, etc.), and no applications for irrigation meters will be accepted or approved. ○ With the exception of situations where a wash down of outside areas is necessary due to public health and safety concerns, the residential use of water for wash down of outside areas is prohibited. Commercial pressure washers shall be permitted to continue normal operations. However, the commercial pressure washer owners and/or operators shall ensure that water wastage does not occur. ○ Residential washing of cars and other vehicles is prohibited. Automobile retail establishments and commercial automobile washing facilities including those providing handheld washing nozzles shall be permitted to continue normal operations. However, the facility owner/operator shall ensure that water wastage does not occur. ○ Restaurants and other food serving establishments shall serve water to patrons only at the request of the patron(s). ○ Commercial, industrial and construction operations shall eliminate all possible waste of water. Large scale commercial and industrial operations and construction activities that utilize 20,000 cubic feet or more of water per month shall submit a water reduction compliance plan to achieve 25%, 50%, or 75% water reduction as specified under the Level II water emergency declaration within 14 days of the effective date of the regulations and restrictions specified in the Level II water emergency declaration. ○ Above-ground pools, Jacuzzis, and hot tubs having a capacity of 500 gallons or more and all newly constructed or drained in-ground pools shall be filled by permit only. The Water Resources Director or his or her designee shall review applications for such fill permits. The issuance of such a permit may be denied on the basis of the assessment by the Water Resources Director of the severity of the situation. • Level III (Mandatory). During a declared Level III water emergency, the following mandatory use restrictions shall be in effect for consumers of water from the city water system: ○ Any form of watering or irrigating lawns, gardens, and/or other plants is prohibited. ○ With the exception of situations where the wash down of certain outside areas is necessary due to public health and safety concerns, the use of water for wash down of outside areas is prohibited.

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		○ With the exception of situations where the washing of certain items is necessary due to public health and safety concerns, the washing of cars, vehicles, and/or other equipment is prohibited. ○ Restaurants and other food serving establishments shall utilize single serving utensils and plates in addition to serving water to patrons only at the request of the patron(s). ○ Recreational use of potable water, including filling of pools, is prohibited. ○ Large scale commercial and industrial water customers and construction activities utilizing 20,000 cubic feet or more of water per month shall achieve mandatory reductions in daily water usage of 25%, 50%, or 75% through whatever means are available. The target reduction percentage shall be determined by the severity of the water emergency and shall be publicly announced as part of the emergency declaration. The Water Resources Director shall determine compliance with the daily usage reduction targets. Variances to this restriction may be granted by the Water Resources Director to public health facilities including, but not limited to, hospitals and nursing homes. ○ Drinking water taps or hydrant permits shall be issued or revoked at the discretion of the Water Resources Director ○ Unless a bulk water sale is made pursuant to an existing contract, bulk water sales shall be prohibited. • Level IV (Mandatory). During a declared Level IV water emergency, the following mandatory water use restrictions shall be in effect for consumers of water from the city water system: ○ All use of water for purposes other than the maintenance of public health and safety is prohibited. ○ Unless a bulk water sale is made pursuant to an existing contract, bulk water sales shall be prohibited. ○ Where the city water system is functional, monthly residential water use shall not exceed 1,200 cubic feet of water at each metered location. ○ Where the city water system is not functional, National Guard and emergency services vehicles shall be utilized to distribute water for household use at prearranged locations within the affected area. Usage by individuals shall be limited to those amounts necessary to sustain life through drinking, food preparation, and personal hygiene. ○ The compliance plan for industries during Level IV remains the same as Level III or as directed by the State Public Health Officials.
Brunswick County	Code of Ordinances, Section 1-13, Article V, 1-13-142	Water emergency response and management. The director or his authorized representative is authorized to declare that a water emergency exists. • 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 consecutive days when water demand exceeds 80% 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 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: ○ Inspect and repair all faulty and defective parts of faucets and toilets. Use shower for bathing rather than bathtub and limit shower to no more than five minutes. ○ Do not leave faucets running while shaving, brushing teeth, rising or preparing food. ○ 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. ○ 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. ○ Water shrubbery the minimum required. Water shrubbery before the peak demand hours of 6:00 a.m. to 10:00 a.m. ○ Limit vehicle washing to a minimum. ○ Do not wash down outside areas such as sidewalks, driveways, patios, etc. ○ Install water saving showerheads and other water conservation devices. ○ Use disposable and biodegradable dishes where possible. ○ Install water saving devices in toilets such as early closing flappers. ○ Limit hours of water-cooled air conditioners. ○ Do not fill swimming or wading pools. • 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 consecutive days when water demand exceeds 90% of the water production capacity. Water production capacity shall be defined as the maximum volume of water that meets or exceeds

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		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: o Watering lawns, grass, shrubbery, trees, flower and vegetable gardens except by handheld 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 handheld hose or drip irrigation under a written warranty. o Filling swimming or wading pools, either newly constructed or previously drained. Make up water for pools in operation will be allowed. o Using water-cooled air conditioners or other equipment, in which cooling water is not recycled, unless there are health or safety concerns. o 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. o Washing outside surfaces such as streets, driveways, service station aprons, parking lots or patios. o Washing the exterior of office buildings, homes, or apartments. o Using water for any ornamental fountain, pool, pond, etc., unless recycled. o Serving drinking water in food establishments such as restaurants or cafeterias, unless requested to do so by a customer. o 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. o Using water to control or compact dust. o Intentionally wasting water. o Commercial and industrial water customers shall achieve mandatory reductions in water usage through whatever means are available. A minimum reduction of 20% 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. • 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 day when water demand exceeds 100% 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 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: o Watering lawns, grass, shrubbery, trees, and flowers. o Washing motor vehicles at commercial car wash establishments. o Watering any vegetable garden except by hand held hose, container, or drip irrigation. o Commercial and industrial water customers shall achieve mandatory reductions in water usage through whatever means are available. A minimum reduction of 50% 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. o 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. o Residential water use shall be limited to the amount necessary to sustain life through drinking, food preparation and personal hygiene. • Compliance plan during Stage 2 and Stage 3 emergencies: o The director or his authorized representative may require that commercial and industrial water customers prepare plans detailing measures to be taken by them to achieve mandatory reductions in daily water usage during Stage 2 and Stage 3 emergencies. Such plans shall be completed within sixty (60) calendar days after receipt of notice to prepare them.

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		• Penalties for violation of mandatory restrictions:
		  ○ Any user who is found to have failed to comply with any of the mandatory restrictions set forth in these regulations may be fined in accordance with the list of rates and charges currently in force for each violation.
		• Authority to discontinue service.
		  ○ Pursuant to the provisions of this article, water service may be temporarily discontinued for failure to comply with the mandatory restrictions in this article. All applicable penalty fees may be applied in the event of such service suspensions. In the event of continued non-compliance with this article, removal of meter and service will be deemed proper and service will be discontinued and tap fees and account deposits shall be forfeited.
		  ○ Appeals by customers of penalties and termination of service. Any user who receives a penalty and/or has service terminated as a result of violations of the mandatory restrictions in this article may appeal upon notification to the director. The director shall be the final decision maker for appeals and shall transmit a written copy of the final decision by registered or certified mail within three (3) days after notification.
		  ○ Adoption and enforcement of ordinance by public or private water system. Public or private water systems purchasing water from the county shall adopt and enforce this entire article as a condition of water service. Upon declaration of a water shortage emergency, the public or private water systems shall enforce the appropriate water use restrictions for the level of declared emergency.
		• Termination of restrictions.
		  ○ A water emergency declaration will expire when the director or his authorized representative determines that the condition that causes the emergency has abated. The expiration or cancellation of a water shortage emergency declaration shall be promptly and extensively publicized.

	Code of Ordinances, Section 1-13, Article V 1-13-143	• Reclaimed Water Usage Policy:
		  ○ The reclaimed water usage policy is an integral part of the counties overall water conservation program aimed at reducing the demand for potable water used for irrigation.
		  ○ The County may require developments with more than 500 residential units planned for construction and approved for construction after the effective date of this to policy to utilize irrigation systems capable of using reclaimed water to irrigate required common areas.

	Brunswick County Unified Development Ordinance (UDO) Section 6.1.5	• Location of plants and design of landscaping, including maintenance, shall be according to sound landscape and horticultural principles. The use of native vegetation and other lower maintenance landscape materials is desired to promote environmental protection, energy efficiency, and water conservation. • Landscape plans submitted for approval for the purposes of satisfying the requirements of this Section shall clearly indicate the name, location, and size of vegetation to be installed as well as trees to be preserved.
Burgaw	Code of Ordinances Section 36, Article V, 36-153	Compliance required in the event of shortage. • In the event the mayor issues any such proclamation described in section 36-152, then in that event it shall be unlawful for any person, firm or corporation to use or permit the use of water from the water system within the Town of Burgaw for any of the purposes as hereinafter set forth until such times as this article be amended or repealed, or until the mayor, by public proclamation has declared certain provisions no longer in effect. In exercising this discretionary authority consideration shall be given to the availability of the water supply, water production, water transmission, water storage, available usage, outlook for precipitation, daily water use patterns and availability of water from other sources. • In the event of a water shortage, the Town of Burgaw will deal with variance requests on a case by case basis. Variance requests will be in writing and will be reviewed by the water and sewer committee. • In light of the many benefits that can be derived by conserving water, all residents, businesses and users of the water supply in the community should follow water conservation practices, regardless of the time of the year or whether or not a water shortage exists. (Ord. No. 2002-21, 8-13-2002; Ord. No. 2010-02, 2-9-2010)
	Code of Ordinances Section 36, Article V, 36-154	Restrictions applicable for water conservation. The severity of water shortage shall be determined by static water levels within the Town of Burgaw's wells and the restrictive measures in effect at each stage are as follows: • In the event that the static water level in the town's wells begin to drop to a level which is below what is considered normal and where the well begins to operate for more than 12 hours per 24-hour day for any well a "voluntary restriction phase" may be declared in effect and the following water restrictions imposed:

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		○ A publicity campaign will be initiated using public media and specialized methods to inform the public of any impending water shortage. The Town of Burgaw will notify users and system employees by local newspapers, radio, and water bills. Water users and system employees will be notified at the time of shortage, of what will be required and measures to take to assist the town in reducing water usage. The Town of Burgaw will hold a public hearing to review and allow for public comments prior to final plan adoption. Residential conservation measures will be encouraged and recommended including the following: ○ Use shower for bathing rather than bathtub and limit shower to no more than five (5) minutes. ○ Limit flushing of toilets by multiple usages. ○ Do not leave faucets running while grooming or rinsing dishes. ○ Limit use of clothes washers and dishwashers and when used, operate fully loaded. ○ Limit lawn watering to that which is necessary for plants to survive. ○ Water shrubbery the minimum required. ○ Limit car washing to commercially operated car washes and gas or electric operated pressure washer. ○ Do not wash down outside areas such as sidewalks, patios, houses and etc. ○ Install water flow restrictive devices in showerheads. ○ Use disposable and biodegradable dishes. ○ No fundraisers that involve car washes. ○ It is recommended that water supply line pressure reducing valves be set to the minimum necessary for effective operations of fixtures and equipment. ○ Conservation in public buildings, schools, etc. is encouraged by reducing pressure at plumbing fixtures, by installation of restricting devices and shutting down on water flow control devices, and by periodic flushing of urinals. ○ All residents, business and schools are requested to temporarily delay new landscape work and installation of irrigation meters until water shortage has ended. • In the event that there is an observation of a drastic change in the static water level in the town's wells and where the wells consistently begin to operate for more than 12 hours per 24-hour day for any well a "Mandatory Restriction Phase" shall be declared in effect and the following water restrictions imposed: ○ To water lawns, grass, shrubbery, trees flower or vegetable gardens except as follows: ○ Customers located north of the intersection of Wilmington Street and Wright Street, Town of Burgaw may water lawns, grass, shrubbery, trees, and flower and vegetable gardens on Saturday morning between the hours of 6:00 a.m. and 10:00 a.m. ○ Customers located south of the intersection of Wilmington Street and Wright Street, Town of Burgaw may water lawns, grass, shrubbery, trees, and flower and vegetable gardens on Sunday morning between the hours of 6:00 a.m. and 10:00 a.m. ○ To fill newly constructed swimming and/or wading pools or refill swimming and/or wading pools that have been drained. A minimal amount of water may be added to maintain continued operation of pools which are in operation at the time of the provisions of a "Mandatory Restriction Phase" are placed into effect. ○ To wash automobiles, trucks, boats, motorcycles, four wheelers, trailers or any other type of mobile equipment including commercial washing. ○ To wash down outside areas such as streets, driveways, service station aprons, parking lots, office buildings, exteriors of existing or newly constructed homes, apartment or buildings, sidewalks or patios, or to use water for other similar purposes. ○ To operate or introduce water into any ornamental fountain, pool or pond or other structure making similar use of water. ○ To serve drinking water in restaurants or other food establishments, except upon the request of a patron. ○ To use water from public or private fire hydrants for any purpose other than fire suppression or other public emergency. ○ To use water for dust control or compaction. ○ To use water for any unnecessary purpose or to intentionally waste water. ○ To install and use irrigation meters. • In the event that the wells cannot pump a sufficient quantity of water required for the health, welfare and safety of the citizens of the Town of Burgaw during periods of fire suppression and failure in the town's water distribution system, then an "Emergency Restriction Phase" may be declared and the following water restrictions imposed: ○ To water or sprinkle any lawn. ○ To water any flower or vegetable garden or ornamental shrubs. ○ To introduce any water into a swimming pool, wading pool or pond.

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		○ To use water outside a structure for any use other than an emergency involving fire. ○ To make any nonessential use of water for commercial or public use.
	Burgaw Unified Development Ordinance, Section 8-4E	• Automotive Detailing Service ○ All car wash facilities shall be equipped with a water recycling system that conforms to the Town of Burgaw Sewer Ordinance and is approved by the Public Works Director and Wastewater Treatment Plan Supervisor.
Burlington	Code of Ordinances Section 40, Article II, 40-10	Response to water shortage: • It shall be the duty of the director of utilities to report to the city manager conditions adversely affecting the city water supply. The manager shall review all relevant and available information, and if deemed necessary, shall recommend that the city council declare water conservation measures contained herein be in full force and effect as necessary. Conditions to be considered include abnormally dry weather conditions, lake water levels below normal for the season, forecasts for persistent drought, failure of treatment processes, piping or equipment, excessive water demand compared to treatment or storage capacity, or declarations by the Governor of North Carolina. If there is a time sensitive emergency (system failure) the highest-ranking official available shall declare a water emergency and require appropriate water conservation measures.
	Code of Ordinances Section 40, Article II, 40-11	Use of raw water: • It shall be unlawful for any person to remove water from city-owned reservoirs for any reason. The City of Burlington shall have sole access to the water for purposes of treatment or other official city needs.
	Code of Ordinances Section 40, Article II, 40-12	Water conservation rates: • In the event of a prolonged drought with worsening consequences, it shall be at the discretion of the city manager to propose an adjustment to the water rates to help promote water conservation. The water conservation rate can be used to address residential, commercial and/or industrial water consumption by increasing the cost per unit volume according to a published rate schedule. The city manager shall recommend as necessary the adoption by the city council of water conservation rates.
	Code of Ordinances Section 40, Article II, 40-13	Continuing voluntary conservation practices, ongoing: • Customers shall be encouraged to observe water conservation measures to reduce the wasting of water as follows: ○ Check plumbing and toilets for leaks annually, and if necessary, repair. ○ Repair leaking faucets whenever they develop. ○ Store drinking water in the refrigerator to avoid trying to run it cool at the tap. ○ Use shower for bathing or reduce the depth of water used for tub baths. ○ Limit showers to four minutes where possible. ○ Refrain from running faucets while shaving or rinsing dishes or brushing teeth. ○ Install water flow restrictive devices in shower heads. ○ Install water-saving devices such as plastic bottles or commercial units in toilet tanks. ○ Wash full loads in clothes washers and dishwashers. ○ Review water uses and where feasible install recycle systems, particularly commercial and industrial customers. Stage I—Voluntary conservation, water alert. Customers shall be encouraged to observe the recommendations for ongoing conservation practices and to increase the level of the conservation effort as follows: • Limit the use of clothes washers and dishwashers, and when used, to operate fully loaded. • Reduce the flushing of toilets to the minimum whenever practical. • Limit lawn watering to only when grass shows signs of withering and apply water as slowly as possible to achieve deep penetration. • Limit shrubbery watering to the minimum reusing household water when possible. • Limit car washing to the minimum. Use a hose with a nozzle to control water flow and minimize waste. • Limit wash downs of outside areas such as sidewalks, patios, driveways, or other similar purposes. • Limit hours of operation of water-cooled air conditioners, if possible. • Use disposable dishes and utensils, both for residential and commercial purposes, where feasible. Stage I Voluntary conservation measures will be implemented based on the level of water in the city reservoirs (75% capacity remaining), abnormally dry conditions, season of the year, long range weather forecast calling for persistent drought, failure of

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		treatment processes, piping or equipment, excessive water demand compared to treatment or storage capacity, declarations by the Governor of North Carolina, or a combination of these factors. Stage II—Moderate mandatory conservation, established drought. Stage II moderate mandatory conservation measures will be implemented based on the level of water in the city reservoirs (60% capacity remaining), abnormally dry conditions, season of the year, long range weather forecast calling for persistent drought, failure of treatment processes, piping or equipment, excessive water demand compared to treatment or storage capacity, declarations by the Governor of North Carolina, or a combination of these factors. Customers shall be encouraged to observe the recommendations of the continuing voluntary conservation and Stage I Voluntary conservation, and the level of the conservation effort shall be increased to require the following mandatory measures. No person shall: • Water lawns, grass, trees, shrubbery, flowers, golf greens or vegetable gardens except between 4:00 p.m. 9:00 p.m. on Wednesday and 7:00 a.m. 12:00 noon on Saturday. The use of well water or private water is the only exception to this rule. • Introduce water into wading pools or swimming pools except to the extent necessary to replenish losses due to evaporation or spillage and maintain operation of chemical feed equipment. • Use water to wash down outside areas such as sidewalks, patios, driveways, or for other similar purposes. • Introduce water into any decorative fountain, pool or pond except where the water is recycled. • Serve water in a restaurant or similar establishment except upon request. • Use water for any unnecessary purpose or intentionally waste water. • Wash the exterior of a motor vehicle or boat (travel or camping trailers) except where 50% or more of the water is recycled, or where a private well water system is used. • Golf courses and institutions owning athletic fields (including artificial surfaces) shall be required to reduce water usage by 50% with watering only permitted between the hours of 10:00 p.m. and 5:00 a.m. Any customer may secure a written license from the city manager or his designee to use water contrary to the Stage II mandatory conservation measures where it can be shown to the manager's satisfaction that use of water pursuant to conditions prescribed by the city manager in the license will result in a 30% or greater saving of water. Any license issued pursuant to this provision: (1) must be in the possession of the licensee whenever water is used contrary to the Stage II mandatory conservations measures; and (2) is subject to amendment or revocation by the city manager at any time for good cause. Businesses with a privilege license for the City of Burlington that use water to maintain their businesses may continue to operate under Stage II. Stage III—Severe mandatory conservation, prolonged drought. Stage III severe mandatory conservation measures will be implemented based on the level of water in the city reservoirs (45% capacity remaining), abnormally dry conditions, season of the year, long range weather forecast calling for persistent drought, failure of treatment processes, piping or equipment, excessive water demand compared to treatment or storage capacity, declarations by the Governor of North Carolina, or a combination of these factors. Customers shall be encouraged to observe the recommendations of the continuing voluntary conservation and Stage I Voluntary conservation measures and required to continue observing the mandatory requirements in Stage II. The level of the conservation effort shall increase to require the following additional mandatory measures. No person shall: • Water lawns, grass, trees, shrubbery, flowers, golf greens or vegetable gardens except by hand-held hose (with shut-off nozzle), container, or drip irrigation system during the hours of 4:00 p.m. 9:00 p.m. on Wednesday and 7:00 a.m. 12:00 noon on Saturday. • No automatic sprinkler system or un-attended watering shall be allowed. The use of well water or private water is the only exception to this rule. • Fill a wading pool or swimming pool or replenish any filled pool except to the minimum essential for operation of chemical feed equipment. • Make non-essential use of water for commercial or public use. • Operate water-cooled air conditioners or equipment that do not recycle cooling water, except when health and safety are adversely affected. • Request industry reduce consumption 10%. Stage IV—Stringent mandatory conservation, severe water loss. Stage IV stringent mandatory conservation measures will be implemented based on the level of water in the city reservoirs (30% capacity remaining), abnormally dry conditions, season of the year,

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		long range weather forecast calling for persistent drought, failure of treatment processes, piping or equipment, excessive water demand compared to treatment or storage capacity, declarations by the Governor of North Carolina, or a combination of these factors. Customers shall be encouraged to observe the recommendations of the continuing voluntary conservation and Stage I Voluntary conservation measures and required to continue observing the mandatory requirements in Stages II and III. The level of the conservation effort shall increase to require the following additional mandatory measures: No person shall: • Use water outside a structure except in an emergency involving a fire. • Operate evaporative air conditioning units, which recycle water except during the operating hours of the business. • Use water to fill or refill any swimming pool or wading pool. • Wash any motor vehicle, including commercial washing unless a private well is used. • Request industry reduce consumption an additional 25%. • Industries must submit water conservation plans for city review. • In addition to the conservation measures enumerated above customers of eating establishments shall use plates, glasses, cups and eating utensils that are disposable. Stage V—Rationing. Stage V rationing measures will be implemented based on the level of water in the city reservoirs (15% capacity remaining), abnormally dry conditions, season of the year, long range weather forecast calling for persistent drought, failure of treatment processes, piping or equipment, excessive water demand compared to treatment or storage capacity, declarations by the Governor of North Carolina, or a combination of these factors. Customers shall be encouraged to observe the recommendations of the continuing voluntary conservation and Stage I Voluntary conservation measures and required to continue observing the mandatory requirements of Stages II, III, and IV. The level of the conservation effort shall increase to require the following mandatory measures: • Fire protection will be maintained, but where possible, tank trucks shall use raw water. • All industrial uses of water shall be prohibited, with the exception of water for domestic sanitation purposes. • All other uses of water will be limited to those necessary to meet minimum health and safety needs of the customers as determined by the city manager upon consultation with the director of utilities in light of conditions present. • Failure to act in accordance therewith or use of water in any manner or attempt to evade or avoid water-rationing restrictions shall be unlawful.
Cary	Water Shortage Response Plan (Modified January 21, 2010)	**Water Shortage Response Stages:** Before Stage 1 is implemented, the Town will communicate to each customer a summary of the customer's historical water use, their normal Tier 1 indoor water use, and information on how much water can be saved with different water use reduction measures. Non-residential customers who have an approved Drought Contingency Plan must reduce water use during each stage as specified in their plan. Stage 1 • Spray irrigation using potable water is limited to one (1) day per week for all purposes except the maintenance of athletic fields. No new turf watering exemption permits will be issued and any existing permits for watering periods that begin later than 14 days after the effective date of Stage 1 will be rescinded. Hand watering, drip irrigation, and subsurface irrigation are still allowed. Other outdoor water uses such as pressure washing, car washing, and keeping swimming pools filled are allowed, although customers are strongly encouraged to minimize such uses. Stage 2 • Spray irrigation using potable water is not allowed for any purpose except the maintenance of athletic fields. No new turf watering exemption permits will be issued, and any previously issued exemption permits for watering periods that have not expired will be rescinded. Hand watering, drip irrigation, and subsurface irrigation are still allowed. Other outdoor water uses such as pressure washing, car washing, and keeping swimming pools filled are allowed, although customers are strongly encouraged to minimize such uses. Stage 3 • No outdoor water use with potable water is allowed, including but not limited to: spray irrigation, hand watering, drip irrigation, and subsurface irrigation, ornamental fountains, car washing, pressure washing, and keeping swimming pools filled. No new turf watering

Jurisdiction	Ordinance or Reference	Description
		exemption permits will be issued and any previously issued permits for watering periods that have not expired will be rescinded. Firefighting and utility system maintenance are the only allowable outdoor water uses. • All customers are required to limit their monthly water use to the amount they normally use during the winter within Tier 1. This amount will be provided to each customer by the Public Works and Utilities Department, based on the water use history for their account, well in advance of Stage 3 implementation. For example, if during the winter a residential customer uses 4,000 gallons per month, then 4,000 gallons per month will be their normal Tier 1 indoor water use; if a customer normally uses 6,000 gallons per month in the winter - 5,000 Tier 1 and 1,000 Tier 2 – then their normal Tier 1 indoor water use will be 5,000 gallons per month. The approach will be the same for non-residential customers even though the maximum number of gallons based on the threshold between Tier 1 and Tier 2 varies for individual customers. Rationing • In this stage, the goal is to ensure there is drinking water available to protect public health (e.g., health care, drinking water, basic sanitation). Customers are encouraged to use the minimum amount of water needed for public health protection. No outdoor water use with potable water is allowed, including but not limited to: spray irrigation, hand watering, drip irrigation, and subsurface irrigation, ornamental fountains, car washing, pressure washing, and keeping swimming pools filled. As in Stage 3, no new turf watering exemption permits will be issued and any previously issued permits for watering periods that have not expired will be rescinded. Firefighting and utility system maintenance are the only allowable outdoor water uses. All customers are required to reduce their normal Tier 1 indoor water use, calculated as defined above in Stage 3, by 15%. Water Shortage Response Triggers: • Stage 1: (Water Shortage Declared) o Days of supply remaining is 120 days or less • Stage 2: o Stage 1 has been in place for 28 continuous days o AND Days of supply remaining is 90 days or less • Stage 3: o Days of supply remaining is 60 days or less • Rationing: o Days of supply remaining is 30 days or less
	Integrated Water Resources Management Plan	Existing Cary Water Conservation Program Elements: • Education: o Public Education/Beat the Peak Campaign o School Based Education Programs o Block Leader Program o Water Audits • Incentives: o Toilet Flapper Rebate o Rain Barrel o Tiered Rate Structure • Regulatory: o Water Waste Ordinance o Rain Sensor Ordinance o Alternate Day Watering Ordinance o Land Development Ordinance o Irrigation Plan Review o Separate Irrigation Meters Reclaimed Water Incentives: • Cary currently has a reclaimed water program in place as part of its strategy to manage and plan for future water supply needs. The Town became the first city in the State of North Carolina to pump treated wastewater effluent to homes and businesses for

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		irrigation and cooling. Cary is currently permitted to divert up to 5 million gallons per day (mgd) of treated wastewater effluent to its reuse system.
	Code of Ordinances Chapter 36, Division 1, Section 36-80	Water service provided by town includes only alternated day outdoor irrigation: • Irrigation of landscape prohibited except in accordance with this section. No person shall use potable water supplied by the town water system to irrigate the landscape on any property except on alternate days assigned to that property for irrigating the landscape. The days of the week on which irrigation of the landscape can take place at a particular property shall be determined by that property's street address. The Town Manager or designee shall develop a Standard Procedure setting forth irrigation days for the various street addresses and other details of alternate day watering. Such Standard Procedure shall be developed, maintained and amended as needed to keep the irrigation days and administration procedures consistent with recommendations from area experts such as the North Carolina Agricultural Extension Service and technological advances. • The use of "reclaimed" or "reused" water, pond water, rainwater and well water or other non-potable water is not governed by this section, nor is the watering of plant material and lawns by use of drip irrigation, watering cans, hand-held hoses, and other hand-held watering tools.
	Code of Ordinances Chapter 36, Division 1, Section 36-83	Water Waste: (Water waste means any of the following) • Using town water so that it falls directly onto impervious surfaces to the extent that running water leaves the property and enters gutters, storm drains, ditches, and other conveyances; or • Using town water to the extent that it is allowed to accumulate on the surface of the ground and leave the property and enter gutters, storm drains, ditches, and other conveyances. • Knowingly allow town water to escape through leaks, breaks, or malfunctions within the water user's plumbing or distribution system for any period of time beyond which such a leak or break should reasonably have been repaired or corrected. • Willfully or negligently wasting water in any other manner. Water waste is prohibited. • The utilities director or designee shall identify persons who waste water. Whenever the director finds that any person wastes water, the director may give such person oral or written notice of that fact, with recommendations as to how the wasting of water can be eliminated. Such recommendations might include, but are not limited to, redirection of sprinkler heads, resetting of system timers, addition of devices to prevent water pressure fluctuations, or changes in location of sprinkler systems. • Whenever the director finds that any person repeatedly or flagrantly wastes water, the director may serve upon such person a written notice ("notice of water waste" or "notice"). Such notice shall be served by personal delivery, by mail, or by certified mail, return receipt requested, and shall identify the person and the location at which water is being wasted while watering, shall identify the manner in which the water is being wasted, and shall specify a time within which the wasting of water shall cease. The notice shall also warn that more severe measures (such as imposition of civil penalties or restriction or termination of water service) may be assessed or brought against the person unless the wasting of water ceases within the time provided. The time given to cease wasting water may range from a requirement for immediate compliance to 30 days, depending upon the facts and circumstances of each case. For instance, if a remedy involves moving a portable hose or sprinkler, immediate compliance may be appropriate; if a remedy involves repairing or replacing a sprinkler head, several days may be required; if the remedy involves more extensive or expensive work, up to 30 days may be necessary. If the remedy is affected, there shall be no further action against that person. • Any person who continues to waste water after the period of time specified in the notice for ceasing such activity shall be issued a citation by personal delivery, mail, or certified mail, return receipt requested, and shall be subject to the civil penalty and enforcement procedures specified in subsection (c) below. The civil penalty shall be paid within 30 days of receipt of the citation.
	Code of Ordinances Chapter 36, Division 1, Section 36-84	Required installation of rain sensors: • New installation: From and after August 14, 1997, rain sensors shall be required on all automatic irrigation systems that will receive town water. • Existing systems: Rain sensors shall be installed on all existing automatic irrigation systems that receive town water on or before May 1, 1998. • Required maintenance: All rain sensors shall be adjusted and set so that they automatically shut off the irrigation system after not more than one-fourth inch of rainfall has occurred. All rain sensors shall be installed according to manufacturer's instructions in a location that will provide full exposure to rainfall such that accuracy of operation is assured and shall be maintained in good working

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		condition. No person shall, with the intent of circumventing the purpose of this section, adjust either the rain sensor or irrigation system so that the rain sensor is not able to override and turn off the irrigation system after one-fourth inch of rain has fallen. • Enforcement: The utilities director or designee shall be responsible for enforcing this section. Whenever the director determines that a violation of this section exists, the director shall issue a written citation identifying the date, location and nature of the violation, the person cited, and specifying the penalty and the date by which the penalty must be paid.
	Code of Ordinances Sec. 36-206 and Sec. 36-218	Mandatory use of reclaimed water for irrigation systems: • It is unlawful to use potable water for irrigation systems 90 days after a property owner or water customer has been notified by the director that reclaimed water is available to a particular property or site. Conservation of water resources: • It is the policy of the town of Cary to wisely use natural resources. In addition to all other conservation measures contained in this chapter the town may terminate, suspend or discontinue reclaimed water service if customer usage of reclaimed water varies substantially from the overall loading rates outlined in the customer's application for service.
Clinton	Code of Ordinances Chapter 22, Article VI, Section 22-204	Water Shortage Response Plan levels of response: • In Stage 1, Voluntary Reductions, all water users will be asked to reduce their normal water use by 5%. Customer education and outreach programs will encourage water conservation and efficiency measures including: irrigating landscapes a maximum of one inch per week; preventing water waste, runoff and watering impervious surfaces; watering plants deeply to encourage root growth; washing only full loads in clothes and dishwashers; using spring-loaded nozzles on garden hoses; and identifying and repairing all water leaks. • In Stage 2, Mandatory Reductions I, all customers are expected to reduce their water use by 10% in comparison to their previous month's water bill. In addition to continuing to encourage all voluntary reduction actions, the following restrictions apply: irrigation is limited to a half-inch per week between 8:00 p.m. and 8:00 a.m.; outdoor use of drinking water for washing impervious surfaces is prohibited; and all testing and training purposes requiring drinking water (e.g. fire protection) will be limited. • In Stage 3, Mandatory Reductions II, customers must continue actions from all previous stages and further reduce water use by 20% compared to their previous month's water bill. All nonessential uses of drinking water are banned and garden and landscape irrigation must be reduced to the minimum amount necessary for survival. Additionally, in Stage 3, a drought surcharge of one and five-tenths (1.5) times the normal water rate may be applied. • In Stage 4, Emergency Reductions, customers must continue all actions from previous stages and further reduce their water use by 25% compared to their previous month's water bill. A ban on all use of drinking water except to protect public health and safety is implemented and drought surcharges of two times the normal water rate may be applied. • In Stage 5, Water Rationing, is to provide drinking water to protect public health (e.g., residences, residential health care facilities and correctional facilities). In Stage 5, all customers are only permitted to use water at the minimum required for public health protection. Firefighting is the only allowable outdoor water use and pickup locations for distributing potable water will be announced according to Clinton's Emergency Response Plan. Drought surcharges of five times the normal water rate may be applied.
	Code of Ordinances Chapter 22, Article VI, Section 22-205	Triggers for Clinton's water source (Groundwater): Stage 1: • Pumping time >10 hrs • Twenty (20) percent reduction in seasonal normal distance from static water level and pump intake • Twenty (20) percent increase pumping time for same output Stage 2: • Pumping time >12 hrs • Forty (40) percent reduction in distance from static water level and pump intake • Forty (40) percent increase pumping time for same output Stage 3: • Pumping time >14 hrs • Sixty (60) percent reduction in distance from static water level and pump intake • Sixty (60) percent increase pumping time for same output

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		Stage 4: • Pumping time >20 hrs • Eighty (80) percent reduction in distance from static water level and pump intake Stage 5: • Water level at pump intake elevation
Durham	Code of Ordinances Chapter 70, Article VI, Section 70-552	**Year-Round Water Efficiency Requirements:** Mandatory Irrigation Efficiency Requirements- • Year-Round Irrigation schedule for spray irrigation systems. o Spray Irrigation. Users shall not operate spray irrigation systems more than three days per week and shall follow the following irrigation schedule: • Even-numbered properties may be irrigated only on Sundays, Wednesdays, and/or Fridays. • Odd-numbered properties may be irrigated only on Tuesdays, Thursdays, and/or Saturdays. • Irrigation may not occur between 10:00 a.m. and 6:00 p.m. o Exemptions from Year Round Requirements. The restrictions in above shall not apply to the following: • Properties using drip irrigation, hand watering, or tree or shrub watering bags. • Watering of containerized plants and commercial plant stock in trade for sale. • Outdoor irrigation necessary to establish newly sodded or seeded lawns or new non-turf plant materials within the first 45 days of planting provided that the customer secures a written license from Director, and prominently displays the license. A limit of two licenses per address per year may be issued, and licenses may be revoked for cause. • Irrigation for a maximum of one day necessary when treatment with an application of chemicals requires immediate watering to preserve an existing landscape or to establish a new landscape, provided that such irrigation does not occur between the hours of 10:00 a.m. and 6:00 p.m. • City water used to control dust or to compact soil when alternate methods are not available. • Visually supervised operation of irrigation systems for short periods of time to check system condition and effectiveness. • City water applied to prevent or abate health, safety, or accident hazards when alternate methods are not available. • City water used for construction or maintenance activities where the application of water is the appropriate methodology and where no other practical alternative exists. • Public purpose athletic fields, recreational fields, and botanical sites operated in compliance with a Water Conservation Plan that has been approved by the Director. The plan must specify the conservation measures and irrigation operating modes to be employed at the site year-round and during successive stages of a declared water shortage. o Sensor requirement for new and existing irrigation systems. Users and installers shall not install automatic irrigation systems of any type without a rain or soil moisture sensor that will prevent irrigation during periods of rainfall and when there is sufficient moisture in the ground for plant health and survival. Existing irrigation systems shall install a rain or soil moisture sensor by November 30, 2009. o Sensor settings. All rain sensors shall be adjusted and set so that they automatically shut off the irrigation system after not more than one-fourth (1/4) inch of rainfall has occurred or an equivalent moisture parameter is reached. All rain sensors shall be installed according to manufacturer's instructions in a location that will provide full exposure to rainfall or appropriate moisture parameter such that accuracy of operation is assured. All rain sensors shall be maintained in good working condition. No person shall adjust either the rain sensor or irrigation system so that the sensor is not able to override and turn off the irrigation system after one-fourth inch of rain has fallen or an equivalent moisture parameter is reached. o Hand operated equipment. All hoses used for hand watering, vehicle washing, or other allowable outdoor uses shall be equipped with shutoff nozzles. o System design. All irrigation systems shall be designed, maintained, and operated to prevent, to the extent practicable, water from flowing onto paved or other impervious surfaces.

<table>
<tr><th>Jurisdiction</th><th>Ordinance or Reference</th><th>Description</th></tr>
<tr><td></td><td>Code of Ordinances Chapter 70, Article VI, Section 70-555</td><td>No User shall:
• Cause or allow run off of City water from landscape areas into adjoining impervious areas, adjacent property, or streets, sidewalks, gutters, stormwater drains, or other paved surfaces as a result of incorrectly directed or maintained sprinklers, irrigation systems, or other application devices, or excessive watering.
• Cause or allow irrigation while precipitation is falling.
• Knowingly allow water to escape through leaks, breaks or malfunction within the water user's plumbing or distribution system for any period of time beyond which such a leak or break should reasonably have been repaired or corrected. All leaks, breaks, or malfunctions shall be corrected within 30 days of identification of the source of the leak.
• Use or allow the use of water or flushing from any public or private fire hydrant for any purpose other than fire suppression, necessary fire hydrant or water distribution system maintenance, public emergency, or with prior approved written exception from the City.
• Willfully or negligently wastewater in a manner not otherwise prohibited above.

The prohibitions listed in the subsections above do not apply to:
• Water waste that occurs prior to June 1, 2009.
• Flow from firefighting, inspection of fire hydrants, fire training activities, or from similar government activities.
• Water applied to prevent or abate health, safety, or other hazards when reasonable alternate methods are not available; and
• Flow resulting from the inspection, operation, or maintenance of a public utility system.</td></tr>
<tr><td></td><td>Water Shortage Response Plan</td><td>Table 5.1: Water Shortage Response Triggers, based on the probability of reaching the percentage of combined remaining storage in Durham's water supply reservoirs in the forecast horizon.
<table><tr><th>Stage</th><th colspan="3">Response Triggers: Probability of Reaching Storage Level in Forecast Horizon</th></tr><tr><th></th><th>Probability of Reaching Storage Level at End of Forecast Horizon</th><th>Forecast Horizon (weeks)</th><th>Combined Usable Storage</th></tr><tr><td>Move to Stage 1</td><td>30 %</td><td>12</td><td>45 %</td></tr><tr><td>Move to Stage 2</td><td>20 %</td><td>10</td><td>35 %</td></tr><tr><td>Move to Stage 3</td><td>10 %</td><td>8</td><td>25 %</td></tr><tr><td>Move to Stage 4 (Emergency)</td><td>5 %</td><td>4</td><td>15 %</td></tr></table></td></tr>
<tr><td></td><td>Code of Ordinances Chapter 70, Article VI, Section 70-564</td><td>Response to water shortage:
• The Director shall report to the City Manager conditions adversely affecting the city water supply that trigger mandatory restrictions prescribed by the City's Water Shortage Response Plan. Upon receiving such report, the City Manager will declare a water shortage to exist and will enact the appropriate stage of water restriction as outlined in the City's Water Shortage Response Plan. The restrictions required under each stage shall be as set forth in this Division. The City Manager or the City Council may terminate any stage of water restriction once the triggers for rescission prescribed by the Water Shortage Response Plan occur. The imposition of drought-related mandatory construction restrictions shall be in accordance with section 70-557 below.</td></tr>
<tr><td></td><td>Code of Ordinances Chapter 70, Article VI, Section 70-565</td><td>Water Conservation Plan Requirements for Large Users and Others:
• All Users of more than 100,000 gallons per day, or that own Botanical Sites, or Recreational Fields, or Golf Courses, and other Users whose water use is determined by the Director to be unique or amenable to individually determined controls shall have a Water Conservation Plan on file with the Department of Water Management. New Users shall submit such a plan within six months of beginning operation, or within such time period as allowed by the Director. The Plan must specify the conservation measures to be used by the site or sites of the entity during successive stages of a declared water shortage, which measures shall be targeted to achieve the general percentage reductions for each stage as set forth in this Ordinance. For Botanical Sites and Recreational Fields, the Plan must specify the irrigation operating modes to be employed at the site year-round and during successive stages of a declared water shortage. The Director may approve, disapprove, or require modifications to the Plan. An approved plan may vary the</td></tr>
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Jurisdiction	Ordinance or Reference	Description
		requirements of this Division. The User shall operate in accordance with the approved Plan and shall keep records as required to document compliance with the Plan. Users that do not have an approved Plan are subject to all of the requirements of this Division.
	Code of Ordinances Chapter 70, Article VI, Section 566	**Mandatory Water Restriction Stages:** **Stage 1 Water Shortage.** Upon declaration of a stage 1 water shortage, users shall comply with the following measures: • Spray Irrigation. Users shall not operate spray irrigation systems more than one day per week as specified by the director and based on the location address. Irrigation may not occur between 10:00 a.m. and 6:00 p.m. • Irrigation Exemptions. The restrictions in (1) above shall not apply to the following: o Properties using drip irrigation, hand watering, or tree or shrub watering bags; o Watering of containerized plants and commercial plant stock in trade for sale; o Irrigation for a maximum of one day necessary when treatment with an application of chemicals requires immediate watering to preserve an existing landscape or to establish a new landscape, provided that such irrigation does not occur between the hours of 10:00 a.m. and 6:00 p.m. o Visually supervised operation of irrigation systems for short periods of time to check system condition and effectiveness; o Recreational fields, golf courses, and botanical sites operated in compliance with an approved Water Conservation Plan; o New landscape exemptions granted prior to the declaration of a water shortage. Such exemptions will continue to be honored until the original expiration date of the exemption. No exemptions shall be issued while a water shortage declaration is in effect. o Properties on which water use is in compliance with an approved Water Conservation Plan. • Additional Requirements. In addition to the above restrictions, no User shall: o Add water to any decorative fountain, pool or pond except where the water is recycled. o Serve water in a restaurant or similar establishment except upon request. o Add water to wading pools or swimming pools except to the extent necessary to replenish losses due to evaporation or spillage and maintain operation of chemical feed equipment. • Water Consumption Reduction Goal. Users of more than 100,000 gallons a day shall attempt to reduce water consumption by 15% and shall document such efforts. The goal for Stage 1 for Water Conservation Plans submitted by large users and other special users shall be to reduce consumption by 15%. **Stage 2 Water Shortage.** Upon declaration of a stage 2 water shortage, users shall continue to comply with Stage 1 measures, and the following additional Stage 2 measures, which supplant Stage 1 requirements where they are more restrictive: • Spray Irrigation. Spray irrigation of landscapes with city water shall be prohibited. • Irrigation Exemptions. The restrictions above shall not apply to the following: o Properties using drip irrigation, hand watering, or tree or shrub watering bags; o Watering of containerized plants and commercial plant stock in trade for sale; o Irrigation for a maximum of one day necessary when treatment with an application of chemicals requires immediate watering to preserve an existing landscape, provided that such irrigation does not occur between the hours of 10:00 a.m. and 6:00 p.m.; o Visually supervised operation of irrigation systems for short periods of time to check system condition and effectiveness; o Recreational fields, golf courses, and botanical sites operated in compliance with an approved Water Conservation Plan; o New landscape exemptions granted prior to the declaration of a water shortage. Such exemptions will continue to be honored until the original expiration date of the exemption. No exemptions shall be issued while a water shortage declaration is in effect. • Vehicle Washing. Users shall not use city water to wash vehicles, except at a commercial or institutional car wash facility. Commercial or institutional car washes shall be allowed to operate if they comply with the requirements of this ordinance. • Surface Washing. No city water shall be used for cleaning or washing exterior building surfaces, decks, or paved areas, such as sidewalks, driveways, roadways and parking lots. This restriction shall NOT apply to the cleaning of exterior surfaces or decks prior to painting or re-painting, or for any surface where a health or safety issue arises.

Jurisdiction	Ordinance or Reference	Description
		• Water Consumption Reduction Goal. Users of more than 100,000 gallons a day shall attempt to reduce water consumption by 30% from pre-declaration consumption and shall document such efforts. The goal for Stage 2 for Water Conservation Plans submitted by large users and other special users shall be to reduce consumption by 30%. **Stage 3 Water Shortage.** Upon declaration of a stage 3 water shortage, Users shall continue to comply with Stage 1 and 2 measures, and the following additional Stage 3 measures, which supplant Stage 1 and 2 requirements where they are more restrictive: • No city water shall be used for the purpose of irrigation except for watering of containerized plants and commercial plant stock in trade for sale. • No city water shall be used for any other outdoor purpose, except for emergency fire suppression or other activities necessary to maintain public health, safety, or welfare. • The use of city water for heating and/or cooling purposes shall be reduced in all but the most essential facilities to the extent practical in consideration of the indoor air quality standards, weather conditions, and health and safety requirements. • No city water shall be used to wash any motor vehicle except at commercial or institutional car washes that are in compliance with the requirements of this ordinance. • Water Consumption Reduction Goal. Users of more than 100,000 gallons a day shall attempt to reduce water consumption by 50% from pre-declaration consumption and shall document such efforts. The goal for Stage 3 for Water Conservation Plans submitted by large users and other special users shall be to reduce consumption by 50%. Notwithstanding the restrictions specified in (c), the protection of public health, safety, and welfare may, under special circumstances, require the use of limited amounts of city water. Such uses shall be permitted during declared water shortages, provided that other practical alternatives are not available, and water is used in the least amount practical. **Stage 4 Water Supply Emergency.** Upon declaration of a water supply emergency, users shall continue to comply with Stage 1, 2, and 3 measures, and the following additional Stage 4 measures, which supplant Stage 1, 2 and 3 requirements where they are more restrictive: • All outdoor uses of water are prohibited, except for emergency fire suppression or other activities necessary to maintain public health, safety, or welfare. • The use of water for washing or cleaning mobile equipment including automobiles, trucks, boats and fleet vehicles is prohibited. • No user shall add water to decorative fountains, pools, or ponds. • No user shall add water to wading pools or swimming pools, including hot tubs, spas and whirlpool tubs except for health and rehabilitative purposes as prescribed by a medical doctor or administered by a medical facility. • All other uses of water will be limited to those necessary to meet minimum health and safety needs of the customers as determined by the city manager upon consultation with the director in light of conditions present. Water service may be discontinued or reduced to designated users or in designated portions of the city service area in order to preserve the availability of water for essential public health and safety requirements, such as fire protection, hospitals, clinics and other critical community needs. • The city manager may enact additional measures aimed at reducing water use for any users as conditions warrant. Users shall comply with any directives issued by the city manager to this effect.
	Code of Ordinances Chapter 70, Article VI, Section 70-567	**Additional drought-related mandatory construction restrictions.** Upon receiving a report from the city manager that additional water conservation measures are necessary to adequately address a water shortage, the city council may declare by resolution that an existing water shortage requires imposition of stage 2, 3, or 4 mandatory drought-related construction restrictions. Such action shall be taken separately from the imposition of water conservation stages described in the previous section of this division. The council's resolution may declare one or more stages of mandatory construction restrictions, and may, additionally authorize the city manager to declare subsequent stages of construction restrictions. The city council may modify or terminate any stage of mandatory drought-related constructions restrictions upon determining that the restrictions are no longer necessary, or by resolution may authorize the manager to do the same. • Stage 2 Water Shortage: Additional Drought-Related Mandatory Construction Restrictions. The following restrictions shall be in place during the time that stage 2 construction restrictions have been declared, until such are modified or terminated: o Water lines permitted prior to imposition of stage 2 construction restrictions may be constructed, flushed, and placed into service.

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		○ Water lines not permitted prior to imposition of stage 2 construction restrictions may be permitted and constructed, but shall be subject to stage 3 construction restrictions if such are declared prior to lines being flushed and placed into service. ○ Structures with existing valid building permits that do not expire may be completed, with necessary individual water connections. ○ Building permits issued after declaration of stage 2 constructions restrictions are subject to stage 3 and/or stage 2 construction restrictions if such are declared prior to the permitting of a water connection or meter installation. ○ All water used for the flushing of water lines shall be collected and used only as permitted by the city. ○ Swimming pools, spas, and hot tubs not already in operation shall only be filled with non-city water, and receipts for purchases of such water shall be retained. Stage 3 Water Shortage: Additional Drought-Related Mandatory Construction Restrictions. The following restrictions shall be added to those in stage 2 above, or, where more exacting, shall supersede those restrictions, during the time that stage 3 construction restrictions are declared, until such as are modified or terminated. ○ Water lines that were not permitted prior to imposition of stage 2 construction restrictions shall not be flushed or placed into service. ○ Water connections and meter installations shall not be allowed for structures that received building permits after stage 3 construction restrictions were declared. ○ Permits for the construction or installation of swimming pools, spas, hot tubs including any associated electrical work shall not be issued. ○ Plans for water lines shall be accepted and reviewed but no permit for extension or construction of a water line shall be issued. ○ All permits for water line extensions not already under construction shall be suspended. • Stage 4 Water Emergency: Additional Mandatory Construction Restrictions. The following restriction(s) shall be added to those in stages 2 and 3 above, or, where more exacting, shall supersede those restrictions, during the time that stage 4 construction restrictions are declared, until such are modified or terminated. ○ Certificates of occupancy for new structures requiring public water service shall not be issued until a return to stage 3 or a lower stage. ○ Exceptions to construction restrictions. Public projects are exempted from the above restrictions. In addition, any person may secure a written license from the city manager or his designee to engage in an activity prohibited under the additional mandatory construction restrictions where one or more of the following circumstances are demonstrated to exist: • Service is for an existing residence with a contaminated or failed well and the residence has access to an existing water line; • Permits are for renovations to an existing structure with water service; • Peculiar and unique hardships exist involving one or more of the following, or similar situations: unsafe or temporary housing, subsidized housing involving unique permitting or financing arrangements; and responses to fire or other disasters which require the construction activity.
Fayetteville PWC	Code of Ordinances Chapter 28, Article V, Section 28-261 to 28-270	• The proper officers of the public works commission, and their agents and assistants, may enter the premises of any water consumer, at any reasonable time, in order to examine the pipes and fixtures, the quantity of water used and the manner of its use. In case of fraudulent use of water on the part of the consumer, or the unnecessary water thereof, the supply of water may be cut off from the premises by order of the public works commission. • It shall be unlawful for any person to permit any yard hydrant, sprinkler or other yard fixture to leak or remain open when not in use.
		It shall be mandatory for every user to comply with the following schedule for the irrigation of outdoor landscaping (such as grass, shrubbery, trees, flowers and vegetable gardens) on a year-round basis: • For addresses that end in the number 1, 3, 5, 7 or 9 watering of lawns, grass, shrubbery, trees, flowers and vegetable gardens using an automatic irrigation or sprinkler system or hose end sprinkling device shall only be done on Sunday, Tuesday and Thursday. For addresses that end in the number 0, 2, 4, 6 or 8 watering shall only be done on Saturday, Monday and Wednesday. Provided, however, that a person regularly engaged in the sale of plants shall be permitted to use water for such purposes at any time or any day. • For new sod, seeded lawns or planted landscapes, the user may water any day of the week as necessary to establish the new plantings for a period of 30 days following the planting.

Jurisdiction	Ordinance or Reference	Description
		• These measures shall remain in effect as long as there has been no stage II, III or IV declaration, as stated in sections 28-267 through 28-269 of this article. If a stage II, III or IV declaration is made, the restrictions therein supersede the conservation measures in this section. • The owner or occupant of any land or building which receives water from the public works commission and that also utilizes water from a well or supply other than that of the public works commission, shall post and maintain in a prominent place thereon a sign furnished by the public works commission, giving public notice of the use of the well or other sources of supply. • In addition, all users should attempt to conserve treated water at all times. Users may refer to PWC's water conservation guidelines for tips and information on various water conservation measures. **Water Conservation Stage I:** When a water shortage alert is declared users should begin limiting the following uses where possible: • Outdoor water use for landscape irrigation. • Washing of automobiles, trucks, trailers, boats, airplanes, or any other type of mobile equipment. • Washing of outside areas such as streets, driveways, service station aprons, parking lots, office buildings, exteriors of existing or newly constructed homes or apartments, and sidewalks. • Introduction of water into any pond, ornamental fountain, pool, or other structure. • Use of water from public or private fire hydrants for purposes other than fire suppression, public emergency, or PWC need. • Use of treated water for dust control or compaction. **Water Conservation Stage II:** When a water shortage warning is declared, the following mandatory conservation measures shall be in effect: • For addresses that end in 1, 3, 5, 7 or 9 watering of lawns, grass, shrubbery, trees, flowers, and vegetable gardens using an automatic irrigation or sprinkler system or hose end sprinkling device shall only be done on Sunday and Thursday. For addresses that end in the number 0, 2, 4, 6 or 8 watering shall only be done on Saturday and Wednesday. A person regularly engaged in the sale of plants shall be permitted to use water for such purposes at any time or any day. • Treated water shall not be intentionally wasted. • All consumers shall reduce consumption to any degree feasible with a goal of reduction of at least 10% of typical consumption. It is the primary responsibility of each user to meet its mandated water use reduction in whatever manner possible, including limitation of operating hours or days, if necessary. **Water Conservation Stage III:** In the event of a water shortage emergency, the following mandatory water conservation measures shall apply. • Watering or sprinkling any lawn, grass, shrubbery, trees or flowers with treated water using an automated irrigation or sprinkler system or hose end sprinkling device is prohibited. Watering is permitted only by a hand-held hose with a spring-loaded nozzle, by container, or by installed drip type irrigation. • Any person regularly engaged in the sale of plants shall be permitted to use automated irrigation or sprinkler systems but only in amounts necessary to prevent the loss of nursery stock. • Treated water shall not be intentionally wasted. • All consumers shall reduce consumption to any degree feasible with a goal of reduction of at least 20% of typical consumption. It is the primary responsibility of each user to meet its mandated water use reduction in whatever manner possible, including limitation of operating hours or days, if necessary. • Restaurants and other food serving establishments shall use single serving utensils, plates and cups and shall serve water only at the patron's request. • The use treated water from hydrants is prohibited except for fire suppression or other public emergency or PWC need. • The use treated water from for dust control or compaction is prohibited unless Consumer demonstrates to PWC the absence of alternative sources

Jurisdiction	Ordinance or Reference	Description

Water Conservation Stage IV: In the event of a water shortage crisis, in addition to the restriction made unlawful heretofore the following mandatory conservation measures shall be in effect:

- Watering any lawn, grass, shrubbery, trees or flowers with treated water is prohibited. Any person regularly engaged in the sale of plants shall be permitted to use automated irrigation or sprinkler systems but only in amounts necessary to prevent the loss of nursery stock. Persons regularly engaged in the sale of plants shall meet the same percent reduction goals as other commercial establishments as stated in this subsection.
- Treated water shall not be intentionally wasted.
- All consumers (to include nursery operations) shall reduce consumption to the degree feasible with a goal of a reduction of at least 30% of typical consumption. It is the primary responsibility of each user to meet its mandated water use reduction in whatever manner possible, including limitation of operating hours or days, if necessary.
- Restaurants and other food serving establishments shall use single serving utensils, plates and cups and shall serve water only at the patron's request.
- The use treated water from hydrants is prohibited except for fire suppression or other public emergency or PWC need.Fire suppression must be maintained but where possible tank trucks shall use untreated water.
- The use treated water from for dust control or compaction is prohibited
- Washing automobiles, trucks, trailers, boats, airplanes, or any other type of mobile equipment is prohibited except at commercial car wash facilities. Commercial car wash facilities shall meet the same percent reduction goals as other commercial establishments as stated in subsection 28-269(3) above.
- The use of treated water to wash down outside areas such as streets, driveways, service station aprons, parking lots, office buildings, exteriors of existing or newly constructed homes or apartments, sidewalks, or patios or use water for other similar purposes is prohibited. Any person regularly engaged in the business of washing such areas shall be permitted to use water for such purposes. Persons engaged in the business of washing such areas shall meet the same percent reduction goals as other commercial establishments as stated in this subsection.
- It The introduction of treated water into any pond, ornamental fountain, or other structure making similar use of water is prohibited.
- Filling newly constructed swimming or wading pools, or refill swimming or wading pools that have been drained is prohibited. Supplementation of water in existing pools shall only be done in amounts necessary to maintain structural integrity or filtration systems.
- The general manager may declare additional measures of mandatory conservation controls such as larger percentage reductions in consumption, banning of all nonessential use, termination of service to specific areas in the water system on a rotating basis, prohibition of all industrial uses of treated water, etc., or necessary to protect the health and safety of the customers of the water system.

1. *Triggers based on water supply:*

Water Conservation Stage	PWC Trigger
Water Shortage Alert	Unusually dry conditions result in severely low stream flows that are consistently below seasonal norms and dry conditions are forecast
Water Shortage Warning	Target flow of the Cape Fear River at Lillington is reduced to 250 CFS or less
Water Shortage Emergency	Daily demands exceed 50% of available flow
Water Shortage Crisis	Daily demands exceed 75% of available flow

2. *Triggers based on wet well levels:*

Water Conservation Stage	Hoffer Wet Well Level (ft.)	River Stage at Fayetteville (ft.)	Elevation at L&D #3 (ft.)
Voluntary Water Shortage Alert	7 consecutive days at 12.4	9.45	29.97
Water Shortage Warning	11.85	8.9	29.42
Water Shortage Emergency	11.35	8.4	28.92
Water Shortage Crisis	10.66	7.66	28.18

3. *Triggers based on daily water demands:*

Water Conservation Stage	PWC Trigger
Voluntary Water Shortage Alert	3 consecutive days of demand exceeding 85% of available capacity
Water Shortage Warning	3 consecutive days of demand exceeding 90% of available capacity
Water Shortage Emergency	5 consecutive days of demand exceeding 90% of available capacity
Water Shortage Crisis	1 day of demand exceeding 100% of available capacity

Jurisdiction	Ordinance or Reference	Description
Fuquay-Varina	Code of Ordinances Part 5, Chapter 1, Article C, Section 5-1031	Annual water conservation measures: • Every Town customer shall comply with the following schedule for the automated irrigation (sprinklers and irrigation systems) of outdoor landscaping, such as grass, shrubbery, trees, flowers and vegetable gardens, from May 1 through October 31 annually: • For customers whose address numbers end in an even digit, such watering shall be restricted to Tuesdays, Thursdays and Saturdays. • For customers whose address numbers end in an odd digit, such watering shall be restricted to Wednesdays, Fridays and Sundays. • Exceptions to these restrictions (on a temporary 45-day basis, with the payment of a permit fee) may be granted for landscapers or property owners engaged in establishing new grass seed, sod or landscaping on a site-by-site basis, by permit issued by the Town. Any person regularly engaged in the sale of plants shall be permitted to use water for such purposes. These annual restrictions do not apply to any citizens that utilize a drip irrigation system.
	Code of Ordinances Part 5, Chapter 1, Article C, Section 5-1034	Water conservation Stage I, water shortage warning: • Whenever the Town experiences a potential Stage I water shortage, the Town Board shall be empowered to declare a water shortage warning. The goal of Stage I conservation measures is to reduce overall consumption by a total of 10%. o An extensive publicity campaign will be initiated with conservation efforts publicized through the general news media or any other appropriate method for making such notification public. When water shortage warning conditions are declared, the following mandatory conservation measures shall be imposed. o It shall be unlawful to use water from the public water system supplied by the Town: • To water lawns, grass, shrubbery, trees, flowers and vegetable gardens except by the schedule outlined undersection 5-1033. • To wash down outside areas such as streets, driveways, service station aprons, parking lots, office buildings, exteriors of existing or newly constructed homes or apartments, sidewalks or patios, or to use water for other similar purposes; provided, however, that any person regularly engaged in the business of washing such areas shall be permitted to use water for such purposes. • To wash vehicles at home on days others than Saturday or Sunday. • To fill new pools or completely refill existing pools.
	Code of Ordinances Part 5, Chapter 1, Article C, Section 5-1035	Water conservation Stage II, water shortage emergency: • When the Town experiences a shortage of treated water, or when the water supply is not adequate to meet normal needs, the Town Board shall be empowered to declare a Stage II water shortage emergency. The declaration shall exist for the duration of the shortage or until it is declared to have ended by the Town. The goal of Stage II conservation measures is to reduce overall consumption by a total of 20%. o In the event of a Stage II water shortage emergency, in addition to the restrictions heretofore imposed, the following mandatory water conservation measures shall apply. It shall be unlawful to use water from the public water system supplied by the Town for the following purposes: • To water lawns, grass, shrubbery, trees, flower and vegetable gardens except by the following schedule: o Odd-numbered addresses may irrigate lawns and landscapes only between 12:00 midnight and 10:00 a.m. on Tuesdays. o Even-numbered addresses may irrigate lawns and landscapes only between 12:00 midnight and 10:00 a.m. on Wednesdays. • To wash any vehicle and equipment, except at a commercial facility that recycles its wash water. • Non-firefighting hydrant use is prohibited. • Any use of potable water in topping off swimming pools is prohibited. • No new water 45-day permits for grass or sod will be issued. • Exceptions to these restrictions are as follows: o Agricultural irrigation is allowed for the production of food or the maintenance of livestock. o Irrigation is allowed for commercial nurseries at a minimum level necessary to maintain stock. o Pools used by health care facilities can be filled.
	Code of Ordinances Part 5, Chapter 1, Article C, Section 5-1036	Water conservation Stage III, water shortage crisis: Whenever the Town Board has declared a water shortage crisis and finds a need to provide for the equitable distribution of critically limited treated water or water supplies to ensure that sufficient treated water is available to preserve public health and safety of the citizens, the Town may enforce a water rationing policy. Such rationing policy shall be approved by the Town Board at the time of the declaration of the water shortage crisis and should be reflective of the following criteria:

Jurisdiction	Ordinance or Reference	Description
		• It is imperative that water customers achieve an immediate further reduction in water use to extend existing water supplies and, at the same time, assure that sufficient water is available to preserve the public health and sanitation and to provide fire protection service. This immediate further reduction in water usage is another step along a continuum of responses to any water shortage crisis. Should the crisis continue, further reductions in water usage may be required. It must be emphasized that additional usage reductions in the rationed area is a valid and attainable goal reflective of the conditions of the crisis. The goal of Stage III conservation measures is to reduce overall consumption by a total of 30%. • The policy must provide for equitable reductions in water usage and for equal sacrifice on the part of each water customer. The success of this policy depends on the cooperation of all water customers in the emergency area. • The policy must ensure that fire protection is maintained. • The policy shall make it unlawful to fail to act in accordance with the restrictions on potable water use or to attempt to evade or avoid such water rationing restrictions. • The policy may include additional measures of mandatory conservation controls such as a percentage reduction in consumption, termination of service to specific areas in the water system on a rotating basis, prohibition of all industrial uses of potable water, and the like, or whatever is necessary to protect the health and safety of the customers of the water system. • In the event of a Stage III water shortage crisis, the following mandatory water conservation measures shall apply. It will be unlawful to use water from the public water system supplied by the Town for the following purposes: o To water or sprinkle any lawn, grass, shrubbery, trees or flowers with potable water supplied by the Town. o To wash automobiles, trucks, boats, airplanes or any other type of mobile equipment, even at commercial facilities that recycle water. o All 45-day grass or sod permits are suspended.
Greensboro	Water Shortage Response Plan	**Stage I Voluntary Restrictions** • Voluntary, commercial, manufacturing, institutional and residential conservation measures will be strongly encouraged and recommended including the following: o Inspect and repair all faulty and defective parts of faucets and toilets. o Use shower for bathing rather than bathtub and limit shower to no more than five (5) minutes. o Do not leave faucets running while shaving, rinsing dishes, or brushing teeth. o Limit use of clothes washers and dishwashers and when used, operate fully loaded. o Limit lawn watering to that necessary for plant survival. o Water shrubbery the minimum required, reusing household water when possible. o Limit vehicle washing. o Do not wash down outside areas such as sidewalks, patios, driveways, etc. o Install water flow restrictions in showerheads and other water saving devices. o Use disposable and biodegradable dishes where possible. o Install water saving devices in toilets such as early closing flapper valves. o Limit hours of water-cooled air conditioners. o Do not fill swimming or wading pools. • Water supply line pressure should be reduced where feasible to reduce water consumption if it will not affect operation of fixtures, equipment, public safety, or health devices. • Conservation in public buildings, institutions, dormitories, and similar facilities is encouraged by reducing pressure at plumbing fixtures, and by installation of restricting devices. • Water conservation should be followed during all phases of construction-related activities. Where appropriate, water needed should be obtained from supplemental sources. **Stage II Mandatory Restrictions** In the event the previous voluntary restrictions are not sufficient to eliminate reductions in water supply reserves and the Water Resources Director determines that the percentage of reservoir system storage drops to Stage II of the Greensboro Water Shortage Response Curves or it is necessary to access supplementary water from the Haw River Transfer Station during this or any subsequent stage of water restrictions, the city manager shall declare Stage II water restrictions to be in effect. It shall be unlawful to:

Jurisdiction	Ordinance or Reference	Description
		• Water lawns, grass, shrubbery, trees, flower and vegetable gardens except by hand held-hose, container, or drip irrigation system; provided, however, that such plantings may be watered by any customer by manual or automated sprinkling one (1) day a week. Customers are allowed to do such sprinkling on the day of their city garbage pickup. Customers who do not have city garbage service, or who have multiple pickups during the week, shall be permitted to sprinkle on Wednesdays only. Provided, however, that a person regularly engaged in the sale of plants shall be permitted to use water, by any method at any time, for irrigation of their commercial stock in trade. • Exceed the following water usage mandate: Public and private customers owning golf courses, and institutional customers owning athletic and playing fields which are separately metered, may water the courses and fields by any method during the hours of 10:00 p.m. till 5:00 a.m. each day and shall reduce water usage by 40% of their average usage during the corresponding billing period for the most recent twelve-month period, in which no stage of this plan was in effect. If no meter readings are recorded or otherwise available for a customer's billing period an average of similar users will be established for the customer by the Water Resources Department. o It is the primary responsibility of each customer to meet its mandated water use reduction in whatever manner possible. o Each such customer shall provide access to city personnel for the purposes of meter reading and monitoring compliance with this plan. o If the mandated reduction in water usage cannot be obtained without threatening health or safety, or if there has been a significant change in the customer's circumstances, the customer may apply to the Water Resources Director for a variance to the mandate. Any appeal of this administrative decision shall be to the superior court as provided by law. o Any customer who exceeds the allotments established pursuant to this water rationing will be subject to the following excess-use water rates. o "Excess-use water rates" will be collected based on the amount by which a customer's use exceeds the water allotments established pursuant to the local water rationing declaration computed on the basis that all water used in excess of the allotment shall be at five (5) times the normal rate. o Any monies collected through excess-use water rates shall be placed in a reserve account that is dedicated to addressing water shortage problems and water conservation initiatives. o Failure of the customer to remit the periodic amount billed within the allotted time may result in termination of water service to the customer pursuant to the water and sewer regulations. o Other restrictions contained in Stage I shall remain voluntary. **Stage III Mandatory Restrictions** In the event the previous voluntary and mandatory restrictions are not sufficient to eliminate reductions in water supply reserves and the Water Resources Director determines that the percentage of reservoir system storage drops to Stage III of the Greensboro Water Shortage Response Curves, the city manager shall declare Stage III water restrictions to be in effect. It shall be unlawful to: • Water or sprinkle any lawn, vegetable garden, grass, shrubbery, trees, or flowers except by a hand-held hose, container, or drip irrigation system. Provided, however, that a person regularly engaged in the sale of plants shall be permitted to use water for irrigation of their commercial stock in trade. • Provided further, that public and private customers owning golf courses, and institutional customers owning athletic and playing fields which are separately metered, may water the courses and fields by any method pursuant to the same terms and conditions set out in Stage II Restrictions except that the mandatory water use reduction shall be 60%. • Operate water-cooled air conditioners or other equipment that does not recycle cooling water, except when health and safety are adversely affected. • Wash automobiles, trucks, trailers, boats, airplanes, or any other type of mobile equipment; except that parts of vehicles may be washed where required by federal, state, or local laws or for safety reasons. Provided, however, that any commercial or business operated car wash facility shall be permitted to use water for such purposes. • Wash down outside areas such as streets, driveways, service station aprons, parking lots, office buildings, exteriors of existing or newly-constructed homes or apartments, sidewalks, or patios, or to use water for similar purposes; provided, however, hand washing of exterior surfaces of a building for the purpose of preparing them for painting shall be permitted. Provided further, licensed commercial pressure washers shall be permitted to operate.

Jurisdiction	Ordinance or Reference	Description
		• Operate or introduce water into any ornamental fountain, pool, or pond or other structure making similar use of water. • Serve drinking water in restaurants, cafeterias, or other food establishments, except as requested. • Use water from any public or private fire hydrants for any purpose other than fire suppression or other public emergency or Water Resources Department need. Provided, however, that water use for construction from a metered hydrant will be allowed if no alternate water source is available. • Use water for dust control. • Use water for any unnecessary purpose or intentionally wastewater. • The owner or occupant of any land or building who receives water from the city and also uses water from a well or other supply shall post a sign thereon, in a conspicuous place, furnished at no cost by the city Water Resources Department giving notice of the use of well or other sources of supply. • All industrial, manufacturing, and commercial enterprises, and all customers with swimming and wading pools and tennis courts, shall reduce consumption to any degree feasible with a goal of a reduction of at least 25% of their usual usage. **Stage IV Mandatory Restrictions** In the event the previous (voluntary and mandatory) restrictions are not sufficient to eliminate reductions in water supply reserves and the Water Resources Director determines that the percentage of reservoir system storage drops to Stage IV of the water shortage response curves, the city manager shall declare Stage IV water restrictions to be in effect. The following mandatory water restrictions, in addition to those imposed in Stage III, shall be imposed. It shall be unlawful to: • Water lawns, grass, shrubbery, trees, flowers and vegetable gardens except by container, drip irrigation system or soaker hose; provided, however, that such plantings may be watered by hand-held hose equipped with a shut off nozzle two (2) days per week on Wednesdays and Saturdays; provided further that water from saturated planting beds shall not run-off onto impervious surfaces such as driveways, sidewalks and streets. Soaker hoses shall not include any device that sprays water into the air. Provided, however, that a person regularly engaged in the sale of plants shall be permitted to use water for irrigation of their commercial stock in trade. • Fill or refill any single-family swimming or wading pool or water any tennis court if a residential customer. • Make any nonessential use of water for commercial or public use. • Exceed the following water usage mandate: Commercial and multi-family swimming pool customers shall reduce water usage by 25% and public and private customers owning golf courses, and institutional customers owning athletic and playing fields which are separately metered, may water the courses and fields by any method and shall reduce water usage by 80%, of their average usage during the corresponding billing period for the most recent twelve-month period, in which no stage of this plan was in effect. If no meter readings are recorded or otherwise available for a customer's billing period an average of similar users will be established for the customer by the Water Resources Department. Such customers include governmental, commercial, industrial, institutional, public, social, multi-family, and all other such users. o It is the primary responsibility of each non-residential customer to meet its mandated water use reduction in whatever manner possible, including limitation of operating hours, or days, if necessary. o Each customer shall provide access to city personnel for the purposes of meter reading and monitoring of compliance with this plan. o If the mandated reduction in water usage cannot be obtained without threatening health or safety, or if there has been a significant change in the customer's circumstances, the customer may apply to the Water Resources Director, or his designee, for a variance to the mandate. Any appeal of this administrative decision shall be to the superior court as provided by law. o Any customer who exceeds the allotments established pursuant to this water rationing will be subject to the following excess-use water rates. o "Excess-use water rates" will be collected based on the amount by which a customer's use exceeds the water allotments established pursuant to the local water rationing declaration computed on the basis that all water used in excess of the allotment shall be at five (5) times the normal rate. o Any monies collected through excess-use water rates shall be placed in a reserve account that is dedicated to addressing water shortage problems and water conservation initiatives.

Jurisdiction	Ordinance or Reference	Description
		○ Failure of the customer to remit the periodic amount billed within the allotted time may result in termination of water service to the customer pursuant to the water and sewer regulations. • All industrial, manufacturing, and commercial enterprises shall reduce consumption to any degree feasible with a goal of a reduction of at least 50% of their average usage as compared with their usage during the corresponding billing period for the most recent twelve-month period in which no stage of this plan was in effect. **Stage V Mandatory Restrictions** In the event previous restrictions are not sufficient to eliminate reductions in water supply reserves and the Water Resources Director determines that the percentage of Reservoir system storage drops to Stage V of the Greensboro Water Shortage Response Curves, the city manager shall declare Stage V water restrictions to be in effect. The city shall be deemed to be in a state of emergency with respect to its water supply and residential customers shall reduce consumption to any degree feasible with a goal of a reduction of at least 25% of their average usage. The following mandatory water restrictions shall be imposed. • Use water outside a structure for any use other than emergencies involving fire or as needed by the Water Resources Department to maintain the system, except that flowers, plants, and shrubs may be watered from a watering can or other container not exceeding three (3) gallons in capacity with used wash water from inside a structure. • Operate an evaporative air conditioning unit which recycles water except during the operating hours of the business. • Wash any vehicle for any purpose, whether inside or outside a structure, except that commercial and business operated car washes may do so as provided in subsection (4) hereof; and provided that parts of vehicles may be washed where required by federal, state, or local laws for health reasons. • Exceed the following water usage mandate: All non-residential customers shall reduce their water usage by 25% except commercial and business operated car washes and non-single family residential customers who operate swimming or wading pools or tennis courts shall reduce such usage by 50%, of their average usage during the corresponding billing period for the most recent twelve-month period, in which no stage of this plan was in effect. If no meter readings are recorded or otherwise available for a customer's billing period an average of similar users will be established for the customer by the Water Resources Department. Non-residential customers include governmental, commercial, industrial, institutional, public, social, and all other such users. ○ It is the primary responsibility of each non-residential customer to meet its mandated water use reduction in whatever manner possible, including limitation of operating hours, or days, if necessary. ○ Each customer shall provide access to city personnel for the purposes of meter reading and monitoring of compliance with this plan. ○ If the mandated reduction in water usage cannot be obtained without threatening health or safety, or if there has been a significant change in the customer's circumstances, the customer may apply to the Water Resources Director, or his designee, for a variance to the mandate. Any appeal of this administrative decision shall be to the superior court as provided by law. ○ Any such customer who exceeds the allotments established pursuant to this water rationing will be subject to the following excess-use water rates. ○ "Excess-use water rates" will be collected based on the amount by which a customer's use exceeds the water allotments established pursuant to the local water rationing declaration computed on the basis that all water used in excess of the allotment shall be at five (5) times the normal rate; except that commercial and business operated car washes and non-single-family swimming and wading pool and tennis court users shall be computed at ten (10) times the normal rate for excess use. ○ Any monies collected through excess-use water rates shall be placed in a reserve account that is dedicated to addressing water shortage problems and water conservation initiatives. ○ Failure of the customer to remit the periodic amount billed within the allotted time may result in termination of water service to the customer pursuant to the water and sewer regulations. • Make any water service connections except as herein provided. Connections to the city water system shall be allowed, but not required, in the following cases if all other requirements of law pertaining to such connections have been met: ○ Lots, upon which construction has been authorized pursuant to a valid building permit issued prior to the effective date of the Stage IV water shortage emergency; provided, that this exemption shall apply for only so long as such building permit remains in effect.

Jurisdiction	Ordinance or Reference	Description
		○ Public and other schools satisfying the compulsory education requirements of the laws of the State of North Carolina, public facilities for sheriff, police, fire protection, hospitals, emergency medical services, and facilities of public service companies regulated as public utilities under the laws of the State of North Carolina. **Stage VI Mandatory Water Restrictions** In the event previous voluntary and mandatory restrictions are not sufficient to eliminate reductions in water supply reserves and the Water Resources Director determines that the percentage of reservoir system storage drops to Stage VI of the Greensboro Water Shortage Response Curves, the city manager shall declare Stage VI water restrictions to be in effect. Residential customers shall continue to reduce consumption to any degree feasible with a goal of a reduction of at least 40% of their average usage. The following mandatory water restrictions shall be imposed. It shall be unlawful to: • Serve food or beverages in restaurants, cafeterias and other commercial food establishments to customers using anything other than disposable plates, saucers, cups, eating utensils, napkins, and tablecloths. • Wash any vehicle for any purpose, whether inside or outside a structure, except those parts of vehicles may be washed where required by federal, state, or local laws, or for health or safety. ○ Exceed the following water usage mandate. All non-residential customers shall reduce their water usage by 50% of their average usage during the corresponding billing period for the most recent twelve-month period, in which no stage of this plan was in effect; except that water shall not be used to fill or top off any swimming or wading pool. If no meter readings are recorded or otherwise available for a customer's billing period an average of similar users will be established for the customer by the Water Resources Department. ○ It is the primary responsibility of each non-residential customer to meet its mandated water use reduction in whatever manner possible, including limitation of operating hours or days if necessary. ○ Each customer shall provide access to city personnel for the purpose of reading and monitoring of compliance with this plan. ○ If the mandated reduction in water usage cannot be obtained without threatening health or safety, or if there has been a significant change in the customer's circumstances, the customer may apply to the Water Resources Director, or his designee, for a variance to the mandate. Any appeal of this administrative decision shall be to the superior court as provided by law. ○ Any water customer who exceeds the allotments established pursuant to this water rationing will be subject to the following excess-use water rates. ○ "Excess-use water rates" will be collected based on the amount by which a customer's monthly use exceeds the water allotments established pursuant to the local water rationing declaration computed on the basis that all water used in excess of the allotment shall be at ten (10) times the normal rate. ○ Failure of the customer to remit the periodic amount billed within the allotted time may result in termination of water service to the customer pursuant to the water and sewer regulations. ○ Make any new service connections to the city water system except for public and other schools satisfying the compulsory education requirements of the laws of the State of North Carolina, public facilities for sheriff, police, fire protection, hospitals and emergency medical services, and facilities of public service companies regulated as public utilities under the laws of the State of North Carolina.
Highpoint	Code of Ordinances Title 8, Chapter 2, Article A, Section 8	**Emergency Water Conservation** If the availability of water so limits the water system that unrestricted use may endanger the adequacy of the supply, the director of public services will make a recommendation to the city manager and he shall recommend that the city council, exercising its discretion in the protection of the public health, safety and welfare, may by resolution adopt such emergency use restrictions, including increased rates, as are reasonably calculated under all conditions to conserve and protect that supply and to ensure a regular flow of water through the water system. Emergency water use regulations and restrictions shall remain in force and effect until the city council determines that the conditions requiring their imposition no longer exist. A Water Shortage Alert may be declared when a water shortage event poses a potential threat to the ability of the water system to meet the needs of its customers currently or in the foreseeable future. Lake levels, average daily use, and remaining reservoir capacities will be monitored on a daily basis during a water shortage event. The Director of Public Services will declare a Phase I – Water Shortage Alert when the remaining capacity of the combined reservoirs is less than 80% of full capacity. Once a Water Shortage Alert has been

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		declared, all City Departments will immediately cease all non-essential uses of potable water, including but not limited to street flushing, fleet washing, and recreational uses. All water customers of the City of High Point (residential, commercial, industrial, and municipal) will be requested to voluntarily reduce water consumption by: • Limit sprinkling and watering of lawns, shrubbery, and flowers to odd or even calendar days, depending on the last digit of their address. For example: 2011 E. Kivett (odd) would water on July 31 (odd) but would not water on August 2 (even). • Restricting private car washing to a minimum and then only on weekends. • Storing drinking water in the refrigerator to avoid trying to run it cool at the tap. • Showering instead of bathing or reducing the depth of water used for a tub bath to no more than 1/4 full. Limit the length of each shower to 5 minutes. • Not leaving faucets running while shaving or rinsing dishes, brushing teeth, etc. • Washing full loads in clothes washers and dishwashers. • Installing water saving devices such as plastic bottles or commercial units in toilet tanks, unless it is already a new water-saving type unit. • Limiting flushing of toilets by multiple usages. • Limiting hours of operation of water-cooled air conditioners where possible. • Not introducing water into pools except to the extent necessary to maintain operation. • Not washing sidewalks, patios, building exteriors, driveways or other areas. • Not introducing water into any decorative fountain, pool or pond. • Not serving water in a public restaurant except upon request. • Not using water for any unnecessary purpose or intentionally wasting water. • All construction activities involving flushing, filling of water lines, disinfection, and street construction must be approved by and scheduled with the Public Services Department **Phase II - Mandatory Conservation:** Mandatory Conservation may be declared when a water shortage event poses a significant threat to the ability of the water system to meet the needs of its customers currently or in the foreseeable future. The Director of Public Services will declare Phase II – Mandatory Conservation when the remaining capacity of the combined reservoirs is less than 60% of full capacity. Once Mandatory Conservation has been declared, in accordance with the Emergency Water Conservation Ordinance, all conservation measures of the Water Shortage Alert will become mandatory. In addition, all water customers of the City of High Point will: • Residential consumption above the first usage bracket (35 units) will be billed at double the normal rate. • Use disposable dishes in residences and restaurants where possible. • Not water lawns at all, except golf course greens. • Water vegetable gardens only between the hours of 4:00 P.M. and 8:00 P.M. on Saturdays. • Fill no swimming pool, hot tub, spa, or replenish any filled pools except to the minimum level essential for the operation of chemical level equipment. • Operate no water-cooled air conditioners or other equipment that does not recycle cooling water, except when health and safety are adversely affected. • Discontinue washing motor vehicles except where 50% or more of the water is recycled. • The Director of Public Services will be empowered to negotiate with all industrial and commercial accounts to ensure that all reasonable conservation measures are implemented. **Phase III - Stringent Conservation:** Stringent Conservation may be declared when a water shortage event poses a serious threat to the ability of the water system to meet the needs of its customers currently or in the foreseeable future. The Director of Public Services will declare Phase III – Stringent Conservation when the remaining capacity of the combined reservoirs is less than 50% of full capacity. Once Stringent Conservation has been declared in accordance with the Emergency Water Conservation Ordinance, all conservation measures of Mandatory Conservation will be in effect. In addition, all water customers of the City of High Point will: • Be charged at double rates for water consumption above 10 units per month.

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		• Use no water outside a structure except in an emergency involving fire. • Operate no evaporative air conditioning units which recycle water except during the operating hours of the business. • Close all swimming pools. • Wash no motor vehicle, including commercial washing facilities. **Phase IV – Water Rationing:** Water Rationing may be declared when a water shortage event poses an imminent threat to the ability of the water system to meet the needs of its customers currently or in the foreseeable future. The Director of Public Services will declare Phase IV – Water Rationing when the remaining capacity of the combined reservoirs is less than 40% of full capacity. Once Water Rationing has been declared in accordance with the Emergency Water Conservation Ordinance, all conservation measures of Stringent Conservation will be in effect. In addition, all water customers of the City of High Point will: • All other uses of water will be limited to those necessary to meet minimum health and safety needs of the customers. • The Director of Public Services shall be empowered to limit the hours of service to different sections of the city on a rotating basis in order to maintain minimum health and safety needs.

Holly Springs	Code of Ordinances, Chapter 16, Article II, Division 2, Section 16-71 to 16-76	**Year-round permanent water conservation:**
		• It shall be unlawful at any time of the year for any person to intentionally or unintentionally waste water, particularly by overwatering landscape by having irrigation nozzles directed so that water sprays onto impervious surfaces (streets, driveways, sidewalks or other hardscaped areas) to the extent that water runs into storm drains and by overwatering grass or landscape to the extent that the soil can no longer absorb water, which then flows off the landscape into the street or down parking lots.
		• Customers violating this section may be imposed a civil fine of up to $100.00 per violation, at the discretion of the town manager or his designee. In the event of multiple (two or more) uncorrected violations, the town manager may direct suspension of water service at the location of the violations.
		
		Stage 0, permanent voluntary seasonal water conservation measures: The Town of Holly Springs shall observe a water conservation season annually from May 1 through September 30, when every town customer will be encouraged to comply on a voluntary basis with the following schedule for the irrigation systems. ("Irrigation systems" are defined as both unattended hose-end sprinklers and automated irrigation systems; however, does not include attended hand-watering, of outdoor landscaping such as grass, shrubbery, trees, flowers and vegetable gardens.) The town manager is empowered to pronounce the same guidelines to be observed during any other time of the year to be consistent with regulations being observed in and declared by the County of Harnett. Customers are encouraged to practice conservation and best landscape management practices, which includes avoiding the overwatering of outdoor landscaping. To this end, the following voluntary practice is strongly encouraged:
		• For customers whose address numbers end in an even digit, such watering shall be encouraged to take place on Mondays, Wednesdays and Saturdays.
		• For customers whose address numbers end in an odd digit, such watering shall be encouraged to take place on Tuesdays, Thursdays and Sundays.
		• Public property (i.e., schools and park athletic fields), golf courses and businesses with plants for sale are not subject to these irrigation schedules; however, such users should keep nonessential watering to the minimum required to maintain safe playing surfaces or to maintain plant inventory.
		  o Hand-watering with containers or hoses, the use of soaker hoses and the use of alternative sources of water to the town's public water supply are not restricted.
		  o During the annual water conservation season, no other uses of water are restricted, except as provided in subsection 16-73(a).
		  o The town will use its best efforts to provide an educational campaign encouraging customers to limit to the extent possible and practical all uses of water.

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		Stage 1 water shortage alert: When a Stage 1 water shortage alert is declared by Harnett County, the town manager is empowered to declare that the following Stage 1 mandatory conservation measures by users of the town's public water supply shall be in effect: • For customers whose address numbers end in an even digit, such watering shall be restricted to between 6:00 a.m. and 10:00 a.m. and between 6:00 p.m. and 10:00 p.m. Mondays, Wednesdays and Saturdays. • For customers whose address numbers end in an odd digit, such watering shall be restricted to between 6:00 a.m. and 10:00 a.m. and between 6:00 p.m. and 10:00 p.m. Tuesdays, Thursdays, and Sundays. • No irrigation from the town's public water supply shall take place on Friday. • Public and private property of social or economic impact in the community (i.e., public and private schools, day care centers, public and private golf courses, public parks and athletic fields) and businesses with plants for sale are not subject to these irrigation schedules; however, such users must keep nonessential watering to the minimum required to maintain safe playing surfaces or to maintain plant inventory. • Hand-watering with containers or hoses, the use of soaker hoses and the use of alternative sources of water to the town's public water supply are not restricted. • Exceptions to these restrictions on a temporary 30-day basis may be granted with a landscape watering permit from the town clerk's office for the purpose of establishing new plantings, including sod, seed (re-seeding and over-seeding are included) landscape beds, and trees. • A fee, as listed on the town's fees and rate schedule and set at $50.00 on the date of adoption of this section, shall be charged for landscape watering permits, except that a waiver of this fee may be provided for those who show evidence of having planted only warm-season hardy grasses, such as Zoyzia, Bermuda, Centipede or St. Augustine or drought-resistant landscaping. Fee waivers will not be granted for the planting of any cool-season grasses such as Rye or Fescue. • During a Stage 1 water shortage alert, no other uses of water are restricted, except as provided in subsection 16-73(a). • The town will provide an educational campaign encouraging customers to limit to the extent possible and practical all uses of water. • The introduction of water into any new pond, ornamental fountain, pool, or other structure should be postponed until the Stage 1 water shortage alert is lifted, except that existing pools and ponds can be filled to remain operational, support aquatic life and provide sanitary conditions for swimmers. The director of water quality or the town manager or his designee may grant exceptions on a case-by-case basis. **Stage 2 water shortage warning:** When a Stage 2 water shortage warning is declared by Harnett County, the Town Manager of the Town of Holly Springs is empowered to declare that the following Stage 2 mandatory conservation measures by users of the town's public water supply shall be in effect: • For customers, whose address numbers end in an even digit, such watering shall be restricted to Wednesdays and Saturdays. • For customers, whose address numbers end in an odd digit, such watering shall be restricted to Thursdays and Sundays. • No irrigation shall take place on Mondays, Tuesdays, or Fridays. • Public and private property of social or economic impact in the community (i.e., public and private schools, day care centers, public and private golf courses, public parks and athletic fields) and businesses with plants for sale are not subject to these irrigation schedules; however, such users must keep nonessential watering to the minimum required to maintain safe playing surfaces or to maintain plant inventory. • Hand-watering with containers or hoses, the use of soaker hoses and the use of alternative sources of water to the town's public water supply are not restricted. • Exceptions to these restrictions on a temporary 30-day basis may be granted with a new landscape establishment permit from the town clerk's office for the purpose of establishing only new plantings, which are defined as the installation of new sod to the entire yard, whole yard first seeding, or large commercial plantings. The permit will be applicable during the installation and for 30 days from substantial completion of the installation. Irrigation will be permitted only during the hours 6:00 a.m. to 10:00 a.m. and from 6:00 p.m. to 10:00 p.m. on any day. During a Stage 2 water shortage warning, permits are not issued for over-seeding unless the Town of Holly Springs environmental office deems such over-seeding necessary to correct soil erosion control violations. • A fee, as listed on the town's fees and rate schedule and which is set at $50.00 on the date of adoption of this section, shall be charged for new landscape establishment permits, except that a waiver of this fee may be provided for those who show evidence of

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		having planted only warm-season hardy grasses, such as Zoyzia, Bermuda, Centipede or St. Augustine or drought-resistant landscaping. Fee waivers will not be granted for the planting of any cool-season grasses such as Rye or Fescue. • The owner or occupant of any land or building which receives water from the Town of Holly Springs and that also utilizes water from a well or supply other than that of the Town of Holly Springs shall post and maintain in a prominent place thereon a sign, placard or sticker furnished by the Town of Holly Springs giving public notice of the use of a well or other source of water. During a Stage 2 water shortage warning, other uses of water are restricted, including as provided in subsection 16-73(a) and as follows: • It shall be unlawful to wash automobiles, trucks, trailers, boats, airplanes, or any other type of mobile equipment except at commercial car wash facilities; except that any person regularly engaged in a commercial operation or public service that requires equipment be washed shall be permitted to use water for such purposes as long as the amount of water being used is minimized. • It shall be unlawful to wash down outside areas such as streets, driveways, service station aprons, parking lots, office buildings, exteriors of existing or newly constructed homes or apartments, sidewalks, or patios, or to use water for other similar purposes; provided, however, that any person regularly engaged in the business of washing such areas shall be permitted to use water for such purposes. • It shall be unlawful to introduce water into any pond, ornamental fountain, or other structure making similar use of water, except that existing pools and ponds can be filled to remain operational, support aquatic life and provide sanitary conditions for swimmers. Electrical and plumbing permits for new swimming pool construction will not be issued until the Stage II water shortage warning is lifted. • It shall be unlawful to use water from public fire hydrants for any purpose other than fire suppression or other public emergency or water department need. The director of water quality or the town manager or his designee may grant exceptions on a case-by-case basis. • It shall be unlawful to use water for dust control or compaction without demonstrating a lack of alternative sources and obtaining written permission from the director of water quality, the town manager or designee. • It shall be unlawful to fill newly constructed swimming or wading pools or refill swimming or wading pools that have been drained, except that the director of water quality, town manager or designee may grant exceptions on a case-by-case basis. • All industrial, manufacturing, and commercial enterprises, other than those listed as "essential use" in section 16-72(5), shall reduce consumption to any degree feasible with a goal of reduction of at least 20%. • The owner or occupant of any land or building which receives water from the Town of Holly Springs and that also utilizes water from a well or supply other than that of the Town of Holly Springs shall post and maintain in a prominent place thereon a sign, placard or sticker furnished by the Town of Holly Springs giving public notice of the use of a well or other source of water. • The town shall make its best efforts to provide an educational campaign encouraging customers to limit to the extent possible and practical all uses of water. **Stage 3 water shortage emergency:** When a Stage 3 water shortage emergency is declared by Harnett County, the town manager is empowered to declare that the following mandatory conservation measures by users of the town's public water supply shall be in effect, in addition to the restrictions heretofore imposed: • It shall be unlawful to water or sprinkle any lawn, grass, shrubbery, trees, or flowers with treated water using an automated irrigation or sprinkler system. Watering is permitted only by hand-held hose with a spring-loaded nozzle, by container, or by installed drip type irrigation. Provided, however, that any person regularly engaged in the sale of plants shall be permitted to use automated irrigation or sprinkler systems but only in amounts necessary to prevent the loss of nursery stock. • It shall be unlawful to re-fill or supplement swimming and/or wading pools from the Town of Holly Springs water supply. • Restaurants and other food serving establishments shall use single-serving utensils, plates, and cups and shall serve water only at the patron's request. • Except as provided in subparagraph (a) above, it shall be unlawful to use treated water outdoors for any reason other than fire suppression, emergencies relating to health and safety issues, or as needed by the Town of Holly Springs to maintain the water system.

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		• All industrial, manufacturing, and commercial enterprises, other than those listed as "essential use" in section 16-72(5), shall reduce consumption to any degree feasible with a goal of reduction of at least 40%. **Stage 4 water shortage crisis:** When a Stage 4 water shortage crisis is declared by Harnett County, the town manager is empowered to declare that the following mandatory conservation measures by users of the town's public water supply shall be in effect, in addition to the restrictions heretofore imposed: • Residential users shall reduce water consumption to a level necessary to sustain human life and the lives of domestic pets and to maintain minimum standards of hygiene and sanitation. • Fire protection must be maintained, but where possible, tank trucks shall use untreated water. • It shall be unlawful to wash automobiles, trucks, trailer, boats, airplanes, or any other type of mobile equipment. • It shall be unlawful to make any nonessential use of treated water for commercial or public use. • All industrial, manufacturing, and commercial enterprises, other than those listed as "essential use" in section 16-72(5), shall reduce consumption to any degree feasible with a goal of reduction of at least 50%. • The manager may declare additional measures of mandatory conservation controls such as larger percentage reductions in consumption, termination of service to specific areas in the water system on a rotating basis, prohibition of all industrial users of treated water, etc. or whatever is necessary to protect the health and safety of the customers of the water system. The town shall make every effort to limit restrictions to those industrial customers producing essential products for the protection of public health, bioterrorism or homeland defense defined as "essential use" in section 16-72.
	Code of Ordinances, Chapter 16, Article IV, Division 3, Section 16-330	**Water Reuse:** Town Code Chapter 16, Article IV (Reclaimed Water Regulation) outlines the requirements for the Town's reclaimed water system, requiring all customers within the reclaimed water service area to connect irrigation systems (and potentially other secondary uses) to the reclaimed water system. It is the Town's policy to provide reclaimed water to meet non-potable water demands with the following objectives: • Reduce potable water demand. • Reduce wastewater discharges into Utley Creek. The Town is currently permitted to distribute 1.5 MGD of reclaimed water and it has been delegated authority from NCDEQ to issue permits for reclaimed water irrigation systems up to 5 acres for both residential and non-residential properties.
Jacksonville	Code of Ordinances, Chapter 26, Article V, Section 26-200 to 26-203 Water Shortage Response Plan	**Level 1 – Voluntary Reductions** Water users are encouraged to reduce their water use and improve water use efficiency; however, no penalties apply for noncompliance. Water supply conditions indicate a potential for shortage. Target reduction of 5%. • To checking plumbing and toilets for leaks, and, if necessary, repair • To repair leaking faucets whenever they develop • To store drinking water in the refrigerator to avoid trying to run it cool at the tap • To use shower for bathing purposes or reduce the depth of water used for tub baths. • To limit showers to four (4) minutes where possible • To refrain from running faucets while shaving, rinsing dishes or brushing teeth • To install water conservation devices in faucets, showerheads and toilets • To limit the use of clothes washers and dishwashers, and when used, to operate fully loaded • To reduce the flushing of toilets to the minimum whenever practical • To limit lawn watering to only when grass shows signs of withering and apply water as slow as possible to achieve deep penetration • To limit shrubbery watering to the minimum, reusing household water when possible • To limit car washing to the minimum • To limit wash downs of outside areas such as sidewalks, patios, driveways, or other similar purposes • To use biodegradable disposable dishes and utensils, both for residential and commercial purposes, where feasible • To review water uses and where feasible to install recycle systems, particularly for commercial and industrial customers

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		• To avoid peak times of use by setting automatic sprinklers system to come on either 3:30 am to 5:30 am, or from 8:00 am to 10:00 am. And then to only water items 2 to 3 times per week. **Level 2 – Mandatory Reductions I** Water users must abide by required water use reduction and efficiency measures; penalties apply for noncompliance. Water supply conditions are significantly lower than the norm and water shortage conditions are expected to persist. Target reduction is 10%. • To water lawns, grass, shrubbery, trees, flower and vegetable gardens except as follows: o Customers located to the north of the center line of U.S. Highway 17 may water lawns, grass, shrubbery, trees, flower and vegetable gardens on Saturday morning between the hours of 6:00 a.m. and 9:00 a.m. o Customers located to the south of the center line of U.S. Highway 17 may water lawns, grass, shrubbery, trees, flower and vegetable gardens on Sunday morning between the hours of 6:00 a.m. and 9:00 a.m. o Persons regularly engaged in the sale of plants shall be permitted to use water for such purposes on Monday, Wednesday and Friday. All such watering is to be done by a hand-held hose or container or drip irrigation system. • To fill newly constructed swimming or wading pools or refill swimming or wading pools which have been drained. A minimal amount of water may be added to maintain continued operation of pools which are in operation at the time the Stage I shortage is placed into effect. • To wash automobiles, trucks, trailers, boats, airplanes, or any other types of mobile equipment, including commercial washing. A person regularly engaged in the business of washing motor vehicles and any commercial car wash facility shall be permitted to use water for such purposes, when at least 50% water savings are documented. • To wash down outside areas such as streets, driveways, service station aprons, parking lots, office buildings, exteriors of existing or newly constructed homes or apartments, sidewalks, or patios, or to use water for other similar purposes. • To operate or introduce municipal system water into any ornamental fountain, pool, pond or other structure making similar use of water. • To use water from public or private fire hydrants for any purpose other than fire suppression or other public emergency. • To use municipal system water for dust control or compaction. • To use water for any unnecessary purpose or to intentionally waste water. **Level 3 – Mandatory Reductions II** Same as in Level 2. Target reduction is 20%. **Level 4 – Emergency Reductions II** Water supply conditions are substantially diminished and pose an imminent threat to human health or environmental integrity. Target reduction is 25%. A ban on all use of drinking water except to protect public health and safety is implemented and drought surcharges increase to 2 times the normal water volume charge shall apply. It shall be unlawful: • To use water outside a structure for any use other than an emergency involving fire. • To introduce water into any swimming pool. • To serve drinking water in restaurants, cafeterias, or other food establishment, except upon request. • To make any nonessential use of water for commercial or public use, and the use of single-service plates is encouraged and recommended in restaurants. • To operate an evaporative air conditioning unit which recycles water, except during the operating hours of the business **Level 5 – Water Rationing** Water supply conditions are substantially diminished and remaining supplies must be allocated to preserve human health and environmental integrity. All customers will be limited in their use of water to those activities required for personal health and safety. Firefighting is the only allowable outdoor water use. Drought surcharges increase to 5 times the normal water volume charge.

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Mebane	Code of Ordinances, Chapter 36, Article II, Division 2, Section 36	**Declaration of voluntary conservation stage I.** A stage 1 condition may be declared when drought conditions appear to be imminent and Graham-Mebane Lake water level declines to a level of 150 days of usable water storage. • An extensive publicity campaign will be initiated using public media and specialized methods to inform the public of an impending water shortage. • Residential conservation measures will be encouraged and recommended including the following: o Use shower for bathing rather than bathtub and limit shower to no more than four minutes. o Limit flushing of toilets by multiple uses. o Do not leave faucets running while brushing teeth, shaving, or rinsing dishes. o Limit use of clothes washers and dishwashers and when used, operate fully loaded. o Limit lawn water to that which is necessary for plants to survive. o Water shrubbery the minimum required, reusing household water when possible. o Limit car washing to the minimum. o Do not wash down the outside areas such as sidewalks, patios, etc. o Install water flow restrictive devices in shower heads. o Use disposable and biodegradable dishes. o Install water saving devices such as water filled plastic bottle or commercial units in toilet tanks. o Limit hours of operation of water cooled air conditioners. • It is recommended that water supply line pressure reducing valves be set to the minimum necessary for effective operations of fixtures and equipment. • Conservation in public buildings, institutions, dormitories, etc. is encouraged by reducing pressure at plumbing fixtures, by installation of restricting devices and shutting down on water flow control devices, and by periodic flushing of urinals. • All residents, businesses and institutions are requested to temporarily delay new landscape work until the water shortage has ended. **Declaration of mandatory stage II.** A stage II condition may be declared when drought conditions are prolonged and Graham-Mebane Lake water level declines to a level of 120 days of usable water storage. • In addition to the restrictions heretofore imposed, the following moderate mandatory water restrictions shall be in effect. It shall be unlawful to use water from the public water system supplied by the city/town for the following purposes: o To water lawns, grass, shrubbery, trees, flower and vegetable gardens except on Saturday between the hours of 6:00 am and 9:00 am. o To fill newly constructed swimming and/or wading pools or refill swimming and/or wading pools, which have been drained. A minimal amount of water may be added to maintain continued operation of pools which are in operation at the time the provisions of a "Mandatory Stage II" are placed into effect. o To operate water-cooled air conditioners or other equipment that does not recycle cooling water, except when health and safety are adversely affected. o To wash automobiles, trucks, trailers, boats, airplanes, or any type of mobile equipment, including commercial washing, except those commercial operations that recycle at least 50% of their water use. o To wash down outside areas such as streets, driveways, service station aprons, parking lots, office buildings, exteriors of existing or newly constructed homes or apartments, sidewalks, or patios, or to use water for other similar purposes. o To operate or introduce water into any ornamental fountain pool or pond or other structure making similar use of water. o To serve drinking water in restaurants, cafeterias, or other food establishments, except upon request. o To use water from public or private fire hydrants for any purpose other than fire suppression or other public emergency, unless authorized by the City Manager for water quality needs. o To use water for dust control or compaction. To use water for any unnecessary purpose or to intentionally waste water. **Declaration of mandatory stage III.** I. A stage III condition may be declared when drought conditions are prolonged and Graham-Mebane Lake water level declines to a level of 90 days of usable water storage. To water or sprinkle any lawn. To water any vegetable garden or ornamental shrubs except during the hours of 6:00 a.m. to 9:00 a.m. on Saturday. Such watering is only to be done by handheld hose or container or drip irrigation system.

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		Declaration of emergency stage IV. A stage IV condition may be declared when drought conditions are persistent and Graham-Mebane Lake water level declines to a level of 60 days of usable water storage. It shall be unlawful: • To use water outside a structure for any use other than an emergency use involving fire. • To operate an evaporative air conditioning unit which recycles water except during the operating hours of the business. • To introduce water into any swimming pool. **Declaration of rationing stage V.** A stage V condition may be declared when all the conditions exist in stage IV and Graham-Mebane Lake water level declines to a level of 30 days of usable water storage. In the event a "rationing stage V" is declared to exist, a system of water rationing shall be put in effect in addition to all previously imposed restrictions. In the event of water rationing in which water will be supplied in the minimal quantities required for the health, welfare, and safety of the citizens in accordance with the following program. • It shall be unlawful to fail to act in accordance therewith or use water in any manner or attempt to evade or avoid such water rationing restrictions. • Fire protection will be maintained, but where possible, tank trucks shall use raw water.
OWASA	Water Shortage Response Plan	**Major Water Conservation Initiatives of OWASA** Following the extreme droughts of 2001-2002 and 2007-2008, OWASA implemented a number of important strategies to reduce and manage customer demands throughout the year, including: • Implementing a permanent process water recycling system at the Jones Ferry Road Water Treatment Plant. This has reduced average daily raw water withdrawals by about 7% since the fall of 2002. • Establishing seasonal water rates for all customers beginning in 2002 and subsequently implemented a five-tiered increasing block rate structure for all individually metered residential customers beginning in 2007. • Implementing a new reclaimed water system to initially serve the University of North Carolina at Chapel Hill. This system reduces drinking water demands by approximately 0.65 million gallons a day (mgd). • Continuing water conservation education and awareness efforts for OWASA customers, including information and technical assistance for customers interested in implementing cost-effective conservation measures. **Triggers for Implementing Water Shortage Response Stages During Extended Droughts:** • OWASA's drought management decisions are guided primarily by the estimated level of risk that usable reservoir storage will decline to 20% (approximately 700 MG) or less during the next 12 months. At a raw water demand level of 7.5 mgd, 700 MG of raw water supply on-hand would meet customer needs for approximately three months during an extreme drought, thus providing time to implement emergency water supply augmentation and conservation measures. • Water supply risk is determined from OWASA's Reservoir Optimization Model (OWASA-ROM), which includes a statistical analysis of 82 years of actual and simulated streamflow records (1926-2007) for the Cane Creek/University Lake/Quarry Reservoir supply system. The model simulates what reservoir storage levels would be under various levels of annual average-day demand, storage volume remaining at a given time of the year, and historical streamflows and evaporation rates. • The average-day demand for the year is adjusted to reflect historical monthly demand ratios for the OWASA system. The model reflects OWASA's operating protocols and the capacities of existing raw water pumping and transmission facilities. It simulates reservoir inflows, levels, and demands on a daily time-step, and evaluates the reliability of the system to meet demands while maintaining a minimum emergency storage reserve target of 20% of total capacity as a margin of safety. • OWASA-ROM has been used to estimate the total reservoir storage volumes (percent remaining) that correspond to approximately 2% (2 years in 82), 10% (8 years in 82) and 20% (16 years in 82) probabilities that reservoir storage will be drawn down to 20% or less of storage during the following 12 months under various annual average-day demand levels and assuming no other action taken to reduce demands and/or augment the supply. • In the late fall, winter, and early spring, when inflows are typically higher and demand lower, reservoir storage can drop to relatively low levels before the risk of drawdown to 20% or less during the following 12 months becomes significant. From late spring through fall, when demand rises and inflows decline, the level of risk for a given demand increases. • This analysis has been used to establish the trigger levels that will automatically result in OWASA's implementation of the various Water Shortage stages and associated restrictions.

Jurisdiction	Ordinance or Reference	Description
		Year-Round Requirements, Policy, and Practice Exterior Use**:** The following outdoor or exterior use requirements shall apply to all customers using OWASA-supplied potable water: • Spray irrigation shall not occur more than three days per week. Even-numbered properties may be irrigated with spray systems only on Sundays, Wednesdays, and/or Fridays. Odd-numbered properties may be irrigated with spray systems only on Tuesdays, Thursdays, and/or Saturdays. All spray irrigation shall occur only between the hours of 6:00 p.m. and 10:00 a.m. and shall apply no more than one inch of water in any given week. These restrictions shall not apply to properties using underground, drip irrigation, micro spray, low precipitation bubblers, soaker hoses, hand watering, tree, or shrub watering bags, or where watering of containerized plants and commercial plant stock in trade is maintained for resale. • All irrigation systems shall be equipped with automatic controllers that activate the system according to a desired frequency and duration and shall also be equipped with rain or soil moisture sensors that will prevent irrigation during periods of rainfall or when there is sufficient moisture in the ground for plant health and survival. • All hoses used for hand watering, vehicle washing, or other allowable outdoor uses shall be equipped with shutoff nozzles. • No exterior use of OWASA-supplied potable water shall result in the flow of water onto adjacent property or public right-of-way, and all irrigation systems shall be designed and maintained to prevent to the extent practicable water from flowing onto paved or other impervious surfaces. • Outdoor water leaks on property or facilities of OWASA customers shall be repaired within ten (10) days of discovery by the customer and/or notification by OWASA. • Owners of public purpose athletic fields, recreational fields, and/or public purpose botanical sites shall not be subject to the year-round limitations of III.A.1.a-e if those facilities are operated in compliance with an OWASA-approved Water Conservation Plan that specifies the conservation measures and irrigation operating modes to be employed at that facility year-round and during successive stages of a declared water shortage. • Unless superseded by the declaration of a Water Supply Shortage or Emergency, the year-round requirements of III.A.1.a and III.A.1.b above shall not apply to the following: o Outdoor irrigation necessary for the establishment of newly sodded or seeded lawns and for the establishment of new non-turf plant materials within the first 45 days of planting, provided that such irrigation occurs only between the hours of 6:00 p.m. and 10:00 a.m. o Irrigation necessary for one day only where treatment with an application of chemicals requires immediate watering to preserve an existing landscape or to establish a new landscape, provided that such irrigation occurs only between the hours of 6:00 p.m. and 10:00 a.m. o Water used to control dust or to compact soil when alternate methods are not available. o Visually supervised operation of watering systems for short periods of time to check system condition and effectiveness. o Water used for construction or maintenance activities where the application of water is the appropriate methodology and where no other practical alternative exists. o Water used for firefighting, firefighter training, fire hose testing, fire pumper testing, and other emergency situation mitigation purposes. • For situations in which there is no practical alternative, OWASA-supplied potable water may be used for other special purposes, such as washing out garbage trucks, cleaning up hazardous or unsanitary materials, etc., or for other purposes necessary to protect public health, safety, and welfare provided that such water is used in the least quantity needed to accomplish the task. **Interior Use** The following indoor or interior use requirements shall apply to all customers using OWASA-supplied potable water: • Restaurants and dining facilities shall serve water only upon request of the customer. • Hotels, motels, and other facilities providing sleeping accommodations shall change bed linens only upon request of the customer, or upon customer changeover, or every five days for long-term customers. • Indoor water leaks on property or facilities of OWASA customers shall be repaired within ten (10) days of discovery by the customer and/or notification by OWASA.

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		Unless superseded by the declaration of a Water Supply Shortage or Emergency, the year-round requirements of III.B.1. above shall not apply to the following: • Visually supervised operation and flushing of plumbing systems for short periods of time to check system condition and effectiveness. • Water used for construction or maintenance activities where the use of water is the appropriate methodology and where no other practical alternative exists. **Year-Round Policy and Practice** It shall be OWASA's policy and practice to publicize periodically water conservation methods, including but not limited to, methods of conserving water both indoors and outdoors; methods of collecting and storing harvested water in appropriate devices, such as rain barrels and cisterns; as well as information about the availability, feasibility and allowable uses of reclaimed water from OWASA. It shall be OWASA's policy to strongly encourage and promote the following voluntary conservation measures year- round, regardless of water supply conditions: • Operate dishwashers and clothes washers only when loaded to their maximum capacity or at water level settings appropriate for the size of the load. • Where not otherwise required, install ultra-low flow toilets, tank dams, flow restrictors (aerators) and low-flow showerheads. • Repair and maintain plumbing systems to prevent water leaks. • Use harvested rainwater and/or reclaimed water for indoor and outdoor purposes where allowable and practical. **Determination of a Water Supply Shortage or Emergency** **Drought Condition Shortage:** OWASA's drought response strategy and Water Supply Shortage declarations will be guided primarily by the risk that OWASA's water supplies will decline to 20% or less of total storage capacity within the next 12-month period. A Stage One Water Shortage declaration will generally correspond to a 2% (or greater) risk that reservoir levels will decline to 20% or less of total storage capacity within the next 12 months; provided, however, that in making such a determination, OWASA will also consider the actual and projected severity of the ongoing drought relative to historical droughts included in OWASA's water supply simulation models; existing and anticipated demand, including expected customer response to water use restrictions; availability of supplemental supplies, including water purchases from neighboring communities; regional water supply conditions, including, but not limited to, the concurrent drought response status of neighboring jurisdictions; guidance or directives from the State of North Carolina; and other elements of reasonable professional judgment and management. More severe Water Supply Shortage Stages will subsequently be declared if the risk level increases and/or if other factors indicate that further action is needed. Similarly, OWASA will reduce the severity of, or rescind, a Water Supply Shortage declaration as the risk level and related factors improve. **Water Treatment, Storage, or Distribution Capacity Shortage** In addition to conditions caused by drought, OWASA may declare a Water Supply Shortage or Emergency whenever customer demand – as averaged over three consecutive days – exceeds 85% of OWASA's capability of treating and delivering water. The stage and duration of such a Water Supply Shortage or Emergency shall be guided by the degree to which customer demands approach or exceed OWASA's capacity to meet those demands and by the degree to which conservation efforts successfully reduce short-term demands. **Disasters and Catastrophic Equipment or Plant Failure Shortage** Any other circumstances, including service losses caused by equipment or facility failure, human error, deliberate act, weather, or other natural disaster, which constrain OWASA's water supply, treatment, or distribution capacity to less than that reasonably needed by its customers, shall constitute a Water Supply Shortage up to and including a Water Supply Emergency, requiring immediate action by OWASA. **Required Actions Under Water Supply Shortage or Emergency Conditions** In the event of a water supply shortage, OWASA shall, using its best professional judgment, determine which of the following stages is the most appropriate response to the estimated level of risk considering factors in IV.A above.

Jurisdiction	Ordinance or Reference	Description
		Stage One (1) Water Shortage In the event that OWASA declares a Stage One Water Shortage, OWASA shall advise the Mayors of Carrboro and Chapel Hill and the Chair of the Orange County Board of Commissioners of its declaration and shall request that they issue Proclamations of a Stage One Water Supply Shortage. Upon OWASA's declaration of a Stage One Water Shortage, the following actions shall be taken with the goal of reducing overall water demand by 10%: • Spray irrigation of turf grass using OWASA-supplied potable water shall not occur more than one day per week with a maximum of one-half inch of water applied to plant material in any given week. Odd-numbered properties shall be allowed to spray irrigate only on Tuesdays; even-numbered properties shall be allowed to spray irrigate only on Thursdays. Spray irrigation of turf grass shall occur only between the hours of 6:00 p.m. and 10:00 a.m. Owners of public purpose athletic fields, recreational fields, and/or public purpose botanical sites shall not be subject to the limitations of this subsection V.A.1 if those facilities are operated in compliance with an OWASA-approved Water Conservation Plan. • Spray irrigation of non-turf plant materials may occur up to three days per week as provided under the year-round requirements specified in Section III.A.1.a. • Irrigation of non-turf plant materials by underground, drip irrigation, micro spray, low precipitation bubblers, soaker hose systems with automatic shutoffs, or by handheld hoses or watering cans may occur at any time or frequency. • Notwithstanding the restrictions specified in Sections V.A.1 through V.A.3, the protection of public health, safety, and welfare may, under special circumstances, require the use of limited amounts of OWASA-supplied potable water for such purposes as washing out garbage trucks, cleaning up hazardous or other materials. Such uses shall be permitted during declared Water Shortages or Emergencies, provided that other practical alternatives are not available and water is used in the least practical amount. **Stage Two (2) Water Shortage** In the event that OWASA declares a Stage Two Water Shortage, OWASA shall advise the Mayors of Carrboro and Chapel Hill and the Chair of the Orange County Board of Commissioners of its declaration and shall request that they issue Proclamations of a Stage Two Water Supply Shortage, if not already issued. Upon OWASA's declaration of a Stage Two Water Shortage, the following actions shall be taken with the goal of reducing overall water demand by 15%: • Spray irrigation of turf grass with OWASA-supplied potable water shall not be permitted, except at public purpose athletic and recreational fields and public purpose botanical sites operating under OWASA-approved Water Conservation Plans. • Spray irrigation of non-turf plant materials shall not occur more than one day per week according to the schedule specified in Section V.A.1 and in quantities of no more than ½ inch per week, except at public purpose botanical sites operating under OWASA- approved Water Conservation Plans. • Irrigation of non-turf plant material by underground, drip irrigation, micro spray, low precipitation bubblers, soaker hose systems with automatic shutoffs, tree or shrub watering bags, or by hand held hoses or watering cans may occur at any time or frequency. • No OWASA-supplied potable water shall be used to re-fill ornamental fountains, ponds, and like devices; provided, however, that OWASA water may be used to fill and re-fill bird baths and other backyard-scale facilities used to support wildlife. • No OWASA-supplied potable water shall be used for washing vehicles, except at commercial or institutional car washes in which at least 50% of the water has either been recycled, is from a non- potable source, or is supplied by a well. • No OWASA-supplied potable water shall be used for cleaning or washing exterior building surfaces, decks, or paved areas, such as sidewalks, driveways, roadways, and parking lots. This restriction shall not apply to the cleaning of exterior building surfaces or decks prior to painting or re-painting. • No OWASA-supplied potable water shall be used for fire department training or equipment testing unless required by State or Federal regulations. • Notwithstanding the restrictions specified in Sections V.B.1 through V.B.7, the protection of public health, safety, and welfare may, under special circumstances, require the use of limited amounts of OWASA-supplied potable water for such purposes as washing out garbage trucks, cleaning up hazardous or other materials. • Such uses shall be permitted during declared Water Shortages or Emergencies, provided that other practical alternatives are not available and water is used in the least practical amount.

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		Stage Three (3) Water Shortage In the event that OWASA declares a Stage Three Water Shortage, OWASA shall advise the Mayors of Carrboro and Chapel Hill and the Chair of the Orange County Board of Commissioners of its declaration and shall request that they issue Proclamations of a Stage Three Water Supply Shortage, if not already issued. Upon OWASA's declaration of a Stage Three Water Shortage, the following actions shall be taken with the goal of reducing overall water demand by 20%: • The use of OWASA-supplied potable water for heating and/or cooling purposes shall be reduced in all but the most essential facilities to the extent practical in consideration of indoor air quality standards, weather conditions, and health and safety requirements. • No OWASA-supplied potable water shall be used for irrigation of turf grass, except for public purpose athletic and/or recreational fields and public purpose botanical sites operating under water conservation plans that have been approved by OWASA's Executive Director or by his/her designee. • No OWASA-supplied potable water shall be used for irrigating non-turf plant material unless applied (a) via hand held hoses or watering cans, watering bags, drip irrigation or soaker hoses, or (b) at public purpose botanical sites operating under OWASA-approved Water Conservation Plans. • OWASA-supplied potable water may be used to fill, re-fill, or top off swimming pools, or to fill or re-fill bird baths and other backyard-scale facilities used to support wildlife. OWASA supplied potable water shall not be used for any other outdoor purposes, except for emergency fire suppression or other activities necessary to maintain public health, safety, or welfare. • No bulk sale of potable OWASA water shall occur except for the wholesale transmission of potable OWASA water to neighboring communities, or for other purposes necessary to maintain public health, safety, or welfare. • No OWASA-supplied potable water may be used for washing any vehicles. • No OWASA-supplied potable water may be used for pressure washing building exteriors. • No OWASA-supplied potable water may be used for fire department training or equipment testing. • Notwithstanding the restrictions specified in Sections V.C.1 through V.C.8, the protection of public health, safety, and welfare may, under special circumstances, require the use of limited amounts of OWASA-supplied potable water for such purposes as washing out garbage trucks, cleaning up hazardous or other materials. Such uses shall be permitted during declared Water Shortages or Emergencies, provided that other practical alternatives are not available and water is used in the least practical amount. **Water Supply Emergency** In the event that OWASA declares a Water Supply Emergency, OWASA shall so advise the Mayors of Carrboro and Chapel Hill and the Chair of the Orange County Board of Commissioners and shall request the issuance of a Proclamation of a Water Supply Emergency. In addition to those applicable measures listed above for a Stage Three Water Shortage, the following actions shall be taken upon OWASA's declaration of a Water Supply Emergency: • No OWASA-supplied potable water may be used for any outdoor purposes other than emergency fire suppression or other activities necessary to maintain public health, safety, or welfare. • No OWASA-supplied potable water shall be used to fill, refill or top off the water level in any private or public purpose swimming pool. • No OWASA-supplied potable water shall be used for the flushing or pressure testing of new distribution lines unless that water is returned to the OWASA water supply system through methods approved by OWASA. This restriction shall not apply to the testing of in-building fire control sprinkler systems • The use of OWASA-supplied potable water for heating and/or cooling purposes shall be reduced in all but the most essential facilities to the extent practical in consideration of indoor air quality standards, weather conditions, and health and safety requirements. • Water service may be discontinued or reduced to designated users or in designated portions of the OWASA service area in order to preserve the availability of water for essential public health and safety requirements, such as fire protection, hospitals, clinics, and other critical community needs.

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Pittsboro	Chatham County Code of Ordinances, Title V, Chapter 51	**Year-round practices shall include:**
		Automatic irrigation shall be regulated according to the following attached schedule and time: (see attachment)
		• All irrigation is limited to 1 inch per week.
		• Automatic controllers or moisture sensors are required on all irrigation systems.
		• Wasteful water use is prohibited. Non-beneficial uses include, but are not limited to:
		  o Landscape water applied in such a manner, rate and/or quantity that it overflows the landscaped area being watered and runs onto adjacent property or public right-of-way; or landscape water applied during periods of rainfall or when soil moisture is already adequate.
		  o The use of water for washing vehicles, equipment, or hard surfaces, such as parking lots, aprons, pads, driveways, or other surfaced areas, in such quantities to flow onto adjacent property or the public right-of-way
		  o Water applied in sufficient quantity to cause ponding on impervious surfaces.
		  o Water lost through plumbing leaks that can be readily identified and corrected.
		• Water leaks on property or facilities of Chatham County customers must be repaired within ten (10) days of discovery.
		
		Unless superseded by the declaration of a water supply shortage or emergency, the year-round requirements outlined above shall not apply to the following:
		• Outdoor irrigation necessary for the establishment of newly sodded or seeded lawns and landscaping within the first 30 days of planting.
		• Irrigation necessary for one day only where treatment with an application of chemicals requires immediate watering to preserve an existing landscape or to establish a new landscape.
		• Water used to control dust or to compact soil when alternate methods are not available.
		• Visually supervised operation of watering systems for short periods of time to check system condition and effectiveness.
		• Water applied to prevent or abate health, safety, or accident hazards where alternate methods are not available.
		• Water used for construction or maintenance activities where the application of water is the appropriate methodology and where no practical alternative exits.
		• Water used for firefighting, firefighter training, fire hose testing, fire pumper testing, and other emergency situation mitigation purposes.
		• For situations in which there is no practical alternative, Chatham County-supplied potable water may be used for other special purposes, such as washing out garbage trucks, cleaning up hazardous or unsanitary materials, etc., or provided that such water is used in the least quantity needed to accomplish the task.

Wilmington / Cape Fear Public Utility Authority	Code of Ordinances Chapter 3, Section 3-1 to 3-9	**Waste or misuse of water:** No person shall intentionally waste or misuse potable water. **Declaration of water emergency:** The Executive Director or designee is authorized to declare that a water emergency exists. Depending on the severity of the emergency, staged water use restrictions as described in this article shall be imposed upon all water customers. **Staged water use restrictions:** **Normal conditions:** Water conservation measures and best management practices are encouraged at all times. To implement such practices, persons shall: • Inspect and repair all faulty and defective parts of faucets and toilets. • Inspect and repair all faulty and defective parts of sprinklers, hoses, and outdoor spigots. • Turn off faucets running during shaving, brushing teeth, rinsing or preparing food. • Limit the use of clothes washers and dishwashers. When used, operate fully loaded. • Install water saving showerheads, faucet aerators, and other water saving devices. • Equip all hoses with nozzles or trigger devices. • Water lawns and gardens only when necessary; take rainfall events into account and avoid over-watering. • Limit showers to five minutes or less. • Install water saving devices in toilets such as early closing flappers.

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		• Not use water from a public or private fire hydrant except for firefighting and fire protection purposes; testing or training purposes with adequate notification; approved flushing of water/sewer lines to protect public health and safety; authorized use by special use permit holders; for other public emergency or as authorized by the Executive Director or designee. **Stage 1:** A Stage 1 water emergency shall be declared if water use under the normal conditions and voluntary water conservation best management practices have not resulted in sufficient reduction of the average day customer water demand from the water distribution systems; or, when LCFWASA declares a Stage 1 raw water emergency; or when there are five consecutive days when CFPUA customer water demand exceeds 85 percent of the water production capacity; or it is necessary to implement additional mandatory water use rules to protect the public health, safety, and welfare through the provision of adequate water for essential water use; or the declaration of a D1 drought has been issued. During a declared Stage 1 water emergency the following water conservation measures shall be in effect: • Irrigation water must be applied slowly to achieve deep penetration and prevent water run-off. Overspray and direct watering of impervious surfaces such as streets, parking lots, driveways, and sidewalks is prohibited. • Automatic spray irrigation and non-automatic spray irrigation systems: o May be used between 12:00 midnight and 6:00 a.m. o Properties with odd-numbered addresses (ending in one, three, five, seven, or nine) may irrigate on Tuesday, Thursday, and Saturday. o Properties with even-numbered addresses (ending in zero, two, four, six, or eight) may irrigate on Wednesday, Friday, and Sunday. o No irrigation is allowed on Monday. • Non-spray hose end sprinklers: o May be used between 6:00 a.m. and 10:00 a.m.; 6:00 p.m. and 10:00 p.m. o Properties with odd-numbered addresses (ending in one, three, five, seven or nine) may irrigate on Tuesday, Thursday, and Saturday. o Properties with even-numbered addresses (ending in zero, two, four, six or eight) may irrigate on Wednesday, Friday, and Sunday. o No irrigation is allowed on Monday. • Hand-held hose end watering devices used for irrigation or cleaning purposes must be equipped with a nozzle or trigger device and are allowed at any time. • Low volume drip irrigation is allowed any time. • The watering restrictions shall not apply to: o Properties that do not use water from a public water system for landscape irrigation; o Watering of commercial containerized plants and commercial plant stock in trade maintained for sale; o Visually supervised operation of watering systems for short periods of time to check system conditions and routine maintenance of system; o New lawns and landscapes. o Large commercial, industrial, institutional irrigation systems or golf courses that have received prior approval of a submitted 10% reduction plan. • Using water from a public or private fire hydrant is prohibited except for firefighting and fire protection purposes; testing or training purposes with adequate notification; approved flushing of water/sewer lines to protect public health and safety; authorized use by special use permit holders; for other public emergency or as authorized by the Executive Director or designee. • Using water from a public or private fire hydrant is prohibited except for firefighting and fire protection purposes; testing or training purposes with adequate notification; approved flushing of water/sewer lines to protect public health and safety; authorized use by special use permit holders; for other public emergency or as authorized by the Executive Director or designee. • Lawn/landscape chemical application: Irrigation for a maximum of one day when treatment with an application of chemicals requires immediate watering to preserve the existing landscape or to establish a new landscape. • Restaurants, eating/drinking establishments: no restrictions.

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		• Swimming pools, wading pools, hot tubs, pas, whirlpool tubs: no restrictions. • Pressure washing: no restrictions. • Vehicle washing: no restrictions. • Fountains, artificial waterfalls, misting machines, reflecting pools, ornamental ponds: no restrictions. • Non-essential use, leaks, and water waste: prohibited. **Stage 2**: A Stage 2 water emergency shall be declared in the event of an immediate water shortage; or when LCFWASA declares a Stage 2 raw water emergency; or when there are three consecutive days when CFPUA customer water demand exceeds 90% of the water production capacity; or, it is necessary to implement additional mandatory water use rules to protect the public health, safety, and welfare through the provision of adequate water for essential water use; or the declaration of a D2 drought has been issued. During a declared Stage 2 water emergency the following water conservation measures shall be in effect: • Irrigation water must be applied slowly to achieve deep penetration and prevent water run-off. Overspray and direct watering of impervious surfaces such as streets, parking lots, driveways, and sidewalks is prohibited. • Automatic spray irrigation and non-automatic spray irrigation systems: o May be used between 12:00 midnight and 6:00 a.m. o Properties with odd-numbered addresses (ending in one, three, five, seven, or nine) may irrigate on Tuesday, Thursday, and Saturday. o Properties with even-numbered addresses (ending in zero, two, four, six, or eight) may irrigate on Monday and Thursday. • Non-spray hose end sprinklers: o May be used between 6:00 p.m. and 10:00 p.m. o Properties with odd-numbered addresses (ending in one, three, five, seven, or nine) may irrigate on Tuesday and Friday. o Properties with even-numbered addresses (ending in zero, two, four, six, or eight) may irrigate on Wednesday, Friday, and Sunday. o No irrigation is allowed on Monday. • Non-spray hose end sprinklers: o May be used between 6:00 a.m. and 10:00 p.m. o Properties with odd-numbered addresses (ending in one, three, five, seven or nine) may irrigate on Tuesday, Thursday, and Saturday. o Properties with even-numbered addresses (ending in zero, two, four, six or eight) may irrigate on Wednesday, Friday, and Sunday. o No irrigation is allowed on Monday. • Hand-held hose end watering devices for irrigation purposes must be equipped with a nozzle or trigger device. • Low volume drip irrigation is allowed any time. • The watering restrictions shall not apply to: o Properties that do not use water from a public water system for landscape irrigation; o Watering of commercial containerized plants and commercial plant stock in trade maintained for sale; o Visually supervised operation of watering systems for short periods of time to check system conditions and routine maintenance of system; o Large commercial, industrial, institutional irrigation systems or golf courses that have received prior approval of a submitted 30% reduction plan. o Commercial or residential customers may obtain a 30-day new lawn/landscape establishment permit from the Water Treatment Division for the purpose of establishing new plantings. New plantings, for the purpose of this permit, are defined as the installation of new sod to the entire yard, whole yard first seeding, or large commercial plantings. The permit will be applicable during the installation and for 30 days from substantial completion of the installation. Upon expiration of 30-day establishment period, the customer must establish a watering schedule that follows the restrictions of the water emergency stage that is currently declared.

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		• Hand-held hose end watering devices for cleaning purposes must be equipped with nozzle or trigger device. Commercial users may wash down surfaces when necessary to preserve public health and safety. Residential use is limited to Saturday and Sunday only for purposes of public health and safety. • Using water from a public or private fire hydrant is prohibited except for firefighting and fire protection purposes; testing or training purposes with adequate notification; approved flushing of water/sewer lines to protect public health and safety; authorized use by special use permit holders; for other public emergency or as authorized by the Executive Director or designee. • Lawn/landscape chemical application: Irrigation for a maximum of one day when treatment with an application of chemicals requires immediate watering to preserve the existing landscape or to establish a new landscape. • Restaurants, eating/drinking establishments: no restrictions. • Swimming pools, wading pools, hot tubs, pas, whirlpool tubs: Topping off pools, hot tubs, spas, etc., using minimal amount necessary to maintain structural integrity and filtration system is allowed. No pool filling is allowed. • Pressure washing: no restrictions. • Vehicle washing: no restrictions. • Fountains, artificial waterfalls, misting machines, reflecting pools, ornamental ponds: no restrictions. • Non-essential use, leaks, and water waste: prohibited. **Stage 3:** A Stage 3 water emergency shall be declared in the event of an immediate water shortage; or when LCFWASA declares a Stage 3 raw water emergency; or when there are five consecutive days when CFPUA customer water demand exceeds 90% of the water production capacity; or, it is necessary to implement additional mandatory water use rules to protect the public health, safety, and welfare through the provision of adequate water for essential water use; or the declaration of a D3 drought has been issued. During a declared Stage 3 water emergency the following water conservation measures shall be in effect: • Automatic spray irrigation and non-automatic spray irrigation systems: prohibited • Non-spray hose end sprinklers: prohibited. • Hand-held hose end watering devices for irrigation purposes: prohibited. • Low volume drip irrigation: prohibited. • The watering restrictions shall not apply to: o Properties that do not use water from a public water system for landscape irrigation; o Watering of commercial containerized plants and commercial plant stock in trade maintained for sale; o Visually supervised operation of watering systems for short periods of time to check system conditions and routine maintenance of system; o Large commercial, industrial, institutional irrigation systems or golf courses that have received prior approval of a submitted 50% reduction plan. o Commercial or residential customers may obtain a 30-day new lawn/landscape establishment permit prior to the issuance of the Stage 3 advisory may irrigate any day for 30 days. New plantings, for the purpose of this permit, are defined as the installation of new sod to the entire yard, whole yard first seeding, or large commercial plantings. The permit will be applicable during the installation and for 30 days from substantial completion of the installation. Upon expiration of 30-day establishment period, the customer must establish a watering schedule that follows the restrictions of the water emergency stage that is currently declared. No new permits will be issued after the declaration of a Stage 3 advisory. • Hand-held hose end watering devices for cleaning purposes: prohibited. • Swimming pools, wading pools, hot tubs, pas, whirlpool tubs: Those that use recycled or non-potable water may continue to operate. Non-recyclable units may use minimum amount of make-up water necessary to maintain aquatic life. Topping off pools, hot tubs, spas, etc., using the minimum amount necessary to maintain structural integrity and filtration system is allowed. No pool filling is allowed. • Using water from a public or private fire hydrant is prohibited except for firefighting and fire protection purposes; testing or training purposes with adequate notification; approved flushing of water/sewer lines to protect public health and safety; authorized use by special use permit holders; for other public emergency or as authorized by the Executive Director or designee. • Lawn/landscape chemical application: prohibited

Jurisdiction	Ordinance or Reference	Description

		• Pressure washing: Commercial use or maintenance and/or sanitary and health purposes is allowed; washing horizontal surfaces is prohibited except in the preparation for painting, recoating or sealing. Residential use is prohibited.
		• Restaurants, eating/drinking establishments: Drinking water is prohibited unless requested by a customer.
		• Vehicle washing: residential washing prohibited.
		• Commercial car washes: Operating commercial car washes that utilize the industry's best management practices for the efficient use of water and those that recycle, reclaim, or reuse a portion of their wash water are allowed. Those that do not recycle water must reduce total water consumption by 20 percent from the previous month. Car dealerships may clean vehicles, using less than five gallons of water per vehicle, in preparation for display in a dealer's showroom, upon receipt from manufacturer or prior owner, and following a sale prior to delivery to the purchaser. Cleaning of construction, emergency, transport, or public transportation vehicles is allowed if necessary to preserve proper functioning and safe operation of vehicle.
		• Flushing boat engines is allowed if necessary to preserve the proper functioning and safe operation.
		• Fountains, artificial waterfalls, misting machines, reflecting pools, ornamental ponds that use recycled or non-potable water may continue to operate. Non-recyclable units may use minimum amount of make-up water necessary to maintain aquatic life.
		• Using potable water to control or compact dust is prohibited.
		
		Stage 4: A Stage 4 water emergency shall be declared in the event of an immediate water shortage; or when LCFWASA declares a Stage 4 raw water emergency; or when there is one day when CFPUA customer water demand exceeds 100% of the water production capacity; or, it is necessary to implement additional mandatory water use rules to protect the public health, safety, and welfare through the provision of adequate water for essential water use; or the declaration of a D4 drought has been issued. During a declared Stage 4 water emergency the following activities shall be prohibited:
		• Irrigation uses from the public water supply, including:
		  ○ Watering by automatic spray irrigation and non-automatic spray irrigation systems;
		  ○ Watering by hose end sprinklers;
		  ○ Watering by hand-held hoses;
		  ○ Watering by low volume drip irrigation;
		  ○ The watering restrictions shall not apply to low volume drip irrigation for watering of commercial containerized plants and commercial plant stock in trade maintained for sale.
		• No new lawn/landscape establishment permits will be issued after the declaration of a Stage 4 advisory. Active permits and those issued prior to the declaration of a Stage 4 advisory will be honored if deemed practical by the Executive Director or designee.
		• Large commercial, industrial, institutional irrigation systems or irrigation of golf courses are prohibited.
		• Using hand-held hoses for cleaning purposes is prohibited.
		• Filling of newly constructed or existing swimming pools, wading pools, hot tubs, spas, whirlpool tubs; topping off pools, hot tubs, spas, etc., is prohibited.
		• Using water from a public or private fire hydrant is prohibited except for firefighting and fire protection purposes. Flushing of water/sewer lines to protect public health and safety requires approval by the Executive Director or designee. No water is to be used by special water use permittees unless authorized by the Executive Director or designee.
		• Lawn/landscape chemical application: Prohibited.
		• Commercial and residential pressure washing.
		• Serving drinking water in restaurants or eating/drinking establishments is prohibited.
		• Washing vehicles at any location is strictly prohibited.
		• Use of potable water for fountains, artificial waterfalls, misting machines, reflecting pools, and ornamental ponds is prohibited.
		• Using potable water to control or compact dust is prohibited.
		• Operating water-cooled air conditioners or other equipment that does not recycle cooling water is prohibited, except when health and safety are adversely affected.

Appendix E: Alternatives Analysis Project Cost Opinions

Environmental Impact Statement: IBT Cape Fear River Basin to Neuse River Basin

Opinion of Probable Construction and Project Costs - Conceptual Level Estimate

Alternative 1: Surface Water, Purchase Finished Water from Raleigh Water
Implementation Schedule: 20 to 30 years, use 20 years for start of construction 2044

Improvement	Quantity	Unit	Estimated Construction Cost 2024$	Estimated Project Cost 2024$	Estimated Project Cost in 2044$	Comments
New reservoir on Middle Creek (Town funds 50% of reservoir)						
Property acquisition	1,100	acres		$ 44,000,000	$ 52,051,500	$40,000 per acre (some properties have structures), includes administrative and technical costs
Dam and Foundation	1	LS	$ 20,975,747	$ 31,359,000	$ 37,097,500	$13.6M escalated from Raleigh Water Little River EIS Middle Creek alternative
Clearing and Grubbing	914	acres	$ 26,231,800	$ 39,217,000	$ 46,393,000	$28,700/acre from Johnston County 210 WWTF Schedule of Values ($172,000 for 6 acres)
Wetland and Stream Mitigation	1	LS		$ 25,999,100	$ 30,756,500	From EIS Section 5
New Bridge over HW 42	1	LS	$ 6,500,000	$ 9,718,000	$ 11,496,500	Estimated from NCDOT data
New raw water intake and pump station (22.6 mgd) (Town funds 50%)	1	LS	$ 13,786,000	$ 20,610,000	$ 24,381,500	Unit costs based on Sanford Design
New raw water transmission main, 7.14 miles (Town funds 50%)	37,699	feet	$ 40,715,136	$ 60,869,000	$ 72,007,000	36-inch diameter
Expansion of Dempsey E. Benton WTP, 20 to 42.6 mgd (Town funds 50%)	1	LS		$ 316,400,000	$ 374,297,000	Includes property acquisition and engineering
New finished water transmission main, 9.41 miles	49,685	feet	$ 44,716,320	$ 66,851,000	$ 158,168,000	30-inch diameter
New booster pump station	1	LS	$ 3,250,000	$ 4,859,000	$ 11,496,000	Estimated from Sanford Conveyance
New elevated water tank	1	LS	$ 5,000,000	$ 7,475,000	$ 17,686,000	1 MG
Instream Flow Study (Town funds 50%)	1	LS		$ -	$ 1,000,000	From EIS Section 1.5
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
TOTAL			$ 161,200,000	$ 627,400,000	$ 836,800,000	

Notes:

Contingency per AACE Class 5 estimate	30%	
Engineering Factor (Design and Construction Phase Services)	15%	

Escalation

Baseline year	2024	
Planning year end	2044	
Number of years	20	
Interest Rate, 30 years	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	2.366	(F/P, i%, n) = (1 + i%)^n

Environmental Impact Statement: IBT Cape Fear River Basin to Neuse River Basin

Opinion of Probable Construction and Project Costs - Conceptual Level Estimate

Alternative 2: Surface Water, Purchase Finished Water from Johnston County
Implementation Schedule: 10 years 2034

Improvement	Quantity	Unit	Estimated Construction Cost 2024$	Estimated Project Cost 2024$	Estimated Project Cost in 2034$	Comments
New raw water intake and pump station (13 mgd)	1	LS	$ 7,930,000	$ 11,855,000	$ 18,235,000	Unit costs based on Sanford WTP Design
New raw water transmission main (from Neuse River to quarry), 12 miles	63,360	feet	$ 57,024,000	$ 85,251,000	$ 131,131,000	30-inch dia
New raw water transmission main (quarry to new WTP), 36 miles	190,080	feet	$ 171,072,000	$ 255,753,000	$ 393,392,000	30-inch dia
New raw water quarry pump station	1	LS	$ 7,930,000	$ 11,855,000	$ 18,235,000	Unit costs based on Sanford Design
New booster pump station	1	LS	$ 3,250,000	$ 4,859,000	$ 7,474,000	Estimated from Sanford Conveyance
New WTP (Town of Fuquay-Varina), 13 mgd	1	LS		$ 182,000,000	$ 279,947,000	Includes property acquisition and engineering
New finished water transmission main, 2.48 miles	13,094	feet	$ 11,784,960	$ 17,619,000	$ 27,101,000	30-inch dia
Wetland and Stream Mitigation	1	LS		$ 1,195,500	$ 3,034,000	From EIS Section 5
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
TOTAL			$ 259,000,000	$ 570,400,000	$ 878,500,000	

Notes:

Contingency per AACE Class 5 estimate	30%	
Engineering Factor (Design and Construction Phase Services)	15%	

Escalation

Baseline year	2024	
Planning year end	2034	
Number of years	10	
Interest Rate, 30 years	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	1.538	(F/P, i%, n) = (1 + i%)^n

Environmental Impact Statement: IBT Cape Fear River Basin to Neuse River Basin

Opinion of Probable Construction and Project Costs - Conceptual Level Estimate

Alternative 3: Surface Water, Town of Fuquay-Varina Independent Water Supply in Neuse River Basin
Implementation Schedule: 20 to 30 years, use 20 years for start of construction 2044

Improvement	Quantity	Unit	Estimated Construction Cost 2024$	Estimated Project Cost 2024$	Estimated Project Cost in 2044$	Comments
New reservoir on Middle Creek						
Property acquisition	679	acres		$ 27,140,000	$ 64,213,000	$40,000 per acre (some properties have structures), includes administrative and technical costs
Dam and Foundation	1	LS	$ 20,975,747	$ 31,359,000	$ 74,195,000	$13.6M escalated from Raleigh Water Little River EIS Middle Creek alternative
Clearing and Grubbing	334	acres	$ 9,585,800	$ 14,331,000	$ 33,907,000	$28,700/acre from Johnston County 210 WWTF Schedule of Values ($172,000 for 6 acres)
Wetland and Stream Mitigation	1	LS		$ 14,627,600	$ 34,609,000	From EIS Section 5
New Bridge over HW 42	1	LS	$ 10,900,000	$ 16,296,000	$ 38,556,000	Estimated from NCDOT data
New raw water intake and pump station (13 mgd)	1	LS	$ 7,930,000	$ 11,855,000	$ 28,049,000	Unit costs based on Sanford WTP Design
New raw water transmission line, 1.78 miles	9,398	feet	$ 8,458,560	$ 8,459,000	$ 20,014,000	30-inch dia
New WTP (Town of Fuquay-Varina), 13 mgd	1	LS		$ 182,000,000	$ 430,607,000	Includes property acquisition and engineering
New finished water transmission main, 4.51 miles	23,813	feet	$ 21,431,520	$ 32,040,000	$ 75,806,000	30-inch dia
Instream Flow Study	1	LS		$ -	$ 2,000,000	From EIS Section 1.5
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
TOTAL			$ 79,300,000	$ 338,100,000	$ 802,000,000	

Notes:

Contingency per AACE Class 5 estimate	30%	
Engineering Factor (Design and Construction Phase Services)	15%	
Escalation		
Baseline year	2024	
Planning year end	2044	
Number of years	20	
Interest Rate, 30 years	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	2.366	(F/P, i%, n) = (1 + i%)^n

Environmental Impact Statement: IBT Cape Fear River Basin to Neuse River Basin

Opinion of Probable Construction and Project Costs - Conceptual Level Estimate

Alternative 4: Surface Water, Purchase Finished Water from City of Dunn
Implementation Schedule: 5 to 8 years (use 6 years) 2030

Improvement	Quantity	Unit	Estimated Construction Cost 2024$	Estimated Project Cost 2024$	Estimated Project Cost in 2030$	Comments
New raw water intake and pump station	1	LS	$ 7,930,000	$ 11,855,000	$ 15,350,000	Unit costs based on Sanford WTP Design
New terminal reservoir and pump station	1	LS	$ 6,000,000	$ 8,970,000	$ 11,614,000	$0.286/gal based on reservoir storage calcs
Expansion of A.B. Uzzle WTP with additional property (8 to 21 mgd)	1	LS		$ 182,000,000	$ 235,654,000	Includes property acquisition and engineering
New finished water transmission main, 18.35 miles	96,888	feet	$ 87,199,200	$ 130,363,000	$ 168,794,000	30-inch dia
New booster pump station and ground storage	1	LS		$ 9,425,000	$ 12,203,000	From Sanford Conveyance design estimate
New raw water transmission main, 0.59 miles	3,115	feet	$ 2,803,680	$ 4,192,000	$ 5,428,000	30-inch dia
Wetland and Stream Mitigation	1	LS	$ 106,600	$ 159,000	$ 206,000	From EIS Section 5
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
TOTAL			$ 104,000,000	$ 347,000,000	$ 449,200,000	

Notes:

Contingency per AACE Class 5 estimate	30%	
Engineering Factor (Design and Construction Phase Services)	15%	

Escalation

Baseline year	2024	
Planning year end	2030	
Number of years	6	
Interest Rate, 30 years	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	1.295	(F/P, i%, n) = (1 + i%)^n

Environmental Impact Statement: IBT Cape Fear River Basin to Neuse River Basin

Opinion of Probable Construction and Project Costs - Conceptual Level Estimate

Alternative 5: Surface Water, Purchase Finished Water from Harnett County
Implementation Schedule: 5 to 8 years (use 6 years) 2030

Improvement	Quantity	Unit	Estimated Construction Cost 2024$	Estimated Project Cost 2024$	Estimated Project Cost in 2030$	Comments
New finished water transmission main, 13.3 miles	70,224	feet	$ 63,201,600	$ 94,486,000	$ 122,341,000	30-inch dia
Expansion of raw water pump station and intake (42 to 55 mgd)	1	LS	$ 7,930,000	$ 11,855,000	$ 15,350,000	Unit costs based on Sanford WTP Design
Expansion of Harnett County Regional WTP (42 to 55 mgd)	1	LS		$ 182,000,000	$ 235,654,000	Includes property acquisition and engineering
Instream Flow Study	1	LS		$ -	$ 2,000,000	From EIS Section 1.5
Wetland and Stream Mitigation	1	LS		$ 133,300	$ 173,000	From EIS Section 5
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
TOTAL			$ 71,100,000	$ 288,500,000	$ 375,500,000	

Notes:

Contingency per AACE Class 5 estimate	30%	
Engineering Factor (Design and Construction Phase Services)	15%	

Escalation

Baseline year	2024	
Planning year end	2030	
Number of years	6	
Interest Rate, 30 years	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	1.295	(F/P, i%, n) = (1 + i%)^n

Environmental Impact Statement: IBT Cape Fear River Basin to Neuse River Basin

Opinion of Probable Construction and Project Costs - Conceptual Level Estimate

Alternative 6: Surface Water, Raw Water from Jordan Lake (Cary/Apex)
Implementation Schedule: 10 years 2034

Improvement	Quantity	Unit	Estimated Construction Cost 2024$	Estimated Project Cost 2024$	Estimated Project Cost in 2034$	Comments
New raw water intake and pump station	1	LS	$ 7,930,000	$ 11,855,000	$ 18,235,000	Unit costs based on Sanford WTP Design
New raw water transmission main, 17.5 miles	92,400	feet	$ 83,160,000	$ 124,324,000	$ 191,232,000	30-inch dia
New booster pump station	1	LS	$ 3,250,000	$ 4,859,000	$ 7,474,000	Estimated from Sanford Conveyance
New WTP (Town of Fuquay-Varina), 13 mgd	1	LS		$ 182,000,000	$ 279,947,000	Includes property acquisition and engineering
Wetland and Stream Mitigation	1	LS		$ 106,600	$ 164,000	From EIS Section 5
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
TOTAL			$ 94,300,000	$ 323,100,000	$ 497,100,000	

Notes:

Contingency per AACE Class 5 estimate	30%	
Engineering Factor (Design and Construction Phase Services)	15%	

Escalation

Baseline year	2024	
Planning year end	2034	
Number of years	10	
Interest Rate, 30 years	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	1.538	(F/P, i%, n) = (1 + i%)^n

Environmental Impact Statement: IBT Cape Fear River Basin to Neuse River Basin

Opinion of Probable Construction and Project Costs - Conceptual Level Estimate

Alternative 7: Surface Water, Raw Water from Jordan Lake (Western Intake Partnership)
Implementation Schedule: 10 years 2034

Improvement	Quantity	Unit	Estimated Construction Cost 2024$	Estimated Project Cost 2024$	Estimated Project Cost in 2034$	Comments
New raw water intake and pump station	1	LS	$ 7,930,000	$ 11,855,000	$ 18,235,000	Unit costs based on Sanford WTP Design
New raw water transmission main, 23.72 miles	125,136	feet	$ 112,622,400	$ 168,370,000	$ 258,982,000	30-inch dia
New booster pump station	1	LS	$ 3,250,000	$ 4,859,000	$ 7,474,000	Estimated from Sanford Conveyance
New WTP (Town of Fuquay-Varina), 13 mgd	1	LS		$ 182,000,000	$ 279,947,000	Includes property acquisition and engineering
Wetland and Stream Mitigation	1	LS		$ 266,500	$ 410,000	From EIS Section 5
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
TOTAL			$ 123,800,000	$ 367,400,000	$ 565,000,000	

Notes:

Contingency per AACE Class 5 estimate	30%	
Engineering Factor (Design and Construction Phase Services)	15%	
Escalation		
Baseline year	2024	
Planning year end	2034	
Number of years	10	
Interest Rate, 30 years	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	1.538	(F/P, i%, n) = (1 + i%)^n

Environmental Impact Statement: IBT Cape Fear River Basin to Neuse River Basin

Opinion of Probable Construction and Project Costs - Conceptual Level Estimate

Alternative 8A: Surface Water, Town of Fuquay-Varina Intake on the Cape Fear River with Return of Water to Cape Fear River Basin (Cape Fear)
Implementation Schedule: 10 years 2034

Improvement	Quantity	Unit	Estimated Construction Cost 2024$	Estimated Project Cost 2024$	Estimated Project Cost in 2034$	Comments
New raw water intake and pump station	1	LS	$ 7,930,000	$ 11,855,000	$ 18,235,000	Unit costs based on Sanford WTP Design
New raw water transmission main, 11.79 miles	62,251	feet	$ 56,026,080	$ 83,759,000	$ 128,836,000	30-inch dia
New WTP (Town of Fuquay-Varina), 13 mgd	1	LS		$ 182,000,000	$ 279,947,000	Includes property acquisition and engineering
Effluent Pump Station at Terrible Creek WWTP	1	LS	$ 3,600,000	$ 5,382,000	$ 8,278,000	Planning level unit cost $0.50/gallon
New disinfection facility (chlor and dechlor)	1	LS	$ 6,000,000	$ 8,970,000	$ 13,797,000	From Johnston County Schedule of Values, includes bonds, insurance, general conditions, escalation, etc.
New effluent force main to Cape Fear River, 19 miles	100,320	feet	$ 90,288,000	$ 134,981,000	$ 207,624,000	30-inch dia
Water quality modeling in Cape Fear Basin	1	LS		$ -	$ 500,000	
Instream Flow Study	1	LS		$ -	$ 2,000,000	From EIS Section 1.5
Wetland and Stream Mitigation	1	LS		$ 586,400	$ 902,000	From EIS Section 5
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
TOTAL			$ 163,800,000	$ 427,500,000	$ 660,100,000	

Notes:

Contingency per AACE Class 5 estimate	30%	
Engineering Factor (Design and Construction Phase Services)	15%	
Escalation		
Baseline year	2024	
Planning year end	2034	
Number of years	10	
Interest Rate, 30 years	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	1.538	(F/P, i%, n) = (1 + i%)^n

Environmental Impact Statement: IBT Cape Fear River Basin to Neuse River Basin

Opinion of Probable Construction and Project Costs - Conceptual Level Estimate

Alternative 8B: Surface Water, Town of Fuquay-Varina Intake on the Cape Fear River with Return of Water to Cape Fear River Basin (Kenneth Creek)
Implementation Schedule: 10 years 2034

Improvement	Quantity	Unit	Estimated Construction Cost 2024$	Estimated Project Cost 2024$	Estimated Project Cost in 2034$	Comments
New raw water intake and pump station	1	LS	$ 7,930,000	$ 11,855,000	$ 18,235,000	Unit costs based on Sanford WTP Design
New raw water transmission main, 11.79 miles	62,251	feet	$ 56,026,080	$ 83,759,000	$ 128,836,000	30-inch dia
New WTP (Town of Fuquay-Varina), 13 mgd	1	LS		$ 182,000,000	$ 279,947,000	Includes property acquisition and engineering
Effluent Pump Station at Terrible Creek WWTP	1	LS	$ 3,600,000	$ 5,382,000	$ 8,278,000	Planning level unit cost $0.50/gallon
New disinfection facility (chlor and dechlor)	1	LS	$ 6,000,000	$ 8,970,000	$ 13,797,000	From Johnston County Schedule of Values, includes bonds, insurance, general conditions, escalation, etc.
New effluent force main to Kenneth Creek (6.5 miles)	34,320	feet	$ 30,888,000	$ 46,178,000	$ 71,030,000	30-inch dia
Water quality modeling in Cape Fear Basin	1	LS		$ -	$ 500,000	
Instream Flow Study	1	LS		$ -	$ 1,500,000	From EIS Section 1.5
Wetland and Stream Mitigation	1	LS		$ 453,100	$ 697,000	From EIS Section 5
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
TOTAL			$ 104,400,000	$ 338,600,000	$ 522,800,000	

Notes:

Contingency per AACE Class 5 estimate	30%	
Engineering Factor (Design and Construction Phase Services)	15%	
		$ 1,014,184
Escalation		$ 1,103,004
Baseline year	2024	
Planning year end	2034	
Number of years	10	
Interest Rate, 30 years	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	1.538	(F/P, i%, n) = (1 + i%)^n

Environmental Impact Statement: IBT Cape Fear River Basin to Neuse River Basin

Opinion of Probable Construction and Project Costs - Conceptual Level Estimate

Alternative 9A / 9B: Surface Water, Purchase Finished Water from City of Sanford
Implementation Schedule: Construction started Year 2024 2024

Improvement	Quantity	Unit	Estimated Construction Cost 2024$	Estimated Project Cost 2024$	Estimated Project Cost in 2024$	Comments
New raw water intake and pump station improvements	1	LS		$ -	$ -	Included in cost for WTP, Town's share
Expansion of Sanford WTP	1	LS		$ -	$ 126,746,000	Town's share of Sanford WFF Project Cost as of December 2024 (includes construction phase services)
New finished water transmission main	1	LS		$ -	$ 100,514,278	Town's share of Conveyance Project Cost as of September 2024 (includes construction phase services)
New booster pump station and ground storage tank	1	LS		$ -	$ -	Included in cost for conveyance, Town's share
Wetland and Stream Mitigation	1	LS		$ -	$ -	Included in cost for conveyance, Town's share
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
TOTAL			$ -	$ -	$ 227,300,000	

Notes:

Contingency per AACE Class 5 estimate	30%	
Engineering Factor (Design and Construction Phase Services)	15%	

Escalation

Baseline year	2024	
Planning year end	2024	
Number of years	0	
Interest Rate, 30 years	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	1.000	(F/P, i%, n) = (1 + i%)^n

Environmental Impact Statement: IBT Cape Fear River Basin to Neuse River Basin

Opinion of Probable Construction and Project Costs - Conceptual Level Estimate

Alternative 9C: Surface Water, Purchase Finished Water from City of Sanford with Return of Water to Cape Fear River
Implementation Schedule: 10 years 2034

Improvement	Quantity	Unit	Estimated Construction Cost 2024$	Estimated Project Cost 2024$	Estimated Project Cost in 2034$	Comments
New raw water intake and pump station improvements	1	LS		$ -	$ -	Included in cost for WTP, Town's share
Expansion of Sanford WTP	1	LS		$ -	$ 126,746,000	Town's share of Sanford WFF Project Cost as of December 2024
New finished water transmission main (16.3 miles)	1	LS		$ -	$ 100,514,278	Town's share of Conveyance Project Cost as of September 2024
New booster pump station	1	LS		$ -	$ -	Included in cost for conveyance, Town's share
Effluent Pump Station at Terrible Creek WWTP	1	LS	$ 3,600,000	$ 5,382,000	$ 8,278,000	Planning level unit cost $0.60/gallon
New disinfection facility (chlor and dechlor)	1	LS		$ 6,000,000	$ 9,229,000	From Johnston County Schedule of Values, includes bonds, insurance, general conditions, escalation, etc.
New effluent force main to Cape Fear River, 19 miles	100,320	feet	$ 90,288,000	$ 134,981,000	$ 207,624,000	30-inch dia
Water quality modeling in Cape Fear Basin	1	LS		$ -	$ 500,000	
Wetland and Stream Mitigation	1	LS		$ 586,400	$ 902,000	Only effluent force main
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
TOTAL			$ 93,900,000	$ 146,900,000	$ 453,800,000	

Notes:

Contingency per AACE Class 5 estimate	30%	
Engineering Factor (Design and Construction Phase Services)	15%	

Escalation

Baseline year	2024	
Planning year end	2034	
Number of years	10	
Interest Rate, 30 years	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	1.538	(F/P, i%, n) = (1 + i%)^n

Environmental Impact Statement: IBT Cape Fear River Basin to Neuse River Basin

Opinion of Probable Construction and Project Costs - Conceptual Level Estimate

Alternative 9D: Surface Water, Purchase Finished Water from City of Sanford with Return of Water to Cape Fear River via Western Wake Regional WRF
Implementation Schedule: 5 to 8 years (use 6 years) 2030

Improvement	Quantity	Unit	Estimated Construction Cost 2024$	Estimated Project Cost 2024$	Estimated Project Cost in 2030$	Comments
New raw water intake and pump station improvements	1	LS		$ -	$ -	Included in cost for Sanford WTP, Town's share
Expansion of Sanford WTP	1	LS		$ -	$ 126,746,000	Town's share of Sanford WFF Project Cost as of December 2024
New finished water transmission main (16.3 miles)	1	LS		$ -	$ 100,514,278	Town's share of Conveyance Project Cost as of September 2024
New booster pump station	1	LS		$ -	$ -	Included in cost for conveyance, Town's share
Effluent Pump Station at Terrible Creek WWTP	1	LS	$ 3,600,000	$ 5,382,000	$ 6,969,000	Planning level unit cost $0.60/gallon
New disinfection facility (chlor and dechlor)	1	LS		$ 6,000,000	$ 7,769,000	From Johnston County Schedule of Values, includes bonds, insurance, general conditions, escalation, etc.
New effluent force main to Western Wake RWRF, 18.6 miles	98,208	feet	$ 88,387,200	$ 132,139,000	$ 171,094,000	30-inch dia
Wetland and Stream Mitigation	1	LS		$ 586,400	$ 759,000	Only effluent force main
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
TOTAL			$ 92,000,000	$ 144,100,000	$ 413,900,000	

Notes:

Contingency per AACE Class 5 estimate	30%	Association for the Advancement of Cost Engineering International for a Class 5 level of estimation (concept screening with capacity factors), +100 percent to -50 percent
Engineering Factor (Design and Construction Phase Services)	15%	

Escalation

Baseline year	2024	
Planning year end	2030	
Number of years	6	
Interest Rate, 30 years	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	1.295	(F/P, i%, n) = (1 + i%)^n

Environmental Impact Statement: IBT Cape Fear River Basin to Neuse River Basin

Opinion of Probable Construction and Project Costs - Conceptual Level Estimate

Alternative 10: Interbasin Transfer Minimization, Groundwater
Implementation Schedule: 100 wells by 2036; 200 wells by 2046; 362 wells by 2056

Improvement	Quantity	Unit	Estimated Construction Cost 2024$	Estimated Project Cost 2024$	Estimated Project Cost	Comments
388 wells total. Assume 100 wells by 2035	100	each	$ 25,000,000	$ 37,375,000	$ 62,660,000	$250k per well (easements, well house, pipe, GW yield study, etc.)
388 wells total. Assume 200 wells by 2045	100	each	$ 25,000,000	$ 37,375,000	$ 96,381,000	$250k per well (easements, well house, pipe, GW yield study, etc.)
388 wells total. Assume all 388 wells by 2055	162	each	$ 40,500,000	$ 60,548,000	$ 240,168,000	$250k per well (easements, well house, pipe, GW yield study, etc.)
New WTP (Town of Fuquay-Varina), 13 mgd	1	LS		$ 182,000,000	$ 305,125,000	Includes property acquisition and engineering
Raw water transmission main	211,200	feet	$ 76,032,000	$ 113,668,000	$ 190,565,000	Assume 40 miles of pipe network, 12-inch dia
Wetland and Stream Mitigation	1	LS		$ 1,000,000	$ 2,579,000	Estimate based on other alternatives, used 2045 as planning year
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
				$ -	$ -	
TOTAL			$ 166,500,000	$ 432,000,000	$ 897,500,000	

Notes:

Contingency per AACE Class 5 estimate	30%	
Engineering Factor (Design and Construction Phase Services)	15%	
Escalation		
Baseline year	2024	
Planning year end	2036	
Number of years	12	
Interest Rate	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	1.677	(F/P, i%, n) = (1 + i%)^n
Escalation		
Baseline year	2024	
Planning year end	2046	
Number of years	22	
Interest Rate, 30 years	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	2.579	(F/P, i%, n) = (1 + i%)^n
Escalation		
Baseline year	2024	
Planning year end	2056	
Number of years	32	
Interest Rate	4.40%	EPA 2025 Nominal Interest Rates Circular A-94 (M-25-08)
Escalation	3.967	(F/P, i%, n) = (1 + i%)^n

Appendix F: Technical Memorandum for OASIS Hydrologic Model of Cape Fear and Neuse River Basins for Interbasin Transfer

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TECHNICAL MEMORANDUM

To:
Mike Wagner
Public Utilities Director
Town of Fuquay-Varina

Copies:
File

From:
Hazen and Sawyer

Date:
August 2025

Subject:
Cape Fear-Neuse Combined River Basin Hydrologic Model (OASIS) Evaluation
Town of Fuquay-Varina Water Supply and Interbasin Transfer Project
Appendix to Environmental Impact Statement

1. Introduction

General Statute § 143-355(o) compels the Division of Water Resources (DWR) to develop hydrologic models for each of the 17 major river basins in North Carolina with approval and modification responsibilities granted to the Environmental Management Commission (EMC). The models must include water uses in the basin and any other withdrawal, ecological flow, instream flow requirements, future withdrawal projections, and local water supply plan (LWSP) data. DWR is the steward of these hydrologic models.

The hydrologic basin models typically use an OASIS hydrologic model platform. OASIS is a computer program designed to simulate surface water flows through a river basin considering watershed runoff (inflows), withdrawals, discharges, and water management protocols. DWR has developed detailed river basin hydrologic models for long-term water supply planning, management, and regulatory decision-making, especially during drought conditions. For this Environmental Impact Statement (EIS), the Cape Fear-Neuse Combined River Basin (CFNCRB) model was used for the evaluation of alternatives.

The original Cape Fear and Neuse River Basin hydrologic models were developed initially in 2004 and 2008 for separate use in the Cape Fear and Neuse River basins. A single combined OASIS model of the Cape Fear and Neuse River basins was developed in 2011 for the purpose of water supply planning, drought management in the Cape Fear and Neuse River basins, and to evaluate the significant interbasin movement of water in the urbanized upper reaches of the basins, particularly in the Research Triangle area (DWR, 2016a). The combined OASIS model, the CFNCRB model, extends geographically from the headwaters of the Deep and Haw Rivers to the mouth of the Cape Fear River and from the headwaters of the Eno, Flat, and Little Rivers to the mouth of the Neuse River. The CFNCRB model has been used to evaluate Jordan Lake water supply allocation requests and the Towns of Cary and Apex interbasin transfer request in 2014.

The CFNCRB model was updated in this EIS to evaluate the impact of the Town of Fuquay-Varina's proposed interbasin transfer. This Technical Memorandum documents the model development, assumptions, and results of the CFNCRB model used to evaluate the water supply alternatives covered in the EIS. This Technical Memorandum will provide basic background on the model, describe the model inputs and assumptions, and the results of the modeled alternatives. Attachments to this Technical Memorandum are as follows:

- Attachment A: Future Climate Scenarios for Town of Fuquay-Varina Interbasin Transfer Study (Tetra Tech, 2020)
- Attachment B: Summary of Withdrawals and Discharges in Cape Fear-Neuse River Combined River Basin Model
- Attachment C: Fayetteville Public Works Commission Water Shortage Response Trigger Flow Mapping
- Attachment D: Cape Fear-Neuse River Combined River Basin Model OCL Code

2. Model Development

The CFNCRB model was used as a foundation for the existing water supply and demands in the Cape Fear and the Neuse River basins. The purpose of the CFNCRB model is to simulate present day or potential future water management operations and assess impacts to streamflow, reservoir storage, water supply reliability, and other metrics of interest. The model was updated with current information from LWSP data. All known, proposed, and approved developments to the water supply to be completed by 2055 (the planning period for this EIS) were added as new information to the model in the form of nodes, junctions, and/or reservoirs.

The model uses a hydrologic and climatic dataset developed from a 90-year historical period. The period of record starts on January 1, 1930 and extends through September 30, 2020. The data set developed for the model used a comprehensive approach, as follows:

1. The model uses data from over 60 United States Geological Survey (USGS) streamflow gages in the Cape Fear and Neuse River basins. The model also uses historical weather station data to develop information on precipitation and evaporation that is applied to reservoirs in the model.
2. The model accounts for direct human-caused flow alterations, or impairments, from reservoir regulation and net water consumption. The model corrects for these influences so that current or future conditions may be simulated using the adjusted historical hydrologic information.
3. Statistical techniques were used to complete missing hydrologic records for the streamflow gages.

2.1 Significant Updates to CFNCRB Model

For this EIS, the CFNCRB model was significantly updated since the last update by DWR in 2014. The most significant changes include the following:

- The Falls Lake Conservation Pool Reallocation was completed in 2019 to expand the

water supply pool for Raleigh Water (USACE, 2018). The CFNCRB model reflects the Falls Lake reallocation in both the 2025 and 2055 scenarios.

- It was assumed Johnston County would meet its future supply needs by developing a raw water intake on the lower Neuse River in accordance with the 2009 Environmental Assessment (CH2M Hill, 2009).
- It was assumed the Western Intake Partnership (WIP), comprised of Durham, Pittsboro, OWASA, and Chatham County, could collectively meet their future needs via use of their Jordan Lake allocations. Each member utility owns and operates separate supply systems, which are expected to remain online in the future. The proposed WIP water treatment facility will supplement existing water supply for the WIP members. Except for the City of Durham, the exact nature of WIP member's future participation is somewhat uncertain, as follows:
    - Chatham County's North System demand forecast has been revised downward during the WIP planning process. At present, it is unclear whether Chatham would need to draw on the proposed WIP WTP in the 2055 scenario. All model scenarios are set up such that Chatham County's North System meets its entire need via Jordan Lake. For modeling purposes, it will not matter whether Chatham County's water is treated at their existing WTF or the proposed WIP WTP, since all of this water will be sourced from Jordan Lake.
    - OWASA does not anticipate a shortfall in 2055 even without Jordan Lake as a supply. Therefore, Jordan Lake is not assumed to be a regular supply source for OWASA over the planning horizon.
- Jordan Lake allocations were updated in the model to reflect the final Round 4 allocation approvals per the Environmental Management Commission (EMC) in 2017. The one exception is Raleigh Water. Raleigh Water rescinded their allocation from Jordan Lake in March 2019 as a result of the Falls Lake Reallocation Process for additional storage in the Falls Lake reservoir.
- The model assumes that the City of Durham's Teer Quarry Storage Project is on-line and draws on that storage beginning at the first stage of their Water Shortage Response Plan (WSRP).
- The City of Greensboro's North Buffalo Creek Wastewater Treatment Plant (WWTP) was removed from the model as this facility was decommissioned in 2017.

Several other changes were made to update the CFNCRB model. Minor deficiencies in water supply operations and wastewater discharge locations were corrected. Annual withdrawal and discharge patterns were updated and currently known inter-utility wholesale purchase arrangements were also added to the model. Water shortage response protocols were updated per LWSPs submitted to DWR.

Updated water demand projection data from current LWSPs were used in the model. It was noted that a few communities expressed overly optimistic forecasting of future water needs, which were substantially out of alignment with the Office of State Budget and Management (OSBM) population estimates. Nevertheless, unless noted as follows, the demand forecasts used in the CFNCRB model originated from

the 2022 LWSP for each utility. The CFNCRB model updates incorporated recent work with several communities, as follows:

- Water demand projections used for Pittsboro and Chatham County North were from recent work for the Triangle Water Partnership (TWP) (HDR and Hazen, unpublished).
- Water demand projections for Raleigh Water were based on the 25th percentile water demand projection curves from the Integrated Master Plan (HDR, 2021).
- Water demand projections for the Town of Holly springs were from recent work for the TWP (HDR and Hazen, unpublished).
- Projections of water sales were included in the total water demand for any water utility whose sales partner(s) were not already represented in the model.
- Water demand and interbasin transfer projections for the Town of Fuquay-Varina were based on the technical analysis per Section 2 of the EIS.

2.2 Climate Variability

The potential impacts of future climate variability were evaluated in this EIS. Climate variability impacts were applied to Alternatives 1 to 9 for the planning year 2055. Hazen subcontracted with Tetra Tech for a climate variability screening and to produce synthetic hydrology for three selected climate variability scenarios. Tetra Tech's work involved taking outputs from global climate models (GCMs) and running the relevant outputs through a rainfall-runoff model to arrive at basin hydrology that could be incorporated into the CFNCRB model. A detailed report (Tetra Tech, 2020) is provided in Attachment A.

The climate assessment covers a scientifically supported range of future climate variability. As a measure of conservatism, the climate assessment scenarios skew somewhat toward a more severe change (i.e., high emissions scenarios and therefore higher temperatures). Future climate projections remain uncertain, in particular for precipitation (there is less uncertainty for future temperature) and are best used to describe a range of possible future conditions to which adaptation may be needed. To select a set of scenarios that bound the likely range of potential climate futures with respect to water supply, the relative change in mean annual temperature and mean annual precipitation was assessed across a range climate models (over 30 models) paired with two of the more severe but commonly studied greenhouse gas emissions trajectories.

Greenhouse emissions trajectories are standardized by the Intergovernmental Panel on Climate Change (IPCC) and referred to as representative concentration pathways (RCPs) (van Vuuren, 2011). The two RCPs used in this study are RCP 4.5 and RCP 8.5. The number following the RCP (4.5 or 8.5) refers to the climate forcing condition of the emissions trajectory in watts per meter squared (W/m^2) for the year 2100 relative to the pre-industrial year of 1750. The higher the number, the greater the degree of warming expected. A paper published after the scenario screening analysis was conducted suggests that, at present, the most likely warming scenarios are similar to RCP 3.4 (Pielke, 2021). For reference, Table 1 summarizes the currently studied RCPs and the range of global mean temperature increase expected relative to the pre-industrial baseline.

Figure 1 illustrates the relative change in temperature and precipitation predicted by different GCMs and forcing conditions (e.g., RCPs) specific to central North Carolina in a commonly used future climate

scenario dataset. Climate variability scenarios likely to predict higher runoff (and therefore water supply) are located in the upper-left quadrant of Figure 1. These scenarios predict a greater increase in mean annual precipitation and a relatively moderate increase in air temperature and associated evapotranspiration compared to their model peers. Conversely, scenarios likely to predict the less runoff are located in the bottom-right quadrant of Figure 1. These scenarios predict a small increase in mean annual precipitation and a relatively large increase in mean annual air temperature. Three climate future scenarios were selected to develop a quantitative climate assessment that covers a scientifically supported range of future climate variability. The three selected scenarios are listed as follows with the model name first followed by the RCP and the purpose for selecting the scenario.

- CNRM-CM5, RCP 4.5 (higher runoff potential)
- MIROC-ESM-CHEM, RCP 8.5 (lower runoff potential)
- GFDL-ESM2M, RCP 8.5 (approximates ensemble mean)

Table 1: Representative Concentration Pathway Scenarios and Temperature Change Projections

Scenario	Range of Global Mean Temperature Increase for Year 2100 relative to Pre-Industrial Baseline
RCP 1.9	1 to 1.5°C
RCP 2.6	1.5 to 2°C
RCP 3.4	2 to 2.4°C
RCP 4.5 [1]	2.5 to 3°C
RCP 6.0	3 to 3.5°C
RCP 7.5	~ 4°C
RCP 8.5 [1]	~ 5°C

[1] RCPs used in this assessment.

Timeseries output were then downloaded from the archive for the three selected scenarios. A watershed runoff model, the National Hydrologic Model (NHM) with the Precipitation-Runoff Modeling System (PRMS), was then used to convert GCM output (temperature and precipitation in particular) to a hydrologic runoff timeseries and evaporation timeseries for use in the CFNCRB model. A detailed explanation of the selection and processing of the climate scenario data is included in Attachment A.

Hydrologic timeseries associated with each climate future scenario are compared to a historical “hindcast” model run covering 1950 to 2005. Hindcasting is conducted using the GCM with historical forcing conditions (i.e., past atmospheric greenhouse gas concentrations) to simulate the 1950 to 2005 period and evaluate the GCM’s accuracy in reproducing historical climate conditions. When coupled with a future climate forecast, hindcasting provides an apples-to-apples indication of relative change in any number of climatic factors. The relative change is used to adjust the inputs to the CFNCRB model using a bias-adjustment technique. The bias adjustment accounts for systematic differences that may be present between the PRMS model and historically observed flows. The target future year of 2055 is based upon the assumption of a 30-year IBT certificate issued around 2025. Since a 30-year period is typically used to evaluate statistical climate normals, the climate variability scenarios used outputs from the GCM from 2040 to 2070, the mid-point of which is 2055. The 30-year timeseries for each of the three climate variability scenarios was then inserted into the CFNCRB model for evaluation.

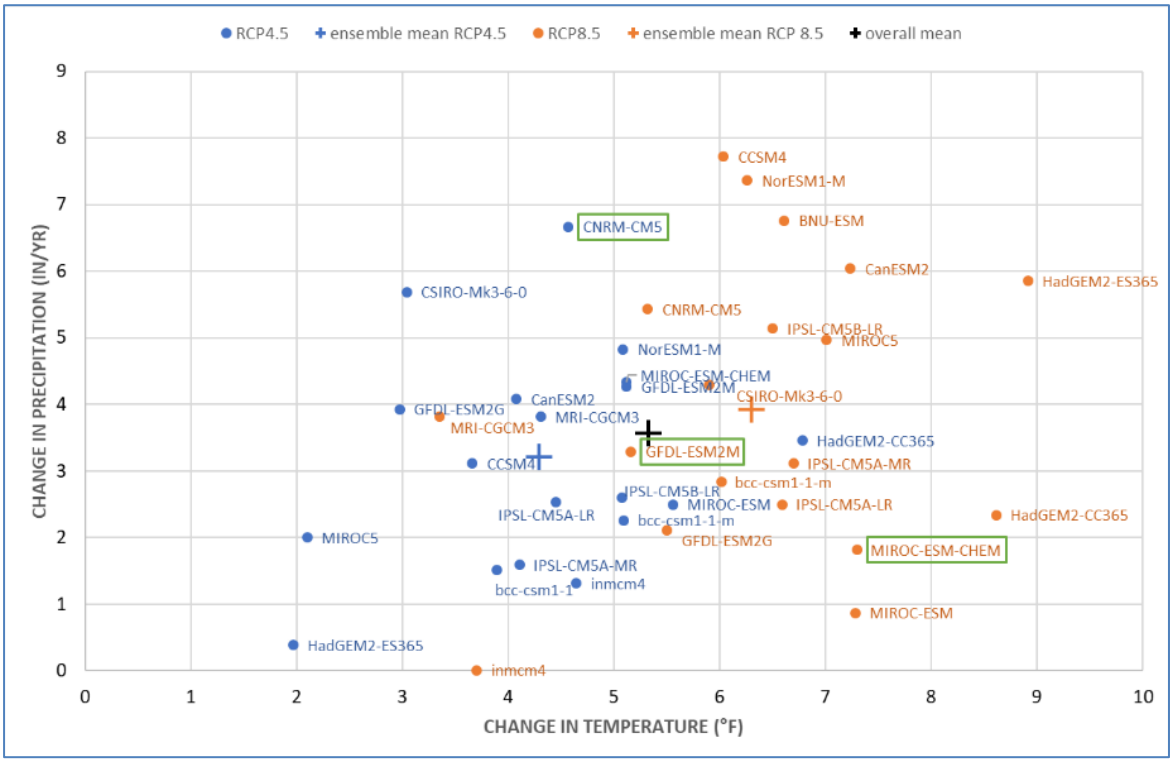

Figure 1: Relative change from historical (1950-2005) for future (2040-2070) average (or mean) annual precipitation and mean annual air temperature for global climate models and greenhouse gas representative concentration pathways (RCP 4.5 and RCP 8.5) for the Central Piedmont Region of North Carolina. Note: Selected scenarios have a green box around the model name (from Attachment A, Tetra Tech 2020).

2.3 Water Supply Alternatives

After completing the model updates required for the 2025 and 2055 baseline conditions, the CFNCRB model was further developed to simulate each of the water supply alternatives considered in the EIS for the year 2055. The models used monthly demand data in the calculations of the deliveries to each demand node. Refer to Section 3 of the EIS for a detailed description and evaluation of alternatives. The CFNCRB model for each alternative was evaluated using the historical hydrologic record contained in the model (1930 to 2020) as well as with each of the three climate variability scenarios (2040 to 2070). A summary of the added CFNCRB model inputs and operational changes to accommodate the alternatives analysis is provided in Table 2. A summary of the withdrawals and discharges in the CFNCRB model are provided in Attachment B. The CFNCRB model inputs and operational changes are described as follows:

- No Action Alternative
    - The demand years of 2025 and 2055 were modeled to show hydrology and supply shortages without any changes to the existing systems, approved or in construction capital improvement projects, or sales contracts.
- Alternative 1 – Surface Water, Purchase Finished Water from Raleigh Water
    - A new reservoir node was created to model Middle Creek Reservoir including storage-area-elevation (SAE) data developed to simulate the manmade

reservoir. The reservoir was sized to meet demand from both Raleigh Water and the Town of Fuquay-Varina. A new connection from the reservoir to the Town of Fuquay-Varina was added.

- Alternative 2 – Surface Water, Purchase Finished Water from Johnston County
    - No new model nodes were added. Water is supplied to the Town of Fuquay-Varina via a new connection from the future Johnston County Quarry Reservoir and WTP.
- Alternative 3 – Surface Water, Town of Fuquay-Varina Independent Water Supply in Neuse River Basin
    - A new reservoir node was created to model Middle Creek Reservoir including SAE data developed to simulate the man-made reservoir. The reservoir was sized to meet demand for the Town of Fuquay-Varina independently. A new connection from the reservoir to the Town of Fuquay-Varina was added. This alternative also assumes a new WTP would be constructed.
- Alternative 4 – Surface Water, Purchase Finished Water from City of Dunn
    - A new connection from the City of Dunn to the Town was added.
- Alternative 5 – Surface Water, Purchase Finished Water from Harnett County
    - The maximum sales from Harnett County was increased to meet the Town of Fuquay-Varina's projected demand.
- Alternative 6 – Surface Water, Raw Water from Jordan Lake (Cary/Apex)
    - A new connection from Jordan Lake to the Town of Fuquay-Varina was added. Alternatives 6 and 7 are identical in simulation. A new WTP would be constructed by the Town of Fuquay-Varina to produce finished water.
- Alternative 7– Surface Water, Raw Water from Jordan Lake (Western Intake Partnership)
    - A new connection from Jordan Lake to the Town of Fuquay-Varina was added. Alternatives 6 and 7 are identical in simulation.
- Alternative 8A – Surface Water, Town of Fuquay-Varina Intake on the Cape Fear with Return of Water to Cape Fear River Basin (Cape Fear River)
    - A new connection from the Cape Fear River at the Lillington gage to the Town of Fuquay-Varina was added and a new connection from the Town of Fuquay-Varina to the Cape Fear River downstream of the Lillington gage for wastewater discharge.
- Alternative 8B – Surface Water, Town of Fuquay-Varina Intake on the Cape Fear with Return of Water to Cape Fear River Basin (Kenneth Creek)
    - A new connection from the Cape Fear River at the Lillington gage to the Town of Fuquay-Varina was added as was a new connection from the Town of Fuquay-Varina to Kenneth Creek for wastewater discharge upstream of the Lillington gage.

- Alternative 9 – Surface Water, Purchase Finished Water from City of Sanford
    - For all sub-alternatives A-D, a new connection to the City of Sanford's water supply was added to the Town of Fuquay-Varina. WTP process loss was factored in for this alternative.
    - The City of Sanford's raw water intake was modeled as a run-of-river intake and does not include storage from the Buckhorn Dam impoundment. Buckhorn Dam is a relatively small impoundment, so the buffering capacity of storage behind the dam is minimal, but the Buckhorn dam impoundment stores approximately one week of withdrawals for the City of Sanford and its partners under the 2055 condition. Therefore, modeling this alternative as a run-of-river withdrawal is conservative.
- Alternatives 9 A/B – Surface Water, Purchase Finished Water from City of Sanford
    - Wastewater is treated and discharged to the basin used by the Town of Fuquay-Varina's retail customers. Wastewater produced in the Neuse River Basin is assumed to be treated and discharged at the Terrible Creek WWTP. Wastewater produced in the Cape Fear Basin is assumed to be treated and discharged at Harnett County's Regional North Harnett Regional WWTP.
- Alternative 9C – Surface Water, Purchase Finished Water from City of Sanford with Return of Water to Cape Fear River
    - This alternative has common components with Alternative 9 A/B plus a new connection from the Town of Fuquay-Varina to the Cape Fear River downstream of the Lillington gage for wastewater discharge.
- Alternative 9D – Surface Water, Purchase Finished Water from City of Sanford with Return of Water to Cape Fear River
    - This alternative has common components with Alternative 9 A/B plus a new connection from the Town of Fuquay-Varina to pump untreated wastewater from the Town's Terrible Creek WWTP service area in the Neuse River basin to the Western Wake WRF.

Table 2: Summary of Modeling Inputs for Cape Fear-Neuse River Hydrologic OASIS Model

	No-action		Raleigh	Johnston County	Indep-endent Reservoir	Dunn	Harnett	Jordan Lake, A	Jordan Lake, B	Fuquay-Varina Intake and Return to Cape Fear River	Fuquay-Varina Intake and Return to Kenneth Creek	Sanford (No Return)	Sanford (With Return)	Sanford (With Return)
Alternative	----		1	2	3	4	5	6	7	8A	8B	9A/B	9C	9D
Model Year	2025	2055	2055	2055	2055	2055	2055	2055	2055	2055	2055	2055	2055	2055
New nodes	N/A	N/A	Middle Creek Reservoir, node 1475, sized for Raleigh and Town use	None	Middle Creek Reservoir, node 1475, sized for Town use only	N/A	N/A	N/A	N/A	N/A	New discharge point	N/A	N/A	N/A
New connections	N/A	N/A	Middle Creek Reservoir to Town, node 1475 to 1706, and Middle Creek to Raleigh, Node 1475 to 1306	Johnston County Quarry Reservoir to Town, node 1648 to 1706	Middle Creek Reservoir to Town, node 1475 to 1706	Dunn Supply to Town, node 662 to 1706	N/A	Jordan Lake to Town, node 0470 to 1706	Jordan Lake to Town, node 0470 to 1706	Cape Fear Lillington Gage to Town, node 0550 to 1706, and Town to downstream of Lillington gage, 1706 to 0650	Cape Fear Lillington Gage to Town, node 0550 to 1706, and Town to Kenneth Creek, 1706 to 0554 (upstream of Lillington)	Sanford Cape Fear withdrawal point to Town, nodes 0489/0492 to 1706 (incorpo-rating process loss)	Sanford Cape Fear withdrawal point to Town, nodes 0489/0492 to 1706, and Town to down-stream of Lillington gage, 1706 to 0650	Sanford Cape Fear withdrawal point to Town, nodes 0489/0492 to 1706, and Town to Western Wake WRF, 1706 to 0930
Operational changes	N/A	N/A	Set Town operations to receive from Raleigh for Neuse demand before exceeding Harnett	Set Town operations to receive from Johnston County for Neuse demand before exceeding	Set Town operations to receive from Middle Creek Res. for Neuse demand before exceeding	Set Town operation to receive from Dunn Water Supply once exceeding Harnett	Set all Town demand to be supplied by Harnett County	Set Town operation to use Jordan Lake once exceeding Harnett contract	Set Town operation to use Jordan Lake once exceeding Harnett contract	Set Town operations to use the Cape Fear, adjust waste-water returns to return to	Set Town operations to use the Cape Fear, adjust waste-water returns to return to	Set Town operations to receive water from Sanford once exceeding Harnett Contract	Set Town operations to receive from Sanford once exceeding Harnett Contract, adjust	Set Town operations to receive from Sanford once exceeding Harnett Contract, adjust

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Table 2: Summary of Modeling Inputs for Cape Fear-Neuse River Hydrologic OASIS Model

	No-action		Raleigh	Johnston County	Indep-endent Reservoir	Dunn	Harnett	Jordan Lake, A	Jordan Lake, B	Fuquay-Varina Intake and Return to Cape Fear River	Fuquay-Varina Intake and Return to Kenneth Creek	Sanford (No Return)	Sanford (With Return)	Sanford (With Return)
Alternative	**----**		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8A**	**8B**	**9A/B**	**9C**	**9D**
Model Year	**2025**	**2055**	**2055**	**2055**	**2055**	**2055**	**2055**	**2055**	**2055**	**2055**	**2055**	**2055**	**2055**	**2055**
			contract	Harnett contract	Harnett contract	contract				Cape Fear	Cape Fear		waste-water returns to Cape Fear	wastewater returns to Cape Fear
Max. Month Sales from Harnett County, mgd	2	2	2	2	2	2	9.9	2	2	2	2	2	2	2
Max. Month Sales from Johnston County, mgd	1.5	0	0	7.9	0	0	0	0	0	0	0	0	0	0
Max. Month Sales from the City of Raleigh, mgd	1.75	0	7.9	0	0	0	0	0	0	0	0	0	0	0
Additional Max. Month Sales, mgd	N/A	N/A	N/A	N/A	N/A	7.9	N/A	7.9, from Cary	N/A	N/A	N/A	7.9, from Sanford	7.9, from Sanford	7.9 from Sanford
Wastewater return routing	Exist-ing	Exist-ing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Discharge 0.5 miles downstream of proposed intake	Discharge at Kenneth Creek at old plant outflow	Existing	Discharge at Cape Fear River	Discharge to Western Wake WRF (to Cape Fear River)

3. Analysis of CFNCRB Model Simulation Results

The modeling results are summarized with the no-action baseline alternative in 2025 and 2055 in comparison with Alternatives 1 through 9 in the planning year 2055. The modeling results for the historic hydrologic record are presented along with the three selected climate variability scenarios for each alternative, including the no-action alternative. Many of the metrics presented are consistent with the metrics presented in the 2014 Cary-Apex IBT analysis in the Cape Fear. The CFNCRB model results were evaluated using three broad classes of model output, as follows:

1. Municipal water supply reliability.
2. Performance of Jordan Lake and Falls Lake in Meeting Flow Targets and Recreational Criteria.
3. Low-flow discharge in the Cape Fear River and Neuse River:
    a. Potential climate change impact to hydrology.
    b. Cumulative impact related to Cape Fear River basin development (i.e., water demand increase between 2025 and 2055).
    c. Project-related impacts to 7Q10.
    d. Gage accuracy and model precision.

3.1 Municipal Water Supply Reliability

The ability of municipal purveyors to meet water supply needs is a key consideration for long-term planning. This section describes model results related to the ability to achieve this goal. The frequency, in percent of days, for meeting nominal (i.e., unrestricted) water demand for each alternative and climate scenario is summarized in Table 3. The nominal demand does not include reductions produced by conservation measures (i.e., when a water shortage response stage is triggered). For example, a frequency of 100 percent indicates that all of the water demand is met over the entire simulation period and no conservation was triggered for that utility. Frequency values less than 100 percent indicate the nominal demand is not always met. This phenomenon occurs for two reasons: 1) water conservation has been invoked, and/or 2) not enough water is available to meet the demand. For those systems whose triggers can be modeled, water demand is reduced according to the utility's WSRP proscribed conservation schedule when appropriate (i.e., a 10 percent reduction in water use in Stage 1 conservation).

An example is Cary-Apex which meets the conditions for triggering its WSRP at various points in all 2055 scenarios. Per Table 3, simulations using the historic inflow record show 100 percent delivery for Cary-Apex in year 2025 for the No-Action alternative and then decreasing to 93.5 percent in 2055. In 2055, the increased water demand on Jordan Lake prompts activation of Cary-Apex's drought plan on approximately 6.5 percent of the days in the model record (1930 to 2020 hydrology representing 33,000 days). Therefore, delivery of water supply in 2055 would meet Cary-Apex's unrestricted demand on 93.5 percent of days. For the other 6.5 percent of days, the model indicates the reduced demand (i.e., triggering the Cary-Apex's WSRP) would be met 100 percent of the time.

Many of the water systems summarized in Table 3 do not have drought (i.e., WSRP) triggers that are quantifiable in the CFNCRB model. For these systems, water demand is not reduced under water shortage conditions. These systems all follow the statutory requirements for water shortage response; however, the triggers for entering the mandatory stages of the water shortage response are not specific enough to model. A failure to meet the unrestricted demands is due to a shortage of water (i.e., insufficient water on some days in the model to meet the full demand). This unrestricted demand scenario includes the Town of Fuquay-Varina. The model indicated that the Town of Fuquay-Varina would have a 0 percent supply reliability in 2055 in the No-Action alternative, as additional supply is not considered to meet the Town's projected 2055 needs.

Shortages due to absolute insufficiency of supply occur for only two other demand nodes in the model (at a single withdrawal point) and are limited to two of the three climate change scenarios. These shortages due to climate change occur for the Cape Fear Public Utility Authority (CFPUA) and Lower Cape Fear Water and Sewer Authority (LCFWSA) raw water intakes at the downstream end of the Cape Fear River basin. Using historical inflows, the 2055 demands are always met for CFPUA and LCFWSA across every modeled alternative. The frequency of shortages under the two more adverse climate change scenarios is extremely small. The period of record for the climate change runs (2040 to 2070) contains 11,000 days. Therefore, a 0.01 percent result equals approximately 1 day of water supply shortage. These rare instances are highlighted as blue cells in Table 3. All of the modeled shortages for CFPUA and LCFWSA were short, intermittent, infrequent, and did not include mitigation from a WSRP with quantifiable demand reductions by WSRP stage. Additionally, the shortages occurred during significant additional demand-side water stress. The municipal surface water demands for Fayetteville Public Works Commission (PWC), CFPUA and LCFWSA are projected to increase by over 57 mgd between 2025 and 2055 per the respective LWSPs submitted by these utilities, which is a 90 percent increase in water demand at these locations over the 30-year planning horizon. Shortages for CFPUA and LCFWSA are described further in Section 4.

For systems that do have quantifiable WSRP triggers, additional information on the nature of WSRP performance is provided in Table 4A and Table 4B**.** There are four water utilities (Cary-Apex, Raleigh Water, City of Dunn, and Town of Benson) whose WSRPs were activated in the CFNCRB model. In July 2023, PWC adopted changes to their WSRP that included quantifiable shortage response triggers based on water elevation in the Cape Fear River at the PWC raw water intake. The PWC WSRP was adopted after the updates to the CFNCRB model. Drought response operations for PWC were modeled similarly to the operation for the City of Dunn. The City of Dunn's drought response rules are based off Cape Fear River discharges. The PWC WRSP elevation triggers were mapped to the flow output from the CFNCRB simulations using historical stage-discharge data at the Fayetteville NC USGS gage and the state HEC-RAS model for this section of the Cape Fear River, further detail is provided in Attachment C. Tables 4A and 4B provide the percent of years in which the WSRP is activated, the median length of time the WSFPs are active once activated (i.e., the length of water use restrictions), the worst case event length, and the highest (i.e., most restrictive) WSRP stage reached during the entire model run.

When evaluating the results in Tables 4A and 4B, it should be noted that the historical hydrologic record is approximately three times as long as each climate change scenario. When comparing the results for any of these utilities by water supply alternative, there is very little difference between the alternatives. There are differences between the climate scenarios, but the most significant difference is simply due to the cumulative change between 2025 and 2055. Both Raleigh Water and Cary-Apex have WSRP

activation frequencies of less than 1 in 3 years for all alternatives and climate outcomes. Using historical hydrology, the median restriction periods extend approximately 2 months for Raleigh Water and about 3.5 months for Cary-Apex. In the most severe historical drought, Cary/Apex spends just over 3 months in Stage 2 of their WSRP and Raleigh Water spends 6 months in Stage 3 of their WSRP. For the City of Dunn and the Town of Benson, the activation frequencies are less than once in ten years and the median restrictions have a one week duration. In the worst case these extend to just under three weeks. For Fayetteville PWC, there is little to no change between the 2025 and 2055 conditions under historical hydrology and the median and maximum event lengths remain the same plus or minus a day across all scenarios within the respective hydrology.

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Table 3: Summary of Frequency of Achieving Nominal (Unrestricted) Demand (% of Days)

Water Supply Alternative	Year	Inflows	Cape Fear River Basin Model Nodes						Neuse River Basin Model Nodes						
			Cary-Apex	Sanford [1]	Harnett County [1]	Dunn	Fayetteville	CFPUA / LCFWSA [1]	Raleigh	Johnston County [1]	Smithfield [1]	Fuquay-Varina [1]	Benson	Goldsboro [1]	Neuse-WASA [1]
No action (baseline)	2025	Historic	100.00%	100.00%	100.00%	99.15%	98.92%	100.00%	100.00%	100.00%	100.00%	100.00%	99.15%	100.00%	100.00%
	2055	Historic	93.53%	100.00%	100.00%	99.83%	98.84%	100.00%	97.72%	100.00%	100.00%	0.00%	99.83%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.55%	100.00%	96.68%	100.00%	100.00%	0.00%	99.57%	100.00%	100.00%
		GFDL	92.41%	100.00%	100.00%	99.98%	99.69%	100.00%	100.00%	100.00%	100.00%	0.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.35%	96.17%	99.98%	96.90%	100.00%	100.00%	0.00%	99.35%	100.00%	100.00%
Alternative 1	2055	Historic	93.46%	100.00%	100.00%	99.83%	98.88%	100.00%	97.73%	100.00%	100.00%	100.00%	99.83%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.55%	99.98%	96.72%	100.00%	100.00%	100.00%	99.57%	100.00%	100.00%
		GFDL	92.41%	100.00%	100.00%	99.98%	99.69%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.35%	96.23%	100.00%	96.91%	100.00%	100.00%	100.00%	99.35%	100.00%	100.00%
Alternative 2	2055	Historic	93.56%	100.00%	100.00%	99.83%	98.88%	100.00%	97.72%	100.00%	100.00%	100.00%	99.83%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.55%	99.90%	96.68%	100.00%	100.00%	100.00%	99.57%	100.00%	100.00%
		GFDL	92.41%	100.00%	100.00%	99.98%	99.69%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.37%	96.23%	99.86%	96.90%	100.00%	100.00%	100.00%	99.37%	100.00%	100.00%
Alternative 3	2055	Historic	93.46%	100.00%	100.00%	99.83%	98.88%	100.00%	97.72%	100.00%	100.00%	100.00%	99.83%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.55%	100.00%	96.68%	100.00%	100.00%	100.00%	99.57%	100.00%	100.00%
		GFDL	92.41%	100.00%	100.00%	99.98%	99.69%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.35%	96.23%	100.00%	96.90%	100.00%	100.00%	100.00%	99.35%	100.00%	100.00%
Alternative 4	2055	Historic	93.48%	100.00%	100.00%	99.83%	98.74%	100.00%	97.72%	100.00%	100.00%	100.00%	99.83%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.33%	99.96%	96.68%	100.00%	100.00%	100.00%	99.57%	100.00%	100.00%
		GFDL	92.41%	100.00%	100.00%	99.98%	99.60%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.35%	95.98%	99.97%	96.90%	100.00%	100.00%	100.00%	99.35%	100.00%	100.00%

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Table 3: Summary of Frequency of Achieving Nominal (Unrestricted) Demand (% of Days)

Water Supply Alternative	Year	Inflows	Cape Fear River Basin Model Nodes						Neuse River Basin Model Nodes						
			Cary-Apex	Sanford [1]	Harnett County [1]	Dunn	Fayetteville	CFPUA / LCFWSA [1]	Raleigh	Johnston County [1]	Smithfield [1]	Fuquay-Varina [1]	Benson	Goldsboro [1]	Neuse-WASA [1]
Alternative 5	2055	Historic	93.44%	100.00%	100.00%	99.77%	98.74%	100.00%	97.72%	100.00%	100.00%	100.00%	99.77%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.41%	98.46%	99.89%	96.68%	100.00%	100.00%	100.00%	99.41%	100.00%	100.00%
		GFDL	92.37%	100.00%	100.00%	99.98%	99.66%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.13%	96.23%	99.91%	96.90%	100.00%	100.00%	100.00%	99.13%	100.00%	100.00%
Alternative 6	2055	Historic													
		CNRM	Identical to Alternative 7 (withdrawal from Jordan Lake)												
		GFDL													
		MIROC													
Alternative 7	2055	Historic	93.46%	100.00%	100.00%	99.83%	98.87%	100.00%	97.72%	100.00%	100.00%	100.00%	99.83%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.55%	100.00%	96.68%	100.00%	100.00%	100.00%	99.57%	100.00%	100.00%
		GFDL	92.38%	100.00%	100.00%	99.98%	99.81%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.76%	100.00%	100.00%	99.37%	96.23%	99.94%	96.90%	100.00%	100.00%	100.00%	99.37%	100.00%	100.00%
Alternative 8A	2055	Historic	93.44%	100.00%	100.00%	99.77%	98.92%	100.00%	97.72%	100.00%	100.00%	100.00%	99.77%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.41%	98.54%	99.97%	96.68%	100.00%	100.00%	100.00%	99.41%	100.00%	100.00%
		GFDL	92.37%	100.00%	100.00%	99.98%	99.69%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.13%	96.28%	99.87%	96.90%	100.00%	100.00%	100.00%	99.13%	100.00%	100.00%
Alternative 8B	2055	Historic	93.46%	100.00%	100.00%	99.78%	98.87%	100.00%	97.72%	100.00%	100.00%	100.00%	99.78%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.55%	99.90%	96.68%	100.00%	100.00%	100.00%	99.57%	100.00%	100.00%
		GFDL	92.41%	100.00%	100.00%	99.98%	99.66%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.23%	96.23%	99.94%	96.90%	100.00%	100.00%	100.00%	99.23%	100.00%	100.00%

Table 3: Summary of Frequency of Achieving Nominal (Unrestricted) Demand (% of Days)

Water Supply Alternative	Year	Inflows	Cape Fear River Basin Model Nodes						Neuse River Basin Model Nodes						
			Cary-Apex	Sanford [1]	Harnett County [1]	Dunn	Fayetteville	CFPUA / LCFWSA [1]	Raleigh	Johnston County [1]	Smithfield [1]	Fuquay-Varina [1]	Benson	Goldsboro [1]	Neuse-WASA [1]
Alternative 9A/B	2055	Historic	93.44%	100.00%	100.00%	99.77%	98.74%	100.00%	97.72%	100.00%	100.00%	100.00%	99.77%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.41%	98.46%	99.89%	96.68%	100.00%	100.00%	100.00%	99.41%	100.00%	100.00%
		GFDL	92.37%	100.00%	100.00%	99.98%	99.66%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.13%	96.23%	99.91%	96.90%	100.00%	100.00%	100.00%	99.13%	100.00%	100.00%
Alternative 9C	2055	Historic	93.46%	100.00%	100.00%	99.77%	98.91%	100.00%	97.72%	100.00%	100.00%	100.00%	99.77%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.41%	98.54%	99.98%	96.68%	100.00%	100.00%	100.00%	99.41%	100.00%	100.00%
		GFDL	92.37%	100.00%	100.00%	99.98%	99.69%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.11%	96.31%	99.92%	96.90%	100.00%	100.00%	100.00%	99.11%	100.00%	100.00%
Alternative 9D	2055	Historic	93.44%	100.00%	100.00%	99.78%	98.87%	100.00%	97.72%	100.00%	100.00%	100.00%	99.78%	100.00%	100.00%
		CNRM	90.23%	100.00%	100.00%	99.57%	98.52%	99.89%	96.68%	100.00%	100.00%	100.00%	99.57%	100.00%	100.00%
		GFDL	92.41%	100.00%	100.00%	99.98%	99.66%	100.00%	100.00%	100.00%	100.00%	100.00%	99.98%	100.00%	100.00%
		MIROC	87.75%	100.00%	100.00%	99.23%	96.23%	99.93%	96.90%	100.00%	100.00%	100.00%	99.23%	100.00%	100.00%

[1] *These systems do not have quantifiable drought triggers that can be modeled in OASIS, so only the unrestricted demand is considered for these systems. Instances when unrestricted demand for these systems cannot be met are highlighted in blue. The only systems subject to this condition, other than Fuquay-Varina in the No-Action alternative, are CFPUA and LCFWSA.*

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Table 4A: Detailed WSRP Statistics for Cary-Apex, City of Dunn, and Fayetteville PWC

Water Supply Alternative	Year	Inflows [1]	Cape Fear River Basin Model Nodes for Cary-Apex						Cape Fear River Basin Model Nodes for Dunn						Cape Fear River Basin Model Nodes for Fayetteville					
			% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)
No action (baseline)	2025	Historic	0	0	0	0	0	0	0	0	0	0	0	0	15.4	13	33	2	1.1	26
	2055	Historic	25.3	102.5	236	2	1.1	96	3.3	7.5	19	2	1.1	19	16.5	13	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	12.9	9.5	22	2	3.2	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	6.5	8	13	1	6.5	13	32.3	16	37	2	16.1	35
Alternative 1	2055	Historic	25.3	106	236	2	1.1	96	3.3	7.5	19	2	1.1	19	16.5	13	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	12.9	9.5	22	1	12.9	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	6.5	8	13	1	6.5	13	32.3	16	36	2	12.9	31
Alternative 2	2055	Historic	25.3	106	236	2	1.1	96	3.3	7.5	19	2	1.1	19	16.5	13	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	12.9	9.5	22	1	12.9	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	6.5	8	13	1	6.5	13	32.3	16	36	2	12.9	31
Alternative 3	2055	Historic	25.3	106	236	2	1.1	96	3.3	7.5	19	2	1.1	19	16.5	13	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	12.9	9.5	22	1	12.9	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	6.5	8	13	1	6.5	13	32.3	16	36	2	12.9	31

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Table 4A: Detailed WSRP Statistics for Cary-Apex, City of Dunn, and Fayetteville PWC

Water Supply Alternative	Year	Inflows [1]	Cape Fear River Basin Model Nodes for Cary-Apex						Cape Fear River Basin Model Nodes for Dunn						Cape Fear River Basin Model Nodes for Fayetteville					
			% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)
Alternative 4	2055	Historic	25.3	104.5	236	2	1.1	96	3.3	7.5	19	2	1.1	19	17.6	13	34	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	19.4	9	22	2	3.2	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	17.5	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	6.5	8	13	1	6.5	13	32.3	17	37	2	16.1	35
Alternative 5	2055	Historic	25.3	106	236	2	1.1	96	5.5	9	20	2	1.1	19	18.7	13	34	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	9.7	10	13	1	9.7	13	12.9	9.5	22	2	6.5	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	9.7	8.5	13	1	9.7	13	32.3	16	36	2	19.4	35
Alternative 6	2055	Historic																		
		CNRM	Identical to Alternative 7 (Jordan Lake Withdrawal)																	
		GFDL																		
		MIROC																		
Alternative 7	2055	Historic	25.3	106	236	2	1.1	96	3.3	7.5	19	2	1.1	19	16.5	13	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	12.9	9.5	22	1	12.9	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	3.2	9	9	1	3.2	9
		MIROC	32.3	144	249	2	19.4	131	6.5	8	13	1	6.5	13	32.3	16	36	2	12.9	31
Alternative 8A	2055	Historic	25.3	106	236	2	1.1	96	5.5	9	20	2	1.1	19	14.3	14.5	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	9.7	10	13	1	9.7	13	12.9	9	22	2	6.5	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	9.7	8.5	13	1	9.7	13	32.3	16	36	2	19.4	35

Hazen

Table 4A: Detailed WSRP Statistics for Cary-Apex, City of Dunn, and Fayetteville PWC

Water Supply Alternative	Year	Inflows [1]	Cape Fear River Basin Model Nodes for Cary-Apex						Cape Fear River Basin Model Nodes for Dunn						Cape Fear River Basin Model Nodes for Fayetteville					
			% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)
Alternative 8B	2055	Historic	25.3	106	236	2	1.1	96	5.5	8.5	20	2	1.1	19	16.5	13	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	12.9	9.5	22	2	3.2	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	6.5	8.5	13	1	6.5	13	32.3	16	36	2	16.1	35
Alternative 9A/B	2055	Historic	25.3	106	236	2	1.1	96	5.5	9	20	2	1.1	19	18.7	13	34	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	9.7	10	13	1	9.7	13	12.9	9.5	22	2	6.5	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	9.7	8.5	13	1	9.7	13	32.3	16	36	2	19.4	35
Alternative 9C	2055	Historic	25.3	106	236	2	1.1	96	5.5	9	20	2	1.1	19	14.3	14.5	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	9.7	10	13	1	9.7	13	12.9	9	22	2	6.5	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	9.7	8.5	13	1	9.7	13	32.3	16	36	2	19.4	35
Alternative 9D	2055	Historic	25.3	106	236	2	1.1	96	5.5	8.5	20	2	1.1	19	16.5	13	33	2	1.1	26
		CNRM	22.6	136.5	516	2	9.7	436	6.5	11.5	13	1	6.5	13	12.9	9.5	22	2	3.2	22
		GFDL	29	82	184	1	29	184	0	0	0	0	0	0	6.5	14	19	1	6.5	19
		MIROC	32.3	145	249	2	19.4	131	6.5	8.5	13	1	6.5	13	32.3	16	36	2	16.1	35

[1] Note that the historical hydrologic record in OASIS spans 91 years whereas the length of record for each of the CNRM-CM5, GFDL-ESM2M, and MIROC-EMS-CHEM hydrologic scenarios is 31 years.

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Table 4B: Detailed WSRP Statistics for Raleigh Water and Town of Benson

Water Supply Alternative	Year	Inflows [1]	Neuse River Basin Model Nodes for Raleigh Water						Neuse River Basin Model Nodes for Benson					
			% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)
No action (baseline)	2025	Historic	0	0	0	0	0	0	0	0	0	0	0	0
	2055	Historic	20.9	67	211	3	2.2	181	3.3	7.5	19	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8	13	1	6.5	13
Alternative 1	2055	Historic	20.9	67	211	3	2.2	181	3.3	7.5	19	2	1.1	19
		CNRM [2]	6.5	385	385	3	3.2	150	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8	13	1	6.5	13
Alternative 2	2055	Historic	20.9	67	211	3	2.2	181	3.3	7.5	19	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8	13	1	6.5	13
Alternative 3	2055	Historic	20.9	67	211	3	2.2	181	3.3	7.5	19	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8	13	1	6.5	13
Alternative 4	2055	Historic	20.9	67	211	3	2.2	181	3.3	7.5	19	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8	13	1	6.5	13
Alternative 5	2055	Historic	20.9	67	211	3	2.2	181	5.5	9	20	2	1.1	19
		CNRM	6.5	386	386	3	6.5	174	9.7	10	13	1	9.7	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	9.7	8.5	13	1	9.7	13

Hazen

Table 4B: Detailed WSRP Statistics for Raleigh Water and Town of Benson

Water Supply Alternative	Year	Inflows [1]	Neuse River Basin Model Nodes for Raleigh Water						Neuse River Basin Model Nodes for Benson					
			% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)
Alternative 6	2055	Historic												
		CNRM [2]	Identical to Alternative 7 (Jordan Lake Withdrawal)											
		GFDL												
		MIROC												
Alternative 7	2055	Historic	20.9	67	211	3	2.2	181	3.3	7.5	19	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8	13	1	6.5	13
Alternative 8A	2055	Historic	20.9	67	211	3	2.2	181	5.5	9	20	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	9.7	10	13	1	9.7	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	9.7	8.5	13	1	9.7	13
Alternative 8B	2055	Historic	20.9	67	211	3	2.2	181	5.5	8.5	20	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8.5	13	1	6.5	13
Alternative 9A/B	2055	Historic	20.9	67	211	3	2.2	181	5.5	9	20	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	9.7	10	13	1	9.7	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	9.7	8.5	13	1	9.7	13
Alternative 9C	2055	Historic	20.9	67	211	3	2.2	181	5.5	9	20	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	9.7	10	13	1	9.7	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	9.7	8.5	13	1	9.7	13

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Table 4B: Detailed WSRP Statistics for Raleigh Water and Town of Benson

Water Supply Alternative	Year	Inflows [1]	Neuse River Basin Model Nodes for Raleigh Water						Neuse River Basin Model Nodes for Benson					
			% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)	% of Years with WSRP Events [1]	Median Event Length (days)	Max Event Length (days)	Max Stage	% of Years with Max Stage	Max Event Length of Max Stage (days)
Alternative 9D	2055	Historic	20.9	67	211	3	2.2	181	5.5	8.5	20	2	1.1	19
		CNRM [2]	6.5	386	386	3	6.5	174	6.5	11.5	13	1	6.5	13
		GFDL	0	0	0	0	0	0	0	0	0	0	0	0
		MIROC	29	68	150	2	6.5	77	6.5	8.5	13	1	6.5	13

[1] Note that the historical hydrologic record in OASIS spans 91 years whereas the length of record for each of the CNRM-CM5, GFDL-ESM2M, and MIROC-EMS-CHEM hydrologic scenarios is 31 years.

[2] For each alternative using CNRM-CM5 inflows, Raleigh Water experiences a singular water shortage event that spans two years reaching up to shortage response Stage 3 for 150 to 174 days, thus the mean and median event length are equal.

3.2 Performance of Jordan Lake and Falls Lake in Meeting Flow Targets and Recreational Criteria

The second class of modeling results described in this report pertain to the frequency (in percent of days) that an alternative does not meet storage, lake elevation, or flow metrics at specific locations, as summarized in Table 5. These results generally pertain to the ability of Falls Lake and Jordan Lake to meet their authorized purposes. These metrics are consistent with the metrics presented in the 2014 Cary/Apex IBT analysis in the Cape Fear River. Similar metrics were developed for Falls Lake. The specific metrics used in the analysis include the following:

- Jordan Lake < 210 feet
- Jordan Lake < 210 feet Memorial to Labor Day
- Jordan Lake water quality storage < 80%, < 60%, < 40%, and < 20%
- Jordan Lake water supply storage < 50%
- Lillington gage flow < 550 cfs
- Fayetteville intake flow < 600 cfs
- Falls Lake < 242.5 feet
- Falls Lake < 242.5 feet Memorial to Labor Day
- Jordan Lake water quality storage < 80%, < 60%, < 40%, and < 20%
- Jordan Lake water supply storage < 50%
- Falls Lake gage flow < seasonal target at Falls Lake (April to October at 100 cfs; 60 cfs otherwise).
- Clayton gage flow < seasonal target at Clayton gage (April to October at 254 cfs; 184 cfs otherwise).

The 210 feet pool elevation in Jordan Lake and the 242.5 feet pool elevation in Falls Lake (USACE, 2018) represent lake levels at which boat access (i.e., the recreation purpose authorized for both federal projects) are anticipated to be adversely impacted. The normal pool for Jordan Lake is 216 feet. The normal pool elevation for Falls Lake is 251.5 feet. The following is a summary of the key conclusions:

- Jordan Lake drops to less than 210 feet less than 0.8 percent of the time for nearly all alternatives and climate change scenarios and 0.2 percent or less in the key summer recreational period. The singular exception is for the MIROC climate scenario for Alternatives 6 and 7 where the numbers are 1.2 percent and 0.4 percent, respectively.
- Jordan Lake water quality storage never drops less than 20 percent (i.e., equivalent to the Stage 4 trigger) in any alternative using either historic or climate change inflows. The water quality storage declines to less than 40 percent infrequently (i.e., less than 2.4 percent of the time) for all 2055 scenarios.
- The amount of time the Jordan Lake Water Quality Pool contains less than 80 percent storage (i.e., the Stage 1 drought trigger) ranges from approximately 9 percent of days up to 20 percent of days. The results for the historical hydrology generally indicate approximately 15 percent of days in 2055, which is notably a 40 percent reduction in the

amount of time at or below 80 percent storage as compared to the baseline results for 2025 (i.e., 25 percent in 2025 versus 15 percent in 2055). This owes to the contribution that treated wastewater makes toward meeting the flow target in Lillington in 2055 as compared to projections in 2025.

- The results for Jordan Lake Drought Stage 1 are highly correlated to the amount of time that the full flow target at Lillington (550 cfs) is not met. The discharge at Lillington is less than 550 cfs approximately 14.5 percent of the time for the alternatives using the historical inflow record. The discharge at Lillington is less than 550 cfs approximately 9.3 to 18.8 percent across all the climate change scenarios. The variation across the modeled alternatives is very low with the greatest difference between any two alternatives (and the same hydrology) of only 0.5 percent. The 14.5 percent in 2055 compares to 19.5 percent under 2025 conditions, so there is a relative reduction of over 25 percent of days spent in a Stage 1 event or worse.
- The model demonstrates that approximately 5.5 percent of the days the flow at Fayetteville of 600 cfs would not be met using historical inflows, which is a 50 percent reduction in days with discharge upstream of the PWC intake under 600 cfs as compared to the 2025 baseline. The variation under the climate change inflows is modest except for the MIROC (MIROC-EMS-CHEM) scenario, which produces low runoff periods that increase the percentage from 12 to 12.6 percent. Nevertheless, like the other metrics, the variance across alternatives under this climate scenario is small.
- Falls Lake drops to less than 242.5 feet less than 0.4 percent of the time for all alternatives and climate change scenarios, and never does in the key summer recreational period.
- The Falls Lake water quality storage declines to less than 40 percent infrequently (i.e., less than 2.5 percent of the time and 1.5 percent of the time using historical hydrology). Falls Lake storage almost never declines to less than 20 percent. The lowest modeled storage reached 16.9 percent during one event in the historical hydrology (i.e., in late 2007) and never under the climate change scenarios.
- The Falls Lake minimum release and Clayton gage seasonal flow targets are never impacted.

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Table 5: Frequency (% of Days) Alternatives Do Not Meet Storage and Flow Metrics at Select Locations in Cape Fear and Neuse River Basins

Alternative	Year	Inflows	Jordan Lake < 210 feet	Jordan Lake < 210 feet Memorial to Labor Day	Jordan Lake Water Quality Storage < 80%	Jordan Lake Water Quality Storage < 60%	Jordan Lake Water Quality Storage < 40%	Jordan Lake Water Quality Storage < 20%	Jordan Lake Water Supply Storage < 50%	Lillington Gage Flow < 550 cfs	Fayetteville Intake Flow< 600 cfs	Falls Lake < 242.5 feet	Falls Lake < 242.5 feet Memorial to Labor Day	Falls Lake Water Quality Storage < 80%	Falls Lake Water Quality Storage < 60%	Falls Lake Water Quality Storage < 40%	Falls Lake Water Quality Storage < 20%	Falls Lake Water Supply Storage < 50%	Falls Lake Release < Seasonal target [1]	Clayton Flow < Seasonal target [2]
No action (baseline)	2025	Historic	0.0%	0.0%	25.2%	17.0%	5.7%	0.0%	0.0%	19.0%	11.2%	0.0%	0.0%	13.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2055	Historic	0.1%	0.0%	15.0%	5.7%	0.6%	0.0%	0.0%	14.2%	5.6%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.4%	5.5%	1.2%	0.0%	0.0%	12.2%	7.1%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.3%	1.6%	0.0%	0.0%	0.0%	9.3%	2.9%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.7%	0.1%	19.4%	8.5%	1.9%	0.0%	0.0%	18.5%	12.2%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%
1	2055	Historic	0.1%	0.0%	15.0%	5.7%	0.6%	0.0%	0.0%	14.2%	5.5%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.4%	5.5%	1.2%	0.0%	0.0%	12.2%	7.0%	0.2%	0.0%	14.5%	6.4%	1.5%	0.0%	3.4%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.2%	1.6%	0.0%	0.0%	0.0%	9.3%	2.9%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.7%	0.1%	19.3%	8.5%	1.8%	0.0%	0.0%	18.5%	12.0%	0.0%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%
2	2055	Historic	0.1%	0.0%	15.0%	5.7%	0.6%	0.0%	0.0%	14.2%	5.5%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.4%	5.5%	1.2%	0.0%	0.0%	12.3%	7.0%	0.4%	0.0%	14.6%	6.4%	1.7%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.1%	1.6%	0.0%	0.0%	0.0%	9.3%	2.9%	0.0%	0.0%	11.8%	1.1%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.7%	0.1%	19.4%	8.6%	1.9%	0.0%	0.0%	18.5%	12.0%	0.1%	0.0%	23.9%	10.3%	2.5%	0.0%	6.3%	0.0%	0.0%
3	2055	Historic	0.1%	0.0%	15.0%	5.7%	0.6%	0.0%	0.0%	14.2%	5.5%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.4%	5.5%	1.2%	0.0%	0.0%	12.2%	7.0%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.1%	1.6%	0.0%	0.0%	0.0%	9.3%	2.9%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.7%	0.1%	19.4%	8.6%	2.0%	0.0%	0.0%	18.5%	12.0%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%

Hazen

Table 5: Frequency (% of Days) Alternatives Do Not Meet Storage and Flow Metrics at Select Locations in Cape Fear and Neuse River Basins

Alternative	Year	Inflows	Jordan Lake < 210 feet	Jordan Lake < 210 feet Memorial to Labor Day	Jordan Lake Water Quality Storage < 80%	Jordan Lake Water Quality Storage < 60%	Jordan Lake Water Quality Storage < 40%	Jordan Lake Water Quality Storage < 20%	Jordan Lake Water Supply Storage < 50%	Lillington Gage Flow < 550 cfs	Fayetteville Intake Flow< 600 cfs	Falls Lake < 242.5 feet	Falls Lake < 242.5 feet Memorial to Labor Day	Falls Lake Water Quality Storage < 80%	Falls Lake Water Quality Storage < 60%	Falls Lake Water Quality Storage < 40%	Falls Lake Water Quality Storage < 20%	Falls Lake Water Supply Storage < 50%	Falls Lake Release < Seasonal target [1]	Clayton Flow < Seasonal target [2]
4	2055	Historic	0.1%	0.0%	15.0%	5.7%	0.6%	0.0%	0.0%	14.2%	5.9%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.4%	5.5%	1.2%	0.0%	0.0%	12.3%	7.3%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.3%	1.6%	0.0%	0.0%	0.0%	9.3%	3.2%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.7%	0.1%	19.4%	8.5%	1.9%	0.0%	0.0%	18.5%	12.6%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%
5	2055	Historic	0.1%	0.0%	15.7%	6.2%	0.8%	0.0%	0.0%	14.6%	5.7%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.8%	5.7%	1.4%	0.0%	0.0%	12.7%	7.3%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.7%	1.7%	0.0%	0.0%	0.0%	9.8%	3.2%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.8%	0.2%	20.0%	9.1%	2.4%	0.0%	0.0%	18.8%	12.2%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%
6	2055	Historic																		
		CNRM	Identical to Alternative 7 (withdrawal from Jordan Lake)																	
		GFDL																		
		MIROC																		
7	2055	Historic	0.2%	0.0%	15.0%	5.8%	0.6%	0.0%	0.0%	14.4%	5.5%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.4%	0.0%	12.4%	5.5%	1.2%	0.0%	0.0%	12.4%	7.0%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.1%	1.4%	0.0%	0.0%	0.0%	9.8%	2.9%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	1.2%	0.4%	19.4%	8.5%	1.9%	0.0%	0.0%	18.7%	12.0%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%

Hazen

Table 5: Frequency (% of Days) Alternatives Do Not Meet Storage and Flow Metrics at Select Locations in Cape Fear and Neuse River Basins

Alternative	Year	Inflows	Jordan Lake < 210 feet	Jordan Lake < 210 feet Memorial to Labor Day	Jordan Lake Water Quality Storage < 80%	Jordan Lake Water Quality Storage < 60%	Jordan Lake Water Quality Storage < 40%	Jordan Lake Water Quality Storage < 20%	Jordan Lake Water Supply Storage < 50%	Lillington Gage Flow < 550 cfs	Fayetteville Intake Flow< 600 cfs	Falls Lake < 242.5 feet	Falls Lake < 242.5 feet Memorial to Labor Day	Falls Lake Water Quality Storage < 80%	Falls Lake Water Quality Storage < 60%	Falls Lake Water Quality Storage < 40%	Falls Lake Water Quality Storage < 20%	Falls Lake Water Supply Storage < 50%	Falls Lake Release < Seasonal target [1]	Clayton Flow < Seasonal target [2]
8A	2055	Historic	0.1%	0.0%	15.7%	6.2%	0.8%	0.0%	0.0%	14.7%	5.4%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.9%	5.8%	1.4%	0.0%	0.0%	12.7%	7.0%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.7%	1.7%	0.0%	0.0%	0.0%	9.8%	3.0%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.8%	0.2%	19.9%	9.1%	2.4%	0.0%	0.0%	18.8%	12.0%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%
8B	2055	Historic	0.1%	0.0%	15.2%	5.9%	0.7%	0.0%	0.0%	14.3%	5.6%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.6%	5.5%	1.3%	0.0%	0.0%	12.4%	7.1%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.4%	1.5%	0.0%	0.0%	0.0%	9.6%	3.1%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.7%	0.1%	19.5%	8.8%	2.0%	0.0%	0.0%	18.6%	12.0%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%
9A/B	2055	Historic	0.1%	0.0%	15.7%	6.2%	0.8%	0.0%	0.0%	14.6%	5.7%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.8%	5.7%	1.4%	0.0%	0.0%	12.7%	7.3%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.7%	1.7%	0.0%	0.0%	0.0%	9.8%	3.2%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.8%	0.2%	20.0%	9.1%	2.4%	0.0%	0.0%	18.8%	12.2%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%
9C	2055	Historic	0.1%	0.0%	15.7%	6.2%	0.8%	0.0%	0.0%	14.6%	5.4%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.8%	5.7%	1.4%	0.0%	0.0%	12.7%	7.0%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.7%	1.7%	0.0%	0.0%	0.0%	9.8%	3.0%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.8%	0.2%	20.0%	9.1%	2.4%	0.0%	0.0%	18.8%	12.0%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%

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Alternative	Year	Inflows	Jordan Lake < 210 feet	Jordan Lake < 210 feet Memorial to Labor Day	Jordan Lake Water Quality Storage < 80%	Jordan Lake Water Quality Storage < 60%	Jordan Lake Water Quality Storage < 40%	Jordan Lake Water Quality Storage < 20%	Jordan Lake Water Supply Storage < 50%	Lillington Gage Flow < 550 cfs	Fayetteville Intake Flow< 600 cfs	Falls Lake < 242.5 feet	Falls Lake < 242.5 feet Memorial to Labor Day	Falls Lake Water Quality Storage < 80%	Falls Lake Water Quality Storage < 60%	Falls Lake Water Quality Storage < 40%	Falls Lake Water Quality Storage < 20%	Falls Lake Water Supply Storage < 50%	Falls Lake Release < Seasonal target [1]	Clayton Flow < Seasonal target [2]
9D	2055	Historic	0.1%	0.0%	15.2%	5.9%	0.7%	0.0%	0.0%	14.3%	5.6%	0.3%	0.0%	20.2%	8.3%	1.5%	0.1%	5.2%	0.0%	0.0%
		CNRM	0.3%	0.0%	12.5%	5.5%	1.3%	0.0%	0.0%	12.3%	7.1%	0.4%	0.0%	14.5%	6.4%	1.5%	0.0%	3.7%	0.0%	0.0%
		GFDL	0.0%	0.0%	9.4%	1.5%	0.0%	0.0%	0.0%	9.6%	3.1%	0.0%	0.0%	11.7%	1.0%	0.0%	0.0%	0.2%	0.0%	0.0%
		MIROC	0.7%	0.1%	19.5%	8.8%	2.0%	0.0%	0.0%	18.6%	12.0%	0.1%	0.0%	23.8%	10.2%	2.3%	0.0%	6.3%	0.0%	0.0%

[1] *Falls Lake flow target: April to October, 100 cfs; 60 cfs otherwise.*

[2] *Clayton flow target: April to October, 254 cfs; 184 cfs otherwise.*

3.3 Low-Flow Discharge in the Cape Fear River and Neuse River

The third class of output metrics pertains to low flow conditions at various key locations along the Cape Fear and Neuse Rivers. A statistical summary of streamflow impacts was developed to assess and evaluate the alternatives in the Neuse and Cape Fear River basins, focusing on the 7Q10, which is the lowest 7-day flow that occurs on average once every 10 years.

Table 6 summarizes the 7Q10 flow statistics at various nodes in the CFNCRB model. The evaluated 7Q10 locations are illustrated in Figure 2. The locations where the 7Q10 is reported include the Lillington gage, upstream of Fayetteville PWC's raw water intake in the Cape Fear basin, upstream of the CFPUA/LCFWSA raw water intake in the Cape Fear basin, at the Cayton Gage in the Neuse River basin, the confluence of the Neuse and Little Rivers in the Neuse River basins, and upstream of NRWASA's raw water intake in the Neuse River basin. Alternative 9A/B is the Town of Fuquay-Varina partnering with the City of Sanford for finished water supply. Alternatives 9C and 9D are similar, but also include a return of treated wastewater to the Cape Fear River.

The CFNCRB model provided results for four categories of change that could influence future low flow conditions to include the following:

1. Potential climate change impact to hydrology.
2. Cumulative impact related to Cape Fear River basin development (i.e., water demand increase between 2025 and 2055).
3. Project-related impacts to 7Q10.
4. USGS gage accuracy and CFNCRB model precision.

These impacts can be distinguished by comparing the low flows that result from the array of 45 different model runs and observing how an alternative, climate scenario, or target year demand (2025 vs 2055) affects the 7Q10 compared to other model runs. The magnitude of impacts to low flows were compared across the three aforementioned categories. The model suggests that the impact due to climate change would potentially incur the largest impact followed by cumulative impacts from increased water demand in the basin unrelated to a specific alternative. The selection of a water supply alternative for the Town of Fuquay-Varina resulted in minimal impact.

Figures 3 and 4 illustrate the model run comparisons. The chart for each location begins at the 2025 No Action baseline and progresses to indicate the relative impact of development through 2055, then the range of impacts across all the water supply alternatives (removing the baseline No Action climate effect) and finally shows the cumulative range of impacts due to the three climate scenarios evaluated. Where there is a range shown (water supply alternatives and climate scenarios), the green bar represents the median of the dataset and the whiskers at the top and bottom of the bar represent the entire range for that location.

3.3.1 Potential Climate Change Impact to Hydrology

The climate models selected for use in this EIS are not consistent with respect to the direction of change (increasing or decreasing) to future low flow conditions in central North Carolina. However, the magnitude

of the forecasted changes from the climate models are significant. The low flow magnitude of change is 5 to 20 times greater than the change predicted from increased water demand through 2055 or the preferred alternative 9A/B. In the following summaries, the percent value describes the change between the historical hydrology runoff and the indicated climate change scenario for an alternative. Ranges are provided at a fixed location as the magnitude of the impact varies depending on the alternative. For example, the GFDL model suggests the Lillington gage 7Q10 would increase by 23.5 percent in the No-Action alternative but only increase by 18.7 percent for Alternative 9C. Therefore, the range in this scenario is between 19 and 24 percent.

In the Cape Fear River basin, the CNRM and MIROC climate models suggest a decrease in the 7Q10. Both models also suggest the changes are more severe further downstream. This may be a function of more severe hydrologic impacts further south and east in the basin, but it is also a function of how Jordan Lake is managed (refer to Section 4). Compared to the historical hydrology and 2055 water demand, the CFNCRB model 7Q10 results for 2055 are 12 to 20 percent less at Lillington, reduced by 20 percent upstream of PWC's intake, and reduced by 32 to 36 percent at the CFPUA/LCFWSA intake. For the MIROC model the comparative changes are a 35 to 40 percent reduction at Lillington, slightly over a 40 percent reduction at PWC's intake, and a reduction of 60 percent at the CFPUA/LCFWSA intake. The GFDL model suggests the 7Q10 results in the Cape Fear will increase 19 to 24 percent at Lillington, 15 to 18 percent at PWC's intake, and 17 to 19 percent at the CFPUA intake. Ranges are provided as an attempt to characterize the climate impacts broadly across all 12 alternatives.

In the Neuse Reiver basin, all three climate models suggest a decline in the 7Q10. The exception is the GFDL-ESM2M, RCP 8.5 model result at the Clayton gage (+1.5 percent). The MIROC-EMS-CHEM model is the most conservative and resulted in a reduction of 12 percent at Clayton, 19 to 22 percent at the confluence of the Little River and Neuse River, and 24 to 27 percent at the NRWASA intake. The CNRM-CM5, RCP 4.5 model suggests a reduction of 4 percent at Clayton, 1 to 4 percent at the Neuse-Little River confluence, and 2 to 5 percent at the NRWASA intake in Kinston. The GFDL-ESM2M, RCP 8.5 model resulted in a 1.4 percent increase at Clayton, a 5 to 8 percent reduction at the Neuse-Little River confluence, and an 8 to 12 percent reduction at the NRWASA intake. The low flow reductions in the Neuse are more modest than the predicted reductions in in the Cape Fear in part due to the consistency of the flow target at Clayton regardless of the hydrologic scenario.

3.3.2 Cumulative Impact Related to Cape Fear River Basin Development

The cumulative impacts from the increase in water demand between 2025 and 2055 in the Cape Fear basin (excluding the Town of Fuquay-Varina) is forecast to reduce the 7Q10 at the Lillington gage, upstream of PWC's Intake, and upstream of the CFPUA/LCFWSA intake by 4.7 percent, 2.1 percent, and 3.8 percent, respectively. The impact at the Lillington gage is larger and potentially misleading. The Lillington 7Q10 result is reported at the gage location, which is downstream of Harnett County's Regional WTP withdrawal and upstream of the effluent discharge from the North Harnett Regional WWTP. Since Harnett County and partners plan for significant growth between 2025 and 2055, the impact is greater in the one-mile stretch between Harnett County's raw water intake and the effluent discharge than elsewhere along this stretch of the Cape Fear River.

The cumulative impacts due to growth in water demand between 2025 and 2055 in the Neuse Basin are mixed depending on location. At the Clayton gage, the 7Q10 is forecast to rise by nearly 20 percent due

to increased use and discharge at Raleigh's Neuse Regional Resource Recovery Facility (NRRRF) and the Town of Clayton's Sam's Branch WRF. Further downstream at the confluence of the Neuse and Little River in Goldsboro, the models predict a reduction of 2.8 percent in the future 7Q10 and 1.3 percent at NRWASA's raw water intake. The confluence of the Neuse and Little Rivers is downstream of Goldsboro's raw water intake and upstream of the City of Goldsboro's wastewater discharge, so approximately one-half of the impact at this location (between no change and -2.8 percent) is due to the increase in the City of Goldsboro's water demand over the planning horizon.

The CFNCRB model suggests the upstream increase in 7Q10 at Clayton may be counteracted further downstream by growth in Johnston County combined with conservative model assumptions about Johnston County's wastewater return to water demand ratio. The wastewater return to water demand ratio for Johnston County will increase with urbanization similar to other urbanizing areas across the state. The wastewater return to water demand ratio is increasing in urban areas but has not been subject to extensive research and therefore is difficult to forecast. The CFNCRB model reflects the present day wastewater to water demand ratio in the 2055 demand scenario.

3.3.3 Project-related Impacts to 7Q10

The following 7Q10 comparative statistics apply to the historical basin runoff (e.g., hydrology) using the 2055 water demand scenario:

- The 7Q10 difference between the No-Action alternative in 2055 and Alternative 9A/B (no return of wastewater to the Cape Fear River basin) is a reduction of 4.6 cfs (-1.1 percent) for Alternative 9A/B at the PWC raw water intake and 3.1 cfs (-0.8 percent) at the CFPUA raw water intake. In the No-Action alternative, the majority of the Town of Fuquay-Varina's demand is unmet as additional supply options are not considered. In Alternative 9A/B, the Town of Fuquay-Varina's water demand is met with a withdrawal from the Cape Fear River near Sanford, which results in an approximate 1 percent reduction in the 7Q10 downstream of Sanford's intake.
- The 7Q10 difference between the 2055 No-Action alternative and Alternative 9C (return of water to Cape Fear) is an increase of 3.4 cfs (+0.8 percent) at PWC's raw water intake and 4.6 cfs (+1.2 percent) at the CFPUA raw water intake. The difference between the No-Action alternative and Alternative 9D (i.e., Western Wake WRF) is an increase of 0.8 cfs and 0.5 cfs at the same respective downstream locations. The smaller change with Alternative 9D is due to the fact the wastewater is returned upstream of the Lillington gage and the releases from Jordan Lake are adjusted accordingly in the model.
- The difference between Alternatives 9A/B (i.e., no return of water) and 9C (i.e., return of water) is an increase of 8 cfs (+2 percent) at PWC's raw water intake and 7.9 cfs (+2 percent) at the CFPUA raw water intake.
- The difference between Alternatives 9A/B and 9D is an increase of 5.4 cfs (+1.3 percent) at PWC's raw water intake and an increase of 3.9 cfs (+1 percent) at the CFPUA raw water intake.
- The model predicts small differences in 7Q10 downstream of the confluence of Middle Creek and the Neuse River depending on the source of the Town of Fuquay-Varina's future water supply and the location of the Town's discharged wastewater (i.e., Terrible

Creek in the Neuse River basin or returned to the Cape Fear River). The impact to the 7Q10 reported at the confluence of the Neuse and Little Rivers and at the NRWASA intake can be reduced by approximately 7 cfs for Alternative 1 over the 2055 No Action alternative or supplemented by up to nearly 6 cfs for Alternatives 4, 5, 6, 7, and 9A/B. For either Alternatives 9C or 9D, the impact at both locations is a very small reduction of 1.6 cfs compared to the 2055 No Action Alternative.

3.3.4 USGS Gage Accuracy and CFNCRB Model Precision

Models allow a high precision comparison of scenario outputs and relative changes as a result of modifying model variables. Modifying a model variable allows a relational cause and effect to be identified. The CFNCRB model has produced accurate and precise output results for the comparison of alternatives in this EIS. However, the ability to discern marginal changes in the field is a separate issue. The USGS gages used to measure streamflow are not nearly as precise in consistency and reproducibility as results from a mathematical model.

The USGS provides ratings for all installed stream gages. An assessment of gage accuracy is found in the “Remarks” Section in the station description (USGS, 2023). A gage station with an “Excellent" rating indicates that approximately 95 percent of the daily flow records are within 5 percent of the true value. A “Good” rating indicates that flow records are within 10 percent of the true flow value and a “Fair” rating indicates that the daily flow record is within 15 percent of the daily flow value. Stations with a “Poor” rating have daily discharge records of less than “Fair” accuracy. Per USGS, the gage station at Lillington has a “Good” rating, the gage station at Fayetteville has a “Poor” rating, and the gage station at Cape Fear Lock 1 NR Kelly has a “Good” rating. At the Lillington gage, a “Good” rating in the low-flow range of 250 to 600 cfs translates to a margin of error of +/- 25 to 60 cfs.

The modeled 7Q10 differences between any two alternatives using the historical hydrology are less than 10 cfs at Lillington and at the other gage sites reported in Table 6. The difference in the 7Q10 flow values between the evaluated water supply alternatives are substantially less than the station margin of error (i.e., accuracy) for daily discharge for all three gaging stations in the Cape Fear River. Since a 7Q10 event is statistically an event that lasts seven days, it is possible that the gage margins of error are reduced over this longer time period versus an instantaneous flow event. However, even with the potential for a lower margin of error, the CFNCRB model predict differences in streamflow that will most likely not be captured at the USGS gage stations.

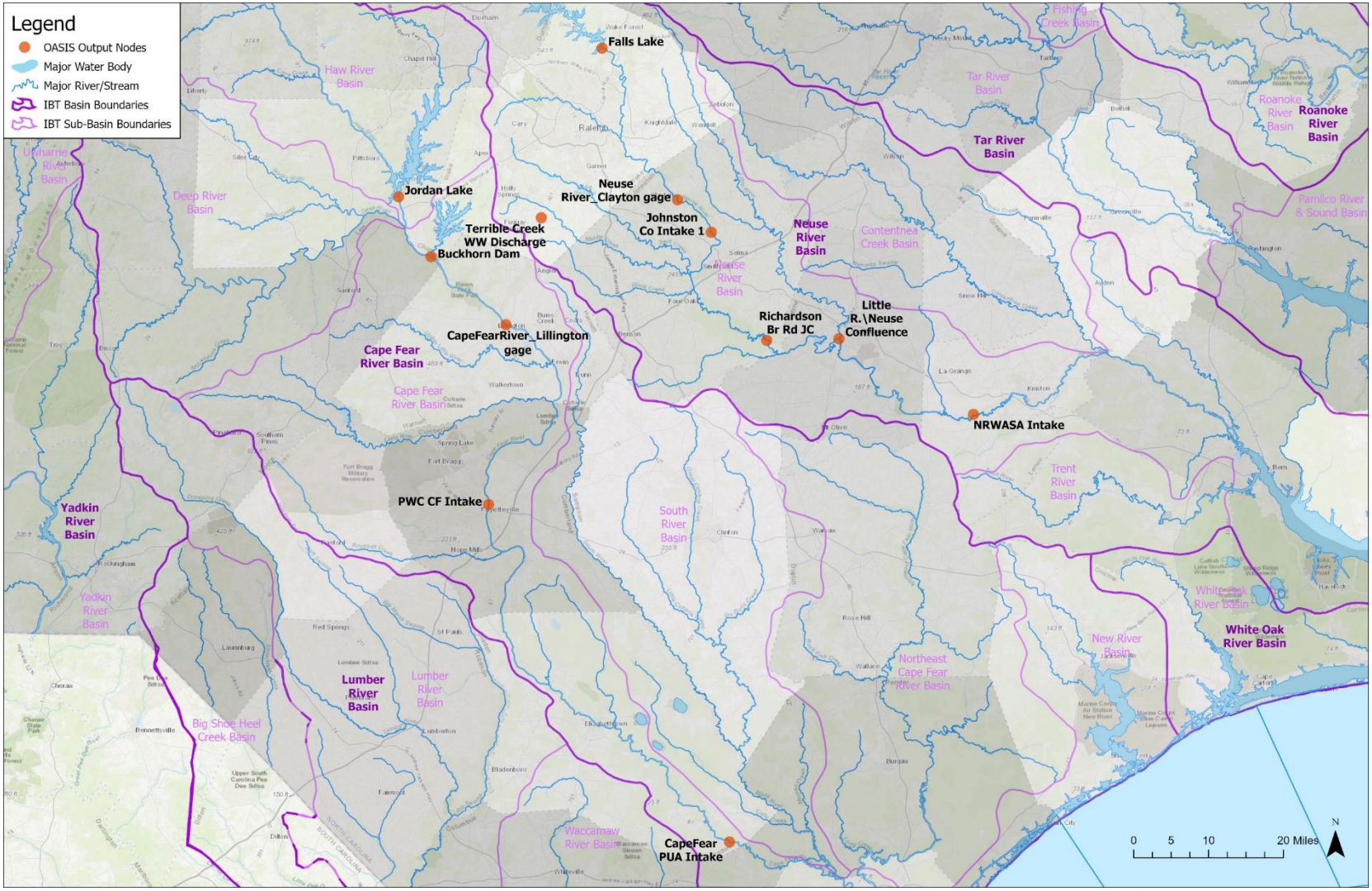

Figure 2: Model Nodes Used for Hydrologic Analysis

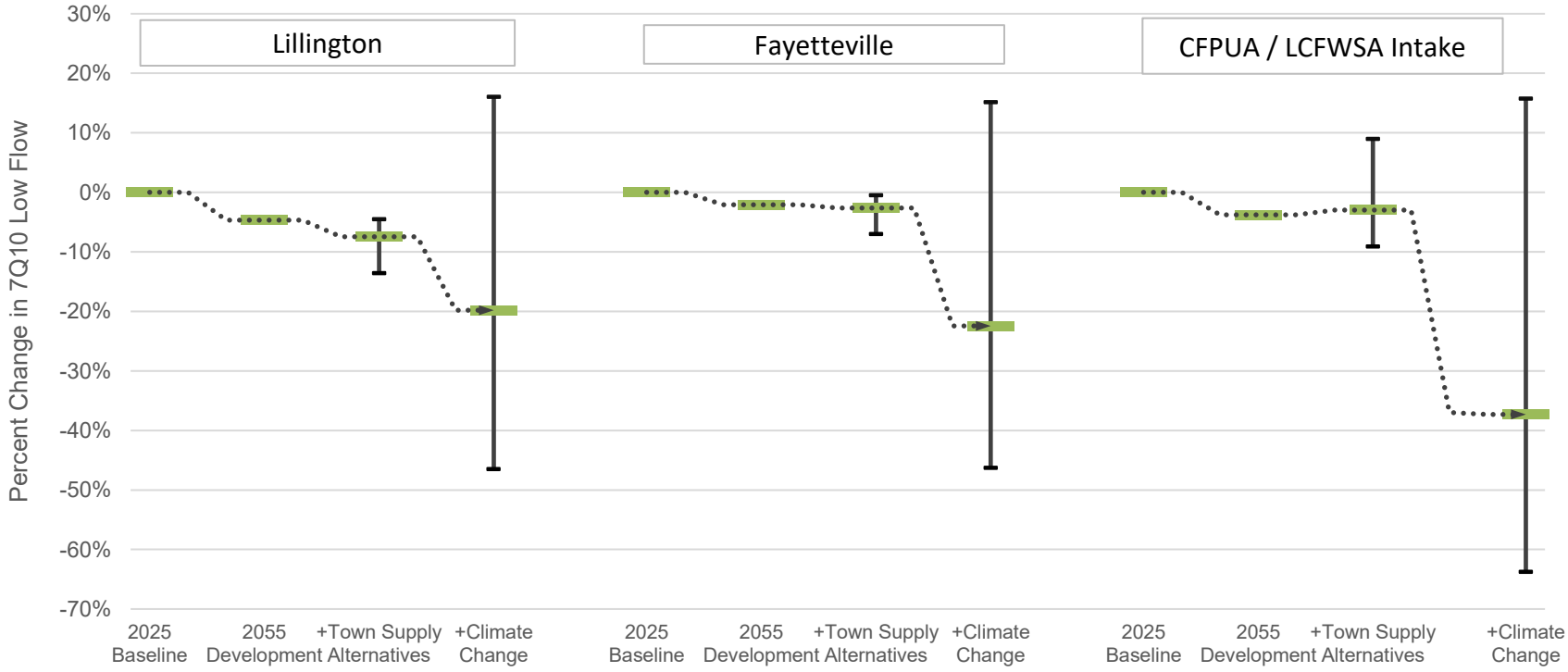

Figure 3: Comparison of Low Flow Impacts at Select Points in the Cape Fear River

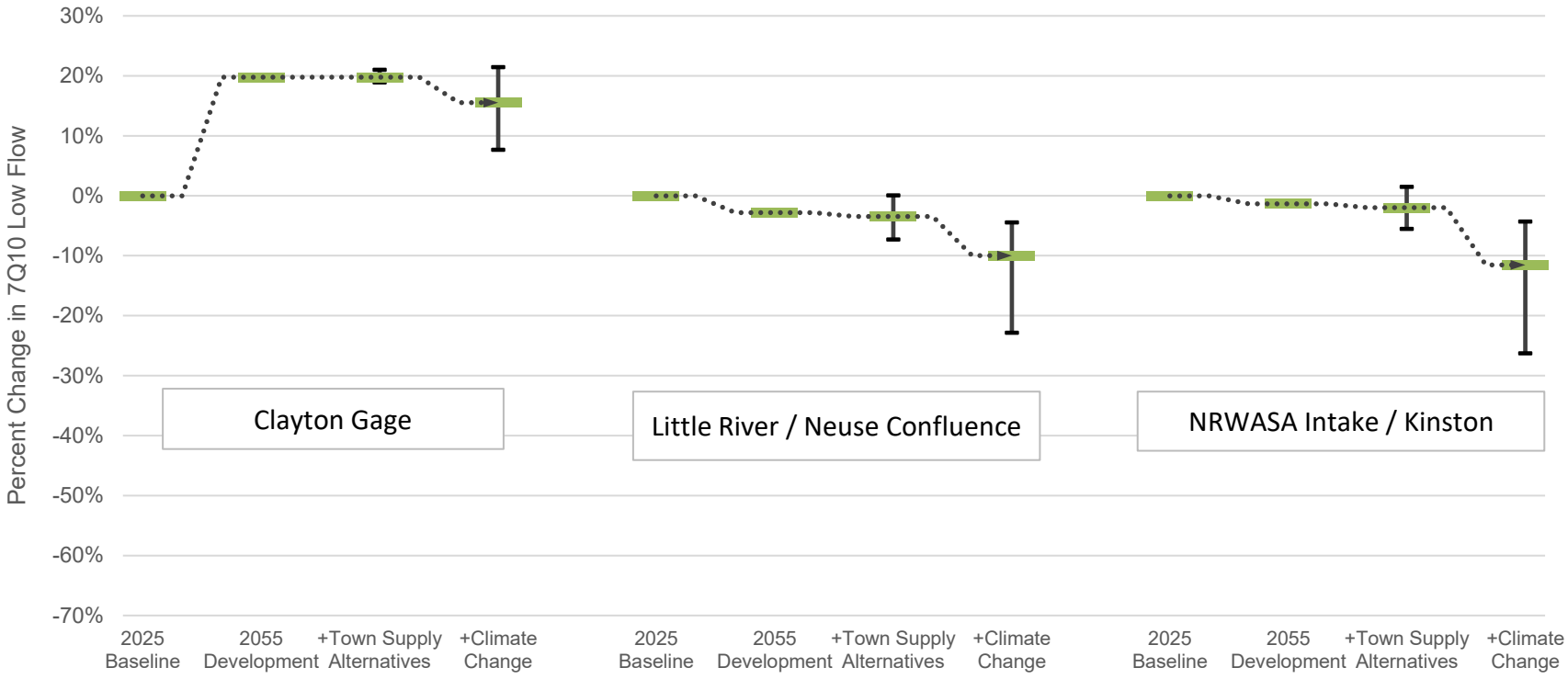

Figure 4: Comparison of Low Flow Impacts at Select Points in the Neuse River

Table 6: Summary of 7Q10 Flow Statistics at Select Nodes in the Neuse and Cape Fear River Basins

Water Supply Alternative	Demand Year	Inflows	Lillington Flow, cfs	Fayetteville Intake, cfs	Cape Fear PUA Intake, cfs	Clayton Flow, cfs	Neuse River / Little River Confluence, cfs	Neuse River WASA Intake, cfs
No-Action (baseline)	2025	Historic	278.9	415.2	407.2	198.8	224.7	244.9
	2055	Historic	265.8	406.5	391.9	238.1	218.4	241.6
		CNRM	233.8	326.7	248.6	228	216.1	236.1
		GFDL	328.2	477.5	462.8	241.4	204.2	218.6
		MIROC	170.7	238.1	164.4	209.8	176.8	183.6
Alternative 1	2055	Historic	266.3	410.3	395.8	238.1	211.2	234.3
		CNRM	233.8	330.5	272.1	230.8	207.3	226.5
		GFDL	319.2	475	466.4	241.4	195.1	209.5
		MIROC	170.9	241.8	169.7	209.8	172.4	181.5
Alternative 2	2055	Historic	266	410.3	396	236.6	217.4	240.7
		CNRM	233.8	330.5	260.7	226.6	215.1	235.1
		GFDL	319.2	474.9	466.2	240.6	205.5	220.5
		MIROC	170.7	241.7	165.4	208	176.3	183.6
Alternative 3	2055	Historic	266.3	410.4	395.8	238.1	212.3	235.3
		CNRM	233.9	330.6	280.2	228	209.5	228.5
		GFDL	319.2	475	466.4	241.4	195.6	210
		MIROC	170.9	241.8	167.8	209.8	173.2	180.1
Alternative 4	2055	Historic	265.8	399.2	384.1	238.1	224.3	247.5
		CNRM	233.8	318.1	273.3	228	220.2	240.7
		GFDL	328.2	470.1	455	241.4	210.1	224.6
		MIROC	170.7	230.8	160.8	209.8	181.5	188.8

Table 6: Summary of 7Q10 Flow Statistics at Select Nodes in the Neuse and Cape Fear River Basins

Water Supply Alternative	Demand Year	Inflows	Lillington Flow, cfs	Fayetteville Intake, cfs	Cape Fear PUA Intake, cfs	Clayton Flow, cfs	Neuse River / Little River Confluence, cfs	Neuse River WASA Intake, cfs
Alternative 5	2055	Historic	258	401.9	388.7	238.1	224.3	247.5
		CNRM	213	313.7	251.2	228	220.8	241.2
		GFDL	315.7	469	461.4	241.4	210.1	224.6
		MIROC	157.3	226.4	158.4	209.8	181.5	188.8
Alternative 6/7	2055	Historic	265.9	409.6	395	238.1	224.3	247.5
		CNRM	233.9	330.6	255	228	220.2	240.7
		GFDL	328.2	481.2	466.4	241.4	210.1	224.6
		MIROC	170.9	241.9	167	209.8	181.5	188.8
Alternative 8A	2055	Historic	258	412.3	399.9	238.1	216.8	240
		CNRM	213	322	269.8	228	214.7	234.5
		GFDL	315.7	476.6	468.8	241.4	202.6	217.1
		MIROC	157.2	234	158	209.8	175	181.9
Alternative 8B	2055	Historic	263.9	407.5	392.9	238.1	216.8	240
		CNRM	230.9	326.7	257.1	228	214.7	234.5
		GFDL	316.6	470.7	463	241.4	202.6	217.1
		MIROC	163.7	234.1	163.4	209.8	175	181.9
Alternative 9A/B	2055	Historic	258	401.9	388.7	238.1	224.3	247.5
		CNRM	213	313.7	251.2	228	220.8	241.2
		GFDL	315.7	469	461.4	241.4	210.1	224.6
		MIROC	157.3	226.4	158.4	209.8	181.5	188.8

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Table 6: Summary of 7Q10 Flow Statistics at Select Nodes in the Neuse and Cape Fear River Basins

Water Supply Alternative	Demand Year	Inflows	Lillington Flow, cfs	Fayetteville Intake, cfs	Cape Fear PUA Intake, cfs	Clayton Flow, cfs	Neuse River / Little River Confluence, cfs	Neuse River WASA Intake, cfs
Alternative 9C	2055	Historic	258	409.9	396.6	238.1	216.8	240
		CNRM	213	322	267.9	228	214.7	234.5
		GFDL	315.7	476.6	468.8	241.4	202.6	217.1
		MIROC	157.3	234	155.6	209.8	175	181.9
Alternative 9D	2055	Historic	263.9	407.3	392.6	238.1	216.8	240
		CNRM	230.9	326.7	257.1	228	214.7	234.5
		GFDL	316.5	470.7	463	241.4	202.6	217.1
		MIROC	163.8	234.2	165.1	209.8	174.8	181.8

4. Interpretation of Future Climate Simulation Results

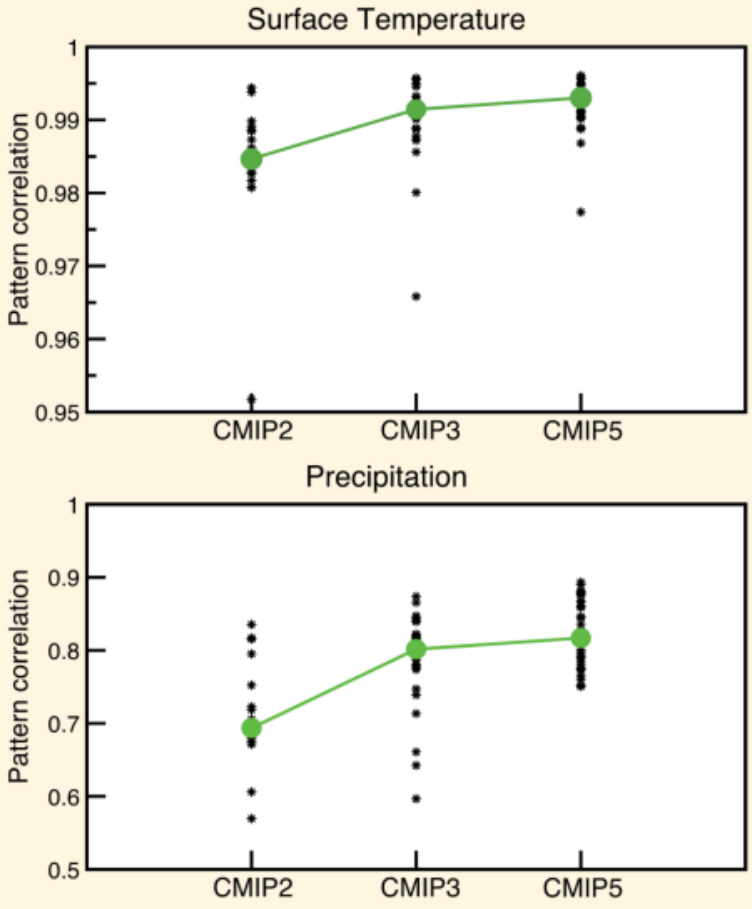
The climate variability scenarios results need to be interpreted with caution as discussed in Section 2.2. Climate models are typically run for hundreds of years to collect statistics on the frequency and intensity of weather events. One variable is changed and the model simulations are re-run to assess the global change in the statistics (Lerner, 2022). When climate models are used to predict the average future surface temperature for a given greenhouse gas emissions scenario, the majority of the models tend to agree (i.e., the models converge). The climate models do not converge as well for precipitation scenarios and struggle particularly with predicting the magnitude and frequency of extreme weather events.

Figure 5 illustrates the improvement of climate models over the course of several generations and also indicates the weaker capability of these models to reproduce precipitation patterns (Flato, 2013). The models used in this evaluation come from the CMIP5 archive. The improvement in skill of CMIP5 models over prior iterations (i.e., CMIP2 and CMIP3) to predict temperature and precipitation is shown in Figure 5. The lesser ability of these models to predict precipitation magnitude and timing will have implications for the hydrologic conditions assumed for these scenarios. Preparing for future climate variability is widely recognized as an important planning consideration for water supply infrastructure and therefore merits attention in this EIS despite continued uncertainty in the timing, magnitude, and patterns.

Shifts in the overall hydrologic productivity and timing of runoff for the three climate scenarios were evaluated with respect to the future water supply reliability in the Cape Fear and Neuse River basins. Table 7 summarizes the median unit runoff for four broad geographic areas in the Cape Fear and Neuse River basins. The median unit runoff provides additional quantitative context on the overall impact to the region's hydrology. The four geographical areas are as follows:

1. Neuse basin upstream of Falls Lake Dam
2. Neuse basin downstream of Falls Lake Dam
3. Cape Fear basin upstream of Jordan Lake Dam
4. Cape Fear basin downstream of Jordan Lake Dam (includes Rocky/Deep River watersheds)

Unit runoff results are presented for both 2010 to 2040 and 2040 to 2070 for the three climate variability scenarios even though the former period was not modeled in the CFNCRB model. The unit runoff results between 2010 and 2040 provide context for how the climate scenarios unfold over the next decades. Both historical observations and climate variability scenarios demonstrate greater unit runoff for the downstream portions of each basin as compared to the upstream portions. Runoff originating in the upper portions of the basins flowing into the lower basins was not included in the runoff statistics for the lower basins. The unit runoff in the Cape Fear basin is marginally higher than for the Neuse River basin. It is also notable that the unit runoff for the MIROC-ESM-CHEM model between 2040 and 2070 indicates a marked reduction compared to the historical runoff and runoff from the other two climate scenarios. The suitability of any of these scenarios is difficult to assess; however, one indication that there are challenges in plausibility of the MIROC-ESM-CHEM model is that the model has a known warm temperature bias at mid-latitudes, including the southeastern United States (Watanabe, 2011). Nevertheless, the MIROC-ESM-CHEM model was selected as a worst-case bounding condition despite this model flaw.



FAQ 9.1, Figure 1 | Model capability in simulating annual mean temperature and precipitation patterns as illustrated by results of three recent phases of the Coupled Model Intercomparison Project (CMIP2, models from about year 2000; CMIP3, models from about 2005; and CMIP5, the current generation of models). The figure shows the correlation (a measure of pattern similarity) between observed and modelled temperature (upper panel) and precipitation (lower panel). Larger values indicate better correspondence between modelled and observed spatial patterns. The black symbols indicate correlation coefficient for individual models, and the large green symbols indicate the median value (i.e., half of the model results lie above and the other half below this value). Improvement in model performance is evident by the increase in correlation for successive model generations.

Figure 5: Generalized comparison of GCM accuracy for temperature and precipitation outputs over the course of 3 generations of the CMIP project (models used for this EIS analysis are from CMIP5).

Table 7: Median Unit Runoff by Inflow Scenario in the Neuse and Cape Fear Upstream and Downstream of Major Basin Reservoir Nodes

Time Period	Climate Change Scenario	Neuse Upstream Falls Lake, cfs/mi^2	Neuse Downstream Falls Lake, cfs/mi^2	Cape Fear Upstream Jordan Lake, cfs/mi^2	Cape Fear Downstream Jordan Lake, cfs/mi^2
Historic (1930 to 2020)	N/A	0.35	0.63	0.47	0.69
2010 to 2040	MIROC-ESM-CHEM	0.36	0.63	0.48	0.70
	GFDL-ESM2M	0.34	0.61	0.45	0.78
	CNRM-CM5	0.40	0.74	0.51	0.80
2040 to 2070	MIROC-ESM-CHEM	0.24	0.44	0.35	0.48
	GFDL-ESM2M	0.30	0.57	0.40	0.66
	CNRM-CM5	0.34	0.64	0.44	0.74

The hydrologic changes modeled in MIROC-ESM-CHEM and CNRM-CM5 produce rare shortages for a single major municipal water supply withdrawal, CFPUA and LCFWSA, at the last freshwater withdrawal point on the Cape Fear River. Per the aforementioned discussion, climate models have difficulty reproducing precipitation patterns under historical conditions, so similar challenges should be anticipated for future predictions. There are six events in the MIROC scenario and three events in the CNRM scenario that produce supply shortages at the CFPUA/LCFWSA intake over a 30-year hydrologic period. These events are typically a single day in length; however, the longest duration event is 11 days.

Table 8 summarizes key system conditions during the months of water supply shortages for CFPUA and LCWSA. In each case, there are several factors or opportunities that would either naturally mitigate these events or could be leveraged to prevent the water supply shortages from occurring. The following are factors and opportunities that will mitigate these shortages:

The monthly average discharge at the intake is well in excess of the raw water need.

The average monthly discharge in the Cape Fear River at the point of withdrawal, even in a severe drought, is well in excess of the magnitude of the water supply withdrawal needed to satisfy CFPUA and LCFWSA demands. This result is demonstrated by comparing the column “Monthly Mean River Discharge at Intake” with the adjacent column, “Monthly Mean Water Withdrawal” in Table 8**.** The data suggests that the river discharge may not decline to the low daily discharges observed in the CFNCRB model to cause the observed shortages. In reality the runoff (and consequently flow) in the Lower Cape Fear may be more stable than the daily fluctuations in these climate scenarios suggest.

The storage behind Lock and Dam #1 is not part of the OASIS model.

The CFNRBM model assumes the CFPUA /LCFWSA intake points are “run-of-river” and that there is no storage in the Cape Fear River. However, backwater from Lock & Dam 1 runs upstream to Lock and Dam 2 (Palmer, 2024), a distance of 32 miles. Combined with an average river width between 200 and 300 feet and a navigation channel of 8 feet deep, over a billion gallons is stored in this reach of the Cape Fear River. Each inch of backwater storage is equivalent to 20 to 30 million gallons. This storage may be sufficient to mitigate the longest modeled shortage timeframe of 11 days. This storage could be a

mitigating factor for an actual sustained shortage, should a shortage occur, particularly when combined with other management factors to help alleviate and buffer low flow events.

CFPUA/LCFWSA do not have target demand reductions in WSRPs or a quantifiable source water trigger condition.

Neither CFPUA nor LCFWSA have WSRPs with quantifiable triggers and target demand reductions in the CFNCRB model. Demand curtailment would undoubtedly accompany the response to drought events of this magnitude. However, the CFNCRB model assumes no water demand reduction for CFPUA nor LCFWSA unlike several other utilities in the Cape Fear River basin.

Modified management of Jordan Lake.

Modified or improved management of Jordan Lake could eliminate the rare shortages observed at the CFPUA/LCFWSA intake with or without consideration of the three aforementioned mentioned mitigation opportunities. The management of Jordan Lake under the current Drought Contingency Plan (DCP) in the CFNCRB model plays a role in causing these rare shortages. In each shortage provided in Table 8, there is sufficient storage in Jordan Lake to mitigate downstream shortages with releases from the Water Quality Pool.

Jordan Lake operations are not explicitly managed to meet needs downstream of Lillington. The release protocol for Jordan Lake was established to help meet downstream water quality needs while maintaining water supply storage in the reservoir. The drought plans for Jordan Lake allow for reductions in this minimum flow target at Lillington. In the Stage 3 and Stage 4 drought protocol, there is no flow target at Lillington but there is a specified maximum release from Jordan Lake. The CFNCRB model uses these operating conditions by limiting the maximum Jordan Lake release to 200 cfs. For example, when a Jordan Lake Stage 3 drought is invoked, there is far less protection remaining for downstream uses. It is only under Stage 3 conditions (Stage 4 is never reached in any scenario) when the CFPUA/LCFWSA shortages occur. Historically, the runoff downstream of Jordan Lake has been sufficient to meet water demands and have not required flow augmentation from Jordan Lake during low-flow periods. However, if water demand growth in the lower portions of the Cape Fear River basin is achieved as forecasted by LWSPs and climate change is severe, there will be a need to change the Jordan Lake operational approach.

Using the Jordan Lake Water Quality Pool to consider water supply needs in the Cape Fear River downstream of Lillington appears to be a viable means of ensuring water supply reliability per the CFNCRB model results. For reference, Jordan Lake drought Stages 1 through 4 are triggered when the Water Quality Pool storage drops below 80 percent, 60 percent, 40 percent, and 20 percent, respectively. The USACE operates Jordan Lake to meet the following flow targets:

- Drought level 0: Flow target at Lillington remains at 600 +/- 50 cfs
- Drought level 1: Flow target at Lillington ranges from 450 to 600 +/- 50 cfs
- Drought level 2: Flow target at Lillington ranges from 300 to 450 +/- 50 cfs
- Drought level 3: No flow target set at Lillington. A maximum release rate of 200 cfs from Jordan Lake, plus any required water supply releases downstream to Lillington.

- Drought level 4: No flow target set at Lillington. A maximum release rate of 100 to 200 cfs from Jordan Lake plus any required water supply releases downstream to Lillington.

The 2008 Jordan Lake DCP indicates the USACE may engage in a range of flow targets at Lillington during drought Stages 1 and 2. The target flow in Stages 1 and 2 is establish via collaboration and coordination on a variety of parameters such as stakeholder input, short and long-term weather outlook, gate status, influences on stream flows downstream, and local inflows to both Jordan Lake and reaches downstream of the dam. When Jordan Lake is in drought Stages 3 and 4, the DCP does not specify how far downstream water supply needs should be fulfilled. Flexibility in adjusting dam releases has some limits under the DCP. When Jordan Lake contains water in the conservation pool (as has always been the case), Jordan Lake will be operated to meet water supply requirements and water quality low flow releases. Utilities using Jordan Lake as a water supply will be unaffected by this change in DCP operating protocol.

The few shortages for the CFPUA/LCFWSA, which only occur in two of the climate variability scenarios, are due to extremely low inflows projected for this downstream portion of the Cape Fear River. The aggregate water supply need for utilities downstream of Lillington are not satisfied by the modest release from Jordan Lake because the shortages occur under significant additional water demand stress. The municipal surface water demands for PWC, CFPUA and LCFWSA are projected to increase by over 57 mgd between 2025 and 2055 per the respective LWSPs submitted by these systems, which is approximately a 90 percent increase in water demand at these locations over the 30-year planning period. The water supply shortages for CFPUA/LCFWSA disappear when the climate models are rerun with a modification to the Jordan Lake Stage 3 minimum release to mimic a Stage 2 release. Adjusting the Jordan Lake releases from the water quality pool to consider downstream water supply needs will require coordination between the State and USACE as specified in the Jordan Lake DCP. The authority to modify releases appears to be vested in the State under the current DCP as described on pages 6-9 of the Jordan Lake DCP.

Given the various mitigation options, it seems reasonable to conclude that if climate impacts of the magnitude suggested by the CNRM and MIROC scenarios occur, there are available options to mitigate the emergency. Per the discussion in Section 3, it is clear that the selection of a water supply alternative for the Town of Fuquay-Varina does not significantly exacerbate the water supply shortages in the Cape Fear River basin nor does the Town of Fuquay-Varina’s preferred water supply alternative prevent mitigation strategies from being implemented.

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Table 8: Key System Conditions During Months with Shortages for CFPUA and LCWSA

Alternative	Climate Scenario	Month and Year	Jordan Lake		CFPUA / LCFWSA			
			Minimum Water Quality Storage, MG (%)	Average Release (mgd)	Monthly Mean River Discharge at Intake (mgd)	Monthly Mean Water Withdrawal (mgd)	Days with Shortage [1]	Average Shortage (mgd) [1]
No Action	MIROC-ESM-CHEM	August, 2043	12,036 (39%)	129	304	68.5	----	----
		September, 2043	9,804 (32%)	119	347	61.3	----	----
		October, 2050	10,631 (34%)	92	352	54.0	1	16.4
		August, 2051	12,056 (39%)	195	218	66.9	----	----
		September, 2056	10,051 (33%)	140	153	60.5	1	30.2
		September, 2063	10,620 (34%)	143	269	58.7	4	16.2
	CNRM-CM5	September, 2057	8,930 (29%)	124	121	61.3	----	----
		August, 2058	10,671 (35%)	141	306	59.7	9	34.3
		September, 2058	11,676 (38%)	136	1,862	61.3	1	7.5
9A/B	MIROC-ESM-CHEM	August, 2043	12,034 (39%)	129	304	62.7	1	0.4
		September, 2043	9,741 (32%)	119	348	60.3	----	----
		October, 2050	10,631 (34%)	92	357	54.6	2	12.6
		August, 2051	12,055 (39%)	195	224	67.6	1	51.2
		September, 2056	10,053 (33%)	140	158	61.1	1	26.2
		September, 2063	10,620 (34%)	143	270	57.2	4	19.8
	CNRM-CM5	September, 2057	8,930 (29%)	124	124	59.8	----	----
		August, 2058	10,671 (35%)	141	317	67.7	11	24.8
		September, 2058	11,676 (38%)	136	1,866	60.4	----	----
9C	MIROC-ESM-CHEM	August, 2043	12,312 (40%)	130	310	68.5	7	26
		September, 2043	10,023 (33%)	119	349	61.3	5	6.5
		October, 2050	10,808 (35%)	92	357	54.6	1	4.9
		August, 2051	12,238 (40%)	196	224	66.7	1	27.7
		September, 2056	10,225 (33%)	141	159	61.1	1	5.8
		September, 2063	11,070 (36%)	147	272	57.1	5	24.7

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Table 8: Key System Conditions During Months with Shortages for CFPUA and LCWSA

Alternative	Climate Scenario	Month and Year	Jordan Lake		CFPUA / LCFWSA			
			Minimum Water Quality Storage, MG (%)	Average Release (mgd)	Monthly Mean River Discharge at Intake (mgd)	Monthly Mean Water Withdrawal (mgd)	Days with Shortage [1]	Average Shortage (mgd) [1]
	CNRM-CM5	September, 2057	9,088 (29%)	124	123	59.8	1	44.9
		August, 2058	10,907 (35%)	147	316	61.7	2	13.4
		September, 2058	11,918 (39%)	133	1,863	60.5	1	29.1
9D	MIROC-ESM-CHEM	August, 2043	12,443 (40%)	152	321	68.5	1	0.4
		September, 2043	9,400 (30%)	122	355	61.3	----	----
		October, 2050	10,973 (36%)	92	356	54.3	1	4.9
		August, 2051	12,325 (40%)	205	230	68.5	2	29.1
		September, 2056	10,196 (33%)	145	162	60.3	1	8.2
		September, 2063	11,254 (37%)	146	272	59.2	5	25.2
	CNRM-CM5	September, 2057	9,280 (30%)	124	125	61.3	1	45.4
		August, 2058	11,010 (36%)	145	312	58.6	9	23.6
		September, 2058	11,981 (39%)	131	1,862	61.1	1	26.2

[1] *The number of days and average shortage quantities are for both CFPUA and LCFWSA as they share a common intake location in the model.*

[2] *One of the two shortage days averaged was 26.3 mgd for CFPUA, the demand for this node on this day was 33.0 mgd.*

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ATTACHMENT A

Future Climate Scenarios for Town of Fuquay-Varina
Interbasin Transfer Study (Tetra Tech, 2020)

Future Climate Scenarios for Town of Fuquay-Varina Interbasin Transfer Study

November 30, 2020

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1.0 Introduction

Hazen & Sawyer ("Hazen") is supporting the Town of Fuquay-Varina ("Town") in developing an Environmental Impact Statement (EIS) in support of an Inter-basin Transfer (IBT) application. The proposed IBT will transfer water from the Cape Fear River basin to the Neuse River basin. Impacts of the proposed IBT will be evaluated using the OASIS Cape Fear - Neuse Combined Hydrologic Model. The potential impact of climate change on the hydrologic status of the Cape Fear and Neuse River basins as a result of the proposed transfer must be evaluated in the EIS. This technical evaluation requires estimating how natural hydrologic inputs to both basins may change over time.

Hazen has subcontracted with Tetra Tech to assess climate variability via the development of quantitative daily timestep hydrology for the Neuse River Cape Fear River basins. Specifically, runoff for all areas upstream of New Bern, NC in the Neuse River Basin, and all areas upstream of Lock and Dam #1 in the Cape Fear River basin were requested. The required estimates are natural flows (i.e., without consideration of dams) at the subbasin scale. The influence of dams, discharges, and flow withdrawals in the basins will be simulated within the OASIS model.

To develop the analysis covering these two large drainage basins and still retain sufficient spatial resolution, the USGS National Hydrology Model (NHM) was used. The NHM Model incorporates a calibrated Precipitation Runoff Modeling System (PRMS) rainfall runoff model (Regan et al., 2018). The NHM and PRMS hydrologic modeling tools are described in Section 2.0.

To provide an assessment that covers a scientifically supported range of future climate variability, timeseries output (statistically downscaled to local conditions) was selected from three global climate models (GCMs) that represent the spectrum of future conditions. Selection and processing of the climate model data is described in Section 3.2. A watershed runoff model (NHM/PRMS) is then used to convert weather to runoff timeseries. Section 4.0 describes the application of the watershed model, including examination of the performance of the model relative to historic streamflow.

Results of the modeling are provided for a 30-year future climate run centered at 2055 (i.e., 2041 – 2070). Flow timeseries associated with each GCM are compared to a historical "hindcast"[1] model run spanning 1950 to 2005 (as recommended by Abatzoglou and Brown [2012], the developers of the downscaled climate dataset). Hindcasting provides an "apples to apples" indication of relative change that is used to adjust the observed inputs to OASIS using a bias-adjustment technique described in Section 4.4. The bias adjustment accounts for systematic differences that may be present between the PRMS model and observed flows.

The workflow for creating future climate-adjusted runoff timeseries is summarized in Figure 1

The results of the modeling are provided in an electronic database compatible with OASIS model inputs and summarized in Section 5.0.

[1] A hindcast is a model produced estimate of all outputs (e.g. runoff, PET, etc.) using historical input conditions (e.g. temperature and precipitation), which can be used to evaluate model performance.

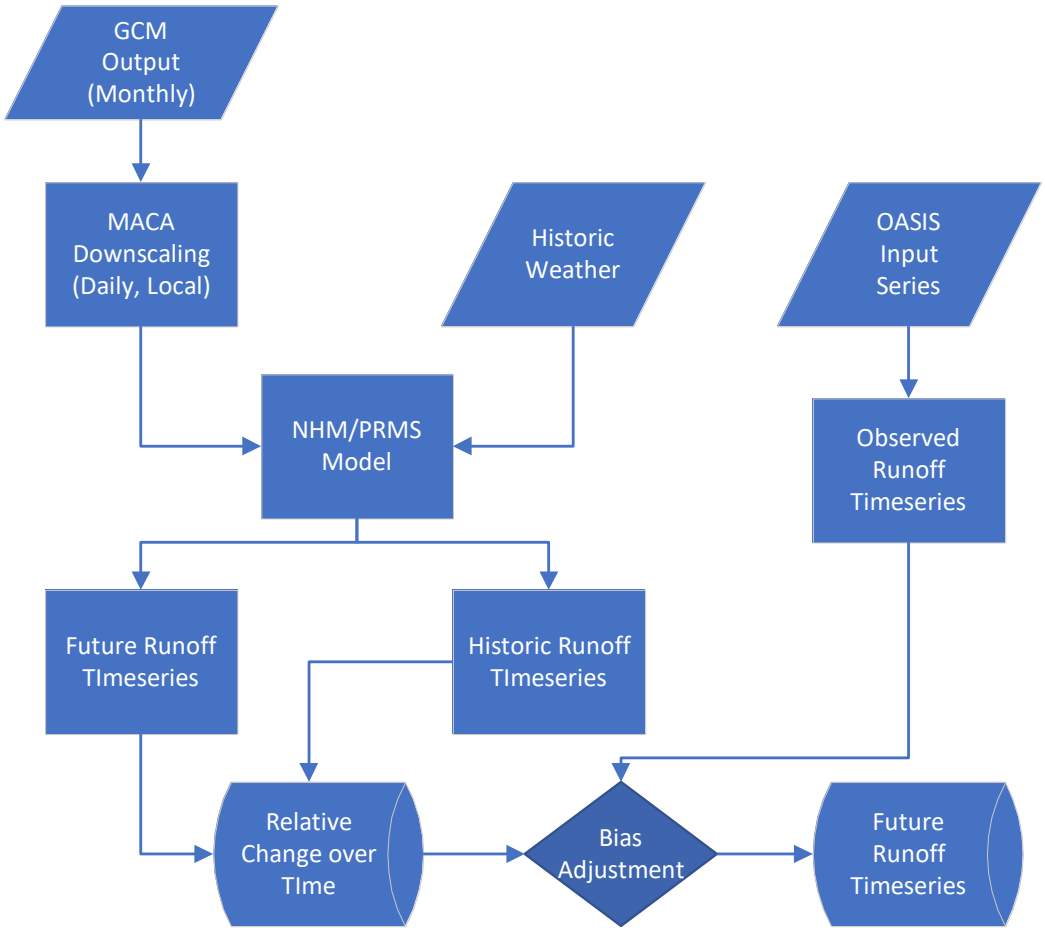

Figure 1. Workflow for creating future runoff timeseries

2.0 Rainfall-Runoff Model

2.1 NHM/PRMS Model

The USGS National Hydrologic Model (NHM) infrastructure supports the efficient construction of local-, regional-, and national-scale hydrologic models. The NHM infrastructure consists of 1) an underlying geospatial fabric of modeling units with an associated parameter database, 2) a model input data archive, and 3) a repository of the physical model simulation code bases. The PRMS model is the rainfall-runoff component of the NHM. Adaptation of PRMS for use in the NHM is described in Regan et al. (2018).

The National Geospatial Fabric for the NHM is based on the National Land Cover Database (NLCD) for 2001. This land use representation is used for simulation of both historic and future conditions and no attempt has been made to simulate future changes in land use. Approximately 10,000 square miles (mi^2) of drainage area in the source and receiving basins are included in the model. Areas with significant recent growth are mostly confined to the Triangle, Triad, and Fayetteville urban areas and represent a small fraction of the source and receiving basin drainage area. It is not anticipated that changes to the small fraction of urbanization in the source and receiving basins will significantly change the findings of the hydrologic analysis. Assuming a constant land cover will allow the model to discern the direction and relative magnitude of hydrologic impacts from climate variability, which are then applied to the OASIS input timeseries calculated from observed gage records. Further, the analysis required for the IBT primarily considers the impacts to the source and receiving basins during low-flow periods. Therefore, use of the 2001 baseline was determined to be adequate for the purpose of this task to evaluate *relative* changes to hydrology that may occur as a result of climate change.

2.2 Model Development and Hydrologic Response Units (HRUs)

Subwatersheds in the NHM (referred to as hydrologic response units or “HRUs” by the model developers) are similar in scale to HUC10 boundaries, but do not follow the HUC10 breakpoints exactly. The geospatial fabric is based on an aggregation of the spatial features associated with NHDPlus version 1. The more than two million catchments in the U.S. in the NHDPlus version 1 dataset were aggregated to approximately 110,000 HRUs. The NHM subwatersheds or HRUs for the Cape Fear and Neuse are displayed in Figure 2 and range in size from 0.02 to 242 square miles with a median of 9.4 and average of 18.6 square miles. These subwatersheds were reviewed with Hazen and determined to be sufficient for providing input to the OASIS model. Aggregated local flows (not including flows from upstream subwatersheds) as well as evaporation rates are provided for each subwatershed. The OASIS model is responsible for aggregating the flows from each HRU along tributaries and the main stems of both river systems as well as simulating operations.

The PRMS model for the Cape Fear consists of 296 HRUs and 168 stream segments while the Neuse model is comprised of 228 HRUs and 127 stream segments. A description of the NHM PRMS modeling system including a discussion of the modules and parameterization is provided in Regan et al. (2018). The parameters in the Cape Fear and Neuse PRMS models (described in Appendix I of Regan et al., 2018) have not been changed from the USGS-provided values for this study.

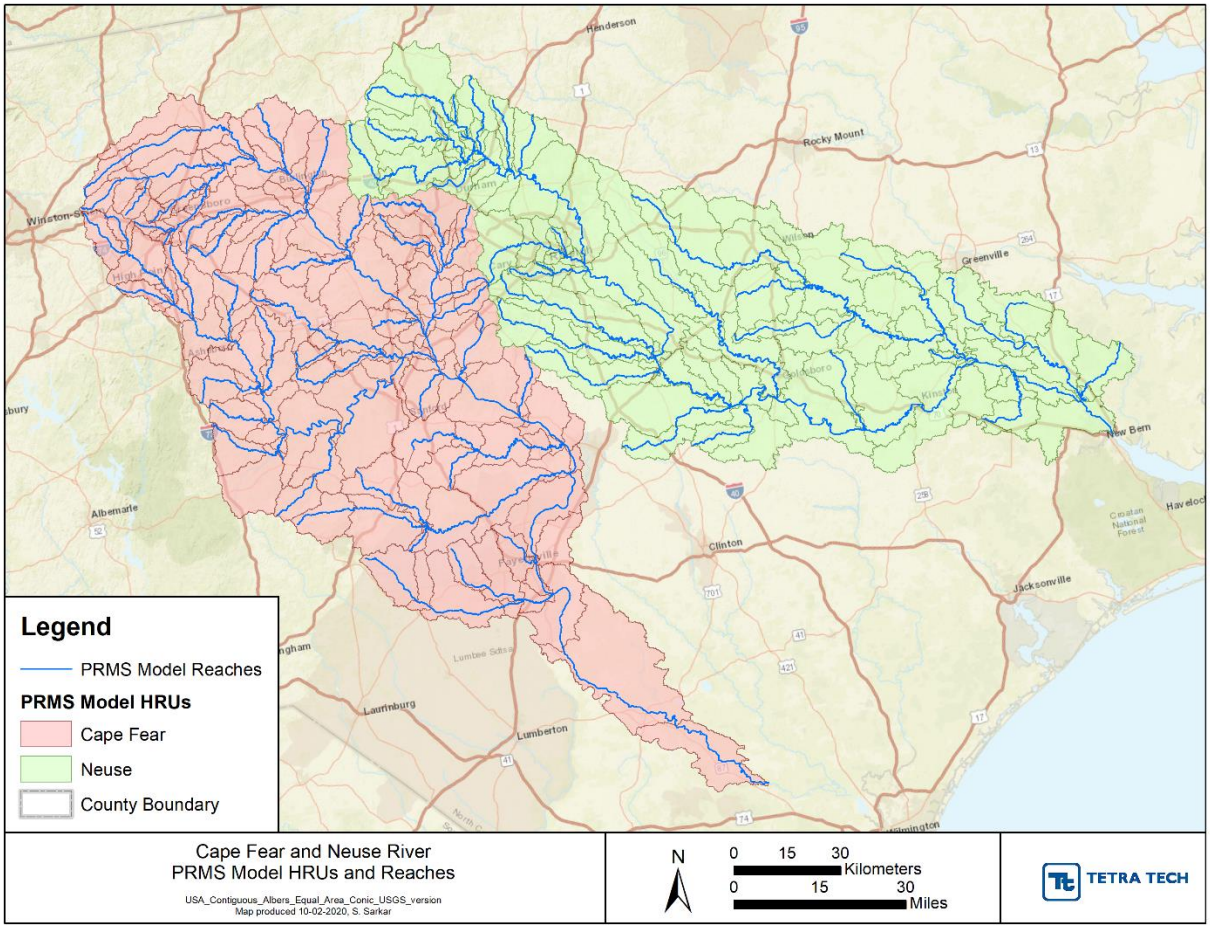

Figure 2. PRMS model HRUs and reaches for the Cape Fear and Neuse River

3.0 Weather and Climate

Estimation of runoff under historic conditions requires daily time step weather series. Prediction of potential future conditions is based on re-estimation of daily weather time series consistent with the projected changes in climate in accordance with climate modeling efforts.

3.1 PRMS Meteorology

The NHM PRMS models require daily precipitation, potential evapotranspiration (PET), and daily maximum and minimum air temperature as meteorological forcing. PET may be supplied as an external time series; however, the PRMS model also has provisions for calculating PET internally using the Jensen-Haise, Hamon, Hargreaves-Samani, Priestley-Taylor, or Penman-Monteith methods. Several of these PET methods require additional meteorological inputs, including solar radiation, relative humidity, and wind travel (total wind movement per unit time independent of direction). For the national NHM PRMS models, USGS estimated PET using the Jensen-Haise method, which uses air temperature and solar radiation as inputs and the calibrated runoff parameters are conditional on this choice for PET. Section 4.1 includes a comparison of model performance using the Penman-Monteith energy balance method for PET that demonstrates that a switch to the Penman-Monteith method degrades model performance and is not advisable.

The meteorological forcing in the national PRMS models is obtained from Daymet, gridMET and other gridded climate datasets. In this study the meteorological inputs are replaced by gridded data from downscaled hindcast and forecast runs of climate models to evaluate expected changes in runoff in the future.

3.2 Selection of Climate Scenarios

Global average air temperatures are rising due to human activities and GCM projections are in general agreement that temperature increases will continue throughout the 21st century. GCM predictions regarding future precipitation patterns are less certain and more variable. Effective water resources planning needs to consider the risks associated with these potential changes to help ensure reliability and resiliency of the water sector.

Assuming that the future will resemble the past is insufficient in the presence of a changing climate, and decisions made today can exacerbate or mitigate a community's vulnerability to change. The risks and impacts of future climate on water resources will vary by location and sector and will depend on complex interactions between precipitation frequency, precipitation intensity, and increases in evaporation associated with warmer temperatures.

Potential climate-related impacts and risks to the Southeast region of the U.S. are summarized as part of the Fourth National Climate Assessment Report (USGCRP, 2018). Daytime and nighttime temperatures in the Southeast for the present decade (2010-present) have been warmer than previous decades on record, extending the freeze-free season length by about 1.5 weeks compared to the early 1900s, and nearly three-quarters of precipitation monitoring locations have recorded more frequent extreme precipitation events (> 3 inches). GCM simulations predict warmer air temperatures and more extreme precipitation events for the Southeast over the 21st century. These changes are predicted across Representative Concentration Pathway (RCP) trajectories that represent anticipated greenhouse gas

concentrations and radiative forcing based on different levels of anthropogenic emissions and greenhouse gas accumulation in the atmosphere produced as part of the Intergovernmental Panel on Climate Change (IPCC) Coupled Model Intercomparison Project, round 5 (CMIP5), completed in 2014 in support of the most recent IPCC Fifth Assessment Report. RCP 4.5 and RCP 8.5 represent lower and higher levels of end-of-century radiative forcing (4.5 and 8.5 W/m^2, respectively), and are believed to bound the likely trajectories that may occur as a result of human economic, political, and climate mitigation activities. Increases in global temperatures are predicted to be more severe for the higher radiative forcing (8.5 W/m^2) scenario. Recent trends in fossil fuel consumption and carbon emissions have been more in line with the trajectory of the higher radiative forcing scenario (RCP 8.5), although both are examined to support planning efforts. Temperature predictions from the two RCPs are not expected to deviate strongly until after the middle of the 21st century, while rainfall predictions vary more between different GCMs than between different RCPs.

If realized, rising air temperatures are anticipated to lengthen the freeze-free growing season in the Southeast by more than a month by the late 21st century as compared to the late 20th century. Daytime high and nighttime low temperatures are expected to increase. Central and Eastern North Carolina are assessed as having a particularly high future heat wave risk. Increasing water demands in urban centers and prolonged dry periods that limit supply replenishment and enhance watershed and reservoir evapotranspiration may stress water supplies. Nevertheless, conservation practices among water users and the increased efficiency of water-using devices have been counteracting these risks in many areas over the past two decades. Changes in ecosystem composition are also expected, potentially including the loss and replacement of local plant species, and such changes may alter the hydrology of water supply watersheds and, ultimately, water availability. Droughts are a primary concern for water supply planning, but increased flooding from extreme rainstorms and hurricanes will put communities simultaneously at risk for inland flooding, infrastructure damage (e.g., water supply reservoir dams), and potentially loss of life.

Results for a large number of GCMs and greenhouse gas scenarios are available from CMIP5. No one climate scenario is predictive of the future because the models have uncertainties and the greenhouse gas emission scenarios that drive these scenarios depend on assumptions about future economic activity and political decisions, all of which are uncertain. To define the range of futures to which adaptation may be needed at a reasonable level of effort, it is appropriate to define a set of bounding scenarios that encompass the likely range of future conditions.

In previous work conducted in the Piedmont region of the Neuse River basin, Tetra Tech identified a set of reasonable bounding climate scenarios for analysis of future impacts on water supply. The future climate conditions assessed for this project are generally applicable throughout the Piedmont region and inland Coastal Plain of North Carolina; therefore, the same set of scenarios were selected for evaluating potential impacts to the broader areas of the Cape Fear and Neuse River basins relevant to the proposed IBT. The reasonableness of this selection is verified in the following paragraphs.

Future climate projections are uncertain and are best used to describe a probability envelope of potential future conditions (an “ensemble of opportunity”; Mote et al., 2011) to which adaptation may be needed. To select a set of GCMs that bound the likely range of potential climate futures with respect to water supply, predicted relative change in mean annual temperature and mean annual precipitation was assessed using USEPA’s LASSO (Locating and Selecting Scenarios On-line) tool (http://lasso.epa.gov). The tool performs automated annual and seasonal summaries of monthly-level spatially downscaled (4 km) GCM output from the Multivariate Constructed Analogs (MACA v2) CMIP5 archive (http://maca.northwestknowledge.net/).

GCMs predict future climate as a function of large-scale forcing, not date-specific weather series. Climate is defined as weather at a place averaged over a long period of time, generally multiple decades, and GCM output must similarly be analyzed over a multi-decadal period. The bi-plot produced by LASSO, represents the future climate as the change in mean annual air temperature and mean annual precipitation for the future-cast period of 2050 to 2080 (centered at 2065) relative to the hind-cast period (1950-2005). The results of the case study in the Neuse are shown in Figure 3. The different model-RCP scenario pairs show a wide range of changes in average annual precipitation for the watershed containing the water supply reservoirs, although all but one predicts some increase. All scenarios also predict an increase in average annual temperature of between 2 and 9° F, which will increase evapotranspiration rates.

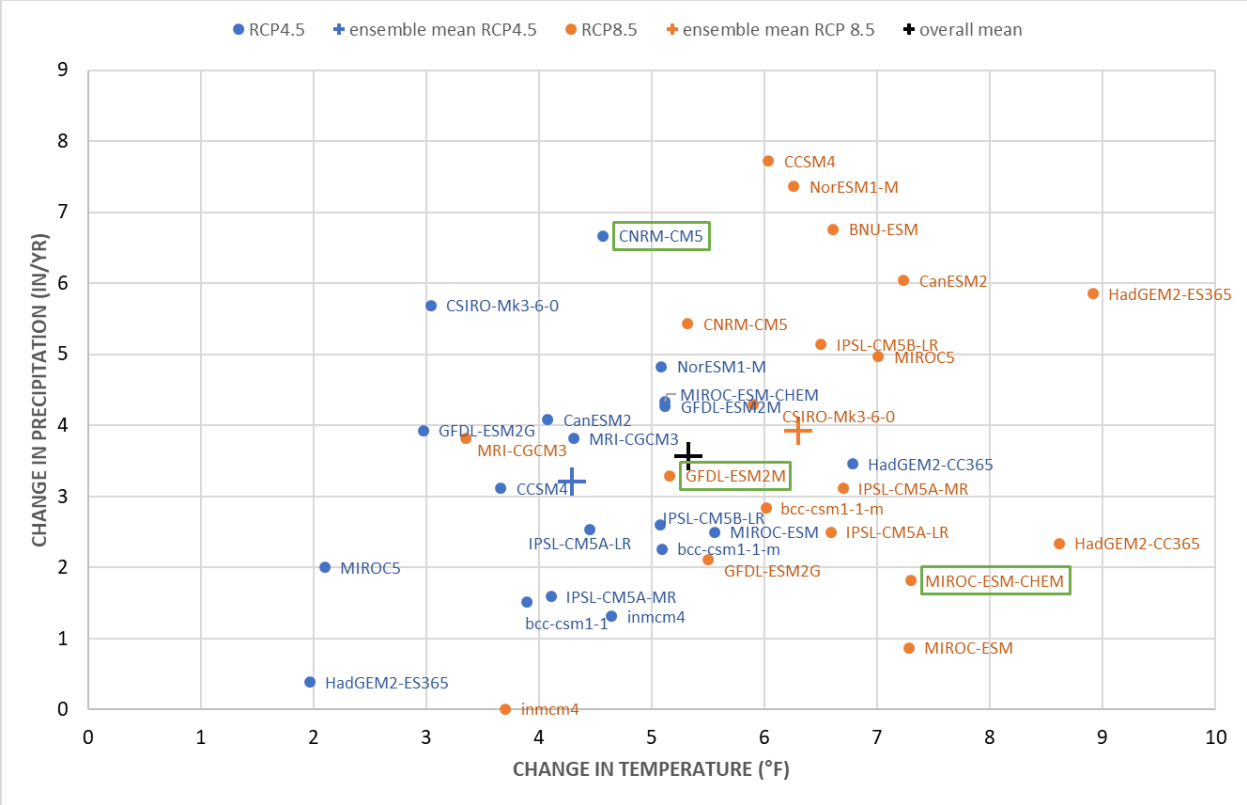

Figure 3. Relative change in hindcast (1950-2005) and future (2050-2080) average annual precipitation and mean annual air temperature for global climate models and greenhouse gas representative concentration pathways (RCP 4.5 and RCP 8.5) for Neuse River Case Study, NC.

Note: Green boxes Identify selected scenarios

Scenarios that are likely to predict the maximum runoff (and therefore water supply) are in the upper-left quadrant – these scenarios predict a greater increase in mean annual precipitation and a relatively moderate increase in air temperature and associated evapotranspiration. Conversely, scenarios that are likely to predict the minimum runoff are in the bottom-right quadrant. These scenarios predict a small increase in mean annual precipitation and a relatively large increase in mean annual air temperature. While both temperature and precipitation changes play a role in future water supply, the changes in precipitation are likely to have the greater impact.

To evaluate the risk associated with possible futures, it is advisable to look at scenarios that span the general range of climate change. However, some GCMs that produce outlying results may not be realistic for this region. Accordingly, scenarios were selected that approximate the mean, 10th percentile, and 90th percentile results of available CMIP5 GCMs across both RCPs for further analysis. Specifically, the GCM CNRM-CM5 under RCP 4.5 was selected as a plausible high runoff potential scenario (e.g., large increase in precipitation with moderate increase in air temperature) and MIROC-ESM-CHEM RCP 8.5 is applied as a plausible low runoff potential scenario (e.g., low increase in precipitation with large increase in air temperature). The CNRM-CM5 model was also ranked highest for its ability to reproduce observed historical climate for the Southeast U.S. (Rupp, 2016), although there is no guarantee that accurately predicting past climate will mean that the model will best predict future climate. The full ensemble average, which combines both the RCP 4.5 and RCP 8.5 scenarios across all GCMs, is designated in the plot by a black cross. The scenario that aligns closest to the ensemble average is GFDL-ESM2M, RCP 8.5, and it is applied as the moderate climate scenario.

To summarize, the following three scenarios were selected for the climate assessment screening based on the aforementioned analysis:

- CNRM-CM5, RCP 4.5 (higher runoff potential)
- MIROC-EMS-CHEM, RCP 8.5 (lower runoff potential)
- GFDL-ESM2M, RCP 8.5 (approximates ensemble mean)

Average annual statistics for the three selected scenarios for the Neuse River basin case study are summarized in Table 1. Note that the results for the case study are centered at 2065, whereas the requested output for this proposed IBT is centered at 2055; however, little change in relative ranking is expected between 2065 and 2055.

Table 1. Precipitation percentiles (in/month) and annual average totals for historic (1981-2010) and future (2050-2074) climate for Neuse River Basin case study

Period	Precipitation Percentile (in/month)					Annual Average (in/yr)
	10%	25%	50%	75%	90%	
MIROC-ESM-CHEM (RCP 8.5)						
1981-2010	1.7	2.5	3.6	4.8	6.6	46.3
2050-2080	1.6	2.5	3.7	5.0	6.4	46.8
Relative Change	-5.4%	2.3%	2.1%	3.2%	-2.6%	1.1%
GFDL-ESM2M (RCP 8.5)						
1981-2010	1.6	2.4	3.6	4.9	6.3	46.2
2050-2080	1.8	2.6	3.8	5.3	7.0	50.5
Relative Change	12.8%	7.0%	4.1%	8.0%	10.4%	8.4%
CNRM-CM5 (RCP 4.5)						

1981-2010	1.7	2.5	3.6	4.8	6.5	46.2
2050-2080	1.8	2.6	3.7	5.2	7.1	50.9
Relative Change	6.0%	3.3%	1.6%	8.7%	7.5%	9.1%

To confirm that the GCMs selected for the Neuse River basin case study remain reasonable for the entire Cape Fear and Neuse River basins when applied to a slightly earlier future time period (2041-2070 instead of 2050-2080), the LASSO tool was re-run for those conditions (Figure 4). While there are some small changes in the relative positioning of the GCM scenarios, the three selected scenarios remain appropriate, representing a median scenario, a hotter and drier scenario, and a wet scenario with moderate temperature increase.

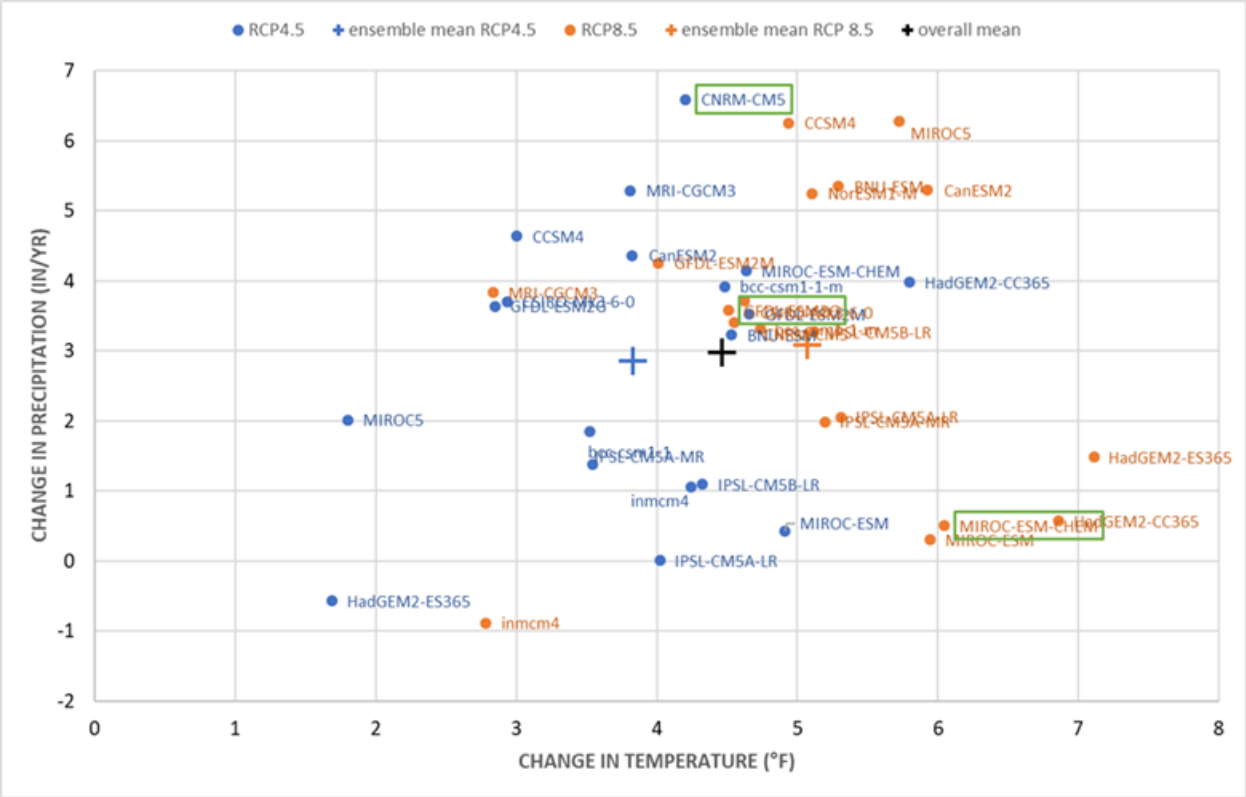

Figure 4. Relative Change in hindcast (1950-2005) and future (2041-2070) Mean Annual Precipitation and Mean Annual Air Temperature for Global Climate Models and Representative Concentration Pathways (RCP 4.5 and RCP 8.5) for the Cape Fear and Neuse River Basins

Note: Green boxes Identify selected scenarios.

3.3 Climate Scenario Processing

Hindcast and forecast downscaled GCM output were obtained from the MACAv2-Metdata archive. A Python script was developed to transform the gridded MACA data to meteorological forcing time-series for the PRMS model. The sequential processes implemented within the Python script include -

1) Generate a reference grid to determine grid cells that intersect each of the PRMS model HRUs.
2) Extract time-series data for grid cells that intersect the PRMS model HRUs from the MACA files for required meteorological parameters (daily precipitation, maximum air temperature, and minimum air temperature).
3) Spatially aggregate gridded climate data to the PRMS model HRUs scale using an area-weighting approach.
4) Generate meteorological forcing files formatted for the PRMS model from the HRU-scale time-series data. Unique time-series for each HRU are supplied to PRMS via the “climate-by-HRU” (CBH) files for each meteorological variable.

4.0 NHM/PRMS Application

The NHM PRMS model is calibrated nationally and comes with a parameter database. The assumption for this project is that the model can be used "as is." However, it is also desirable to document and corroborate model performance.

Such corroboration is challenging because the model is being applied here to generate natural, unregulated flows. Many of the stream gages in the region are strongly affected by water supply reservoirs and dams (most notably Falls Lake and Jordan Lake, but also including many smaller impoundments), water withdrawals, and major and minor wastewater discharges. Even for watersheds that do not have major impoundments, the model does not explicitly represent factors such as well withdrawals, onsite wastewater disposal via septic systems, and irrigation, which together can have a strong effect on baseflow. However, the NHM PRMS model output is an intermediate product that will be used, in conjunction with the OASIS model, to estimate relative changes between historic and future flow. The OASIS model can and will account for withdrawals, discharges, and impoundments and therefore the disregard for these influences at this stage of the analysis is considered acceptable.

4.1 Model Corroboration

The existing NHM PRMS models are configured to simulate watershed hydrology from water year 1981 to 2016. Qualitative corroboration of the Cape Fear and Neuse PRMS models for historic hydrology was done by evaluating components of the water balance against peer-reviewed literature and comparing simulated streamflow against USGS measurements at multiple locations on the mainstems and tributaries. The USGS streamflow monitoring locations used for the corroboration of the Cape Fear and Neuse models are shown in Figure 5.

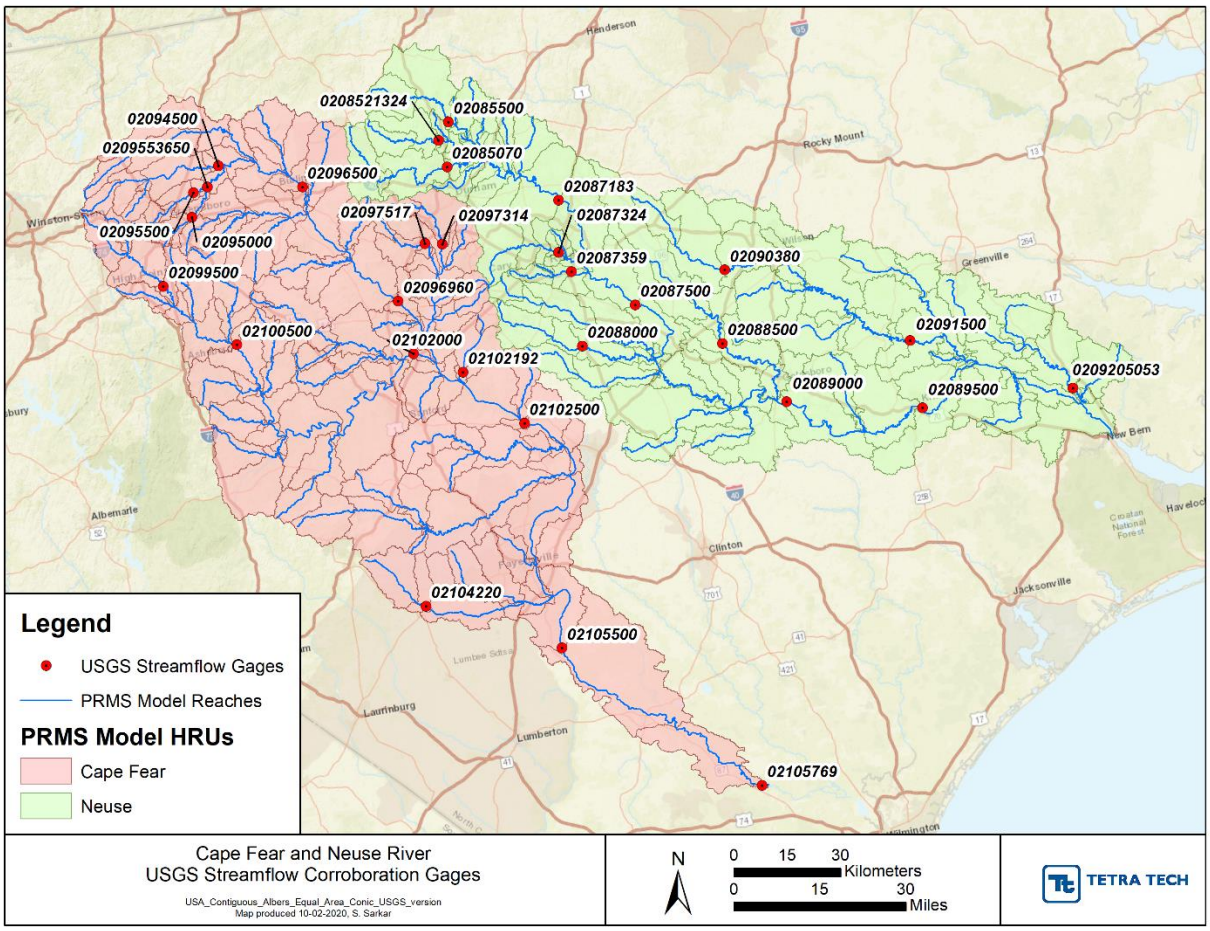

Figure 5. PRMS model HRUs and USGS stream gages for the Neuse and Cape Fear basins

The simulated water budget for the Cape Fear PRMS model (Figure 6) is consistent with the generalized water budgets for the Cape Fear River Basin reported by the North Carolina Department of Natural Resources (NCDENR) in the Cape Fear River Basin Plan (NCDENR, 2009). The simulated water budget for the Neuse PRMS model (Figure 7) is similar to the Cape Fear model and comparable to the water budget for the Piedmont region for the Cape Fear River Basin reported by NCDENR. Note that the groundwater outflow for the PRMS models shown in the water budgets include interflow (i.e., lateral flow through unsaturated soil zones). The changes in storage (not shown in the water budget summaries) simulated for the Cape Fear and Neuse models are negligible, approximately 0.1% of the average annual precipitation.

The ratio of average annual simulated evapotranspiration to precipitation for the Cape Fear and Neuse PRMS models are 0.65 and 0.67, respectively. These ratios are consistent with the range of 0.60 to 0.69 reported by Sanford and Selnick (2012) for this region.

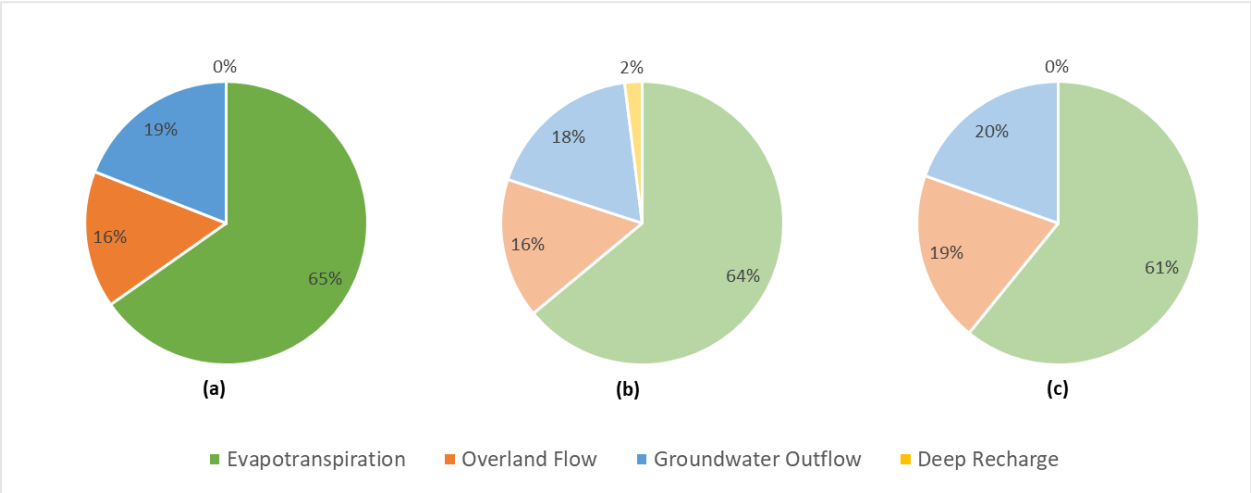

Figure 6. Simulated long-term water budget for the (a) Cape Fear PRMS model compared to the generalized water budgets for the (b) Coastal Plain and (c) Piedmont regions of the Cape Fear River Basin

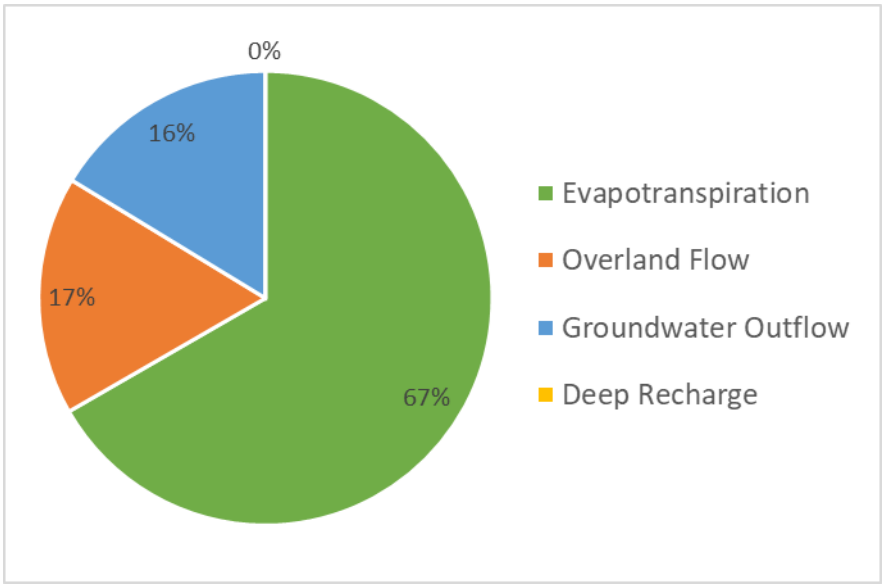

Figure 7. Simulated long-term water budget for the Neuse PRMS model

Comparison of streamflow predicted by PRMS to USGS gages along the Cape Fear River and major tributaries such as the Deep and Haw Rivers, suggest that streamflow is generally over-predicted by the PRMS model relative to gaged flows (Table 2). Much of the over-prediction occurs during low flow periods. On the main-stem Cape Fear, peak flows are generally over-predicted in addition to the low flows.

The majority of these discrepancies are believed to be due to the influence of dams and associated water withdrawals (including Jordan Lake on the Cape Fear, Randleman Lake and the former Carbonton Dam (removed in 2006) on the Deep River, and various smaller dams in the Haw drainage.)

At many gages, including some not strongly influenced by dams, the PRMS model appears to over-predict summer low flows. This suggested possible issues with the calculation of PET. As noted earlier, the NHM PRMS models use a modified version of the Jensen-Haise PET method. The influence of this method choice was checked through comparison to alternative simulations undertaken with the Penman-Monteith energy balance method. This required estimates of daily relative humidity and wind speed time-series, which were obtained from the National Land Data Assimilation System (NLDAS) version 2 forcing data (https://ldas.gsfc.nasa.gov/nldas/nldas-2-forcing-data). As implemented in PRMS, the Penman-Monteith method yields much higher estimates of PET that result in a large under-estimation of runoff when compared to gaged streamflow. As PRMS parameters were regionally calibrated using Jensen-Haise PET, it appears that a switch to Penman-Monteith PET is not advisable as it would require significant additional effort for detailed recalibration of the NHM PRMS model. Instead, a bias correction approach, described in Section 4.4, is used to compensate for uncertainties present in the PRMS model.

For the Cape Fear basin, the monthly Nash-Sutcliffe coefficients of model fit efficiency (NSEs) at the larger-scale USGS gages are generally between 0.6 and 0.7, which falls within the category rated as “Satisfactory” to “Good” as recommended by Moriasi et al. (2007) despite the influence of many dams. A poorer match was found at some of the smaller area gages. Nevertheless, the model performance is believed to be sufficient for the intended purpose of evaluating relative change in local runoff between historic changes and potential future climate.

The match between gaged streamflow and PRMS predictions for Neuse basin is generally better than for the Cape Fear (Table 3). Like the Cape Fear model, the Neuse model also systematically over-predicts of low flows and baseflow, but the comparisons are affected by numerous dams and water withdrawals. The low-flow statistics at the USGS gages for streams not impacted by major water withdrawals or impoundments such as Contentnea Creek and Little River are better than for the main-stem Neuse. Evaluation of incremental flows for Neuse River downstream of Falls Lake to the Goldsboro and Kinston gages demonstrates better agreement for low flow periods, strengthening the hypothesis that the influence of water withdrawals and impoundments is negatively affecting the PRMS to USGS gage comparison at low flows. However, the OASIS model will account for these influences. Based on the magnitude of streamflow error and monthly NSE, the performance of the Neuse PRMS model is rated as “Good” for major USGS streamflow gage locations.

Table 2. Comparison of gaged flow to the Cape Fear River PRMS model

USGS Gage Name	South Buffalo Creek near Greensboro, NC		Buffalo Creek near Greensboro, NC		Buffalo Creek at SR2819 near McLeansville, NC		Reedy Fork near Gibbonsville, NC		Haw River near Haw River, NC		Morgan Creek near Chapel Hill, NC		New Hope Creek near Blands, NC		Deep River near Randleman, NC		Deep River at Ramseur, NC		Haw River near Bynum, NC		Deep River at Moncure, NC		Buckhorn Creek near Corinth, NC		Cape Fear River at Lillington, NC		Rockfish Creek at Raeford, NC		Cape Fear River at Wilmington, NC		Cape Fear River at Lock #1, NC	
USGS Gage Id	02095000		02095500		0206553650		02094500		02096500		02097517		02097314		02099500		02100500		02096960		02102000		02102192		02102500		02104220		02105500		02105769	
Drainage Area	34.0		37.1		88.5		131.0		606.0		41.0		75.9		125.0		349.0		1275.0		1434.0		76.3		3464.0		93.1		4852.0		5255.0	
Analysis Period	8/1/1998 to 9/30/2016		10/1/1981 to 9/30/2016		8/1/1998 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		11/1/1982 to 9/30/2016		10/1/1982 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		7/1/1988 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016	
Constituent	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)
Total flow	19.8	-27.6	17.6	-28.4	23.7	-28.2	9.4	140.9	14.0	33.9	13.5	17.2	17.0	12.3	15.2	37.2	13.2	40.4	12.6	34.1	12.3	39.2	8.6	102.1	12.1	40.5	15.9	-28.0	12.6	32.7	13.1	27.1
Total lowest 50% flows	1.3	33.0	3.2	-43.1	4.6	-43.0	0.5	680.9	1.8	91.4	2.2	-60.6	1.7	-10.5	1.6	41.8	1.4	82.6	1.4	108.2	1.0	190.7	0.2	759.4	1.4	115.0	4.7	-73.5	1.8	77.1	1.9	76.9
Total highest 10% flows	13.7	-54.0	8.5	-37.8	11.6	-43.3	6.3	44.8	7.0	-1.2	6.8	30.3	9.3	5.6	8.4	13.3	7.2	-0.5	6.4	-3.6	7.1	-11.8	4.9	81.1	5.4	12.3	3.9	44.8	5.1	11.0	4.9	11.1
Summer flow volume (months 7-9)	5.2	-23.5	4.0	-20.1	5.8	-22.6	1.3	232.6	2.3	61.8	2.1	23.9	2.5	29.8	2.5	63.4	1.8	91.2	1.8	90.5	1.5	116.3	1.1	196.3	1.7	99.2	3.6	-45.7	1.9	73.4	2.0	66.5
Fall flow volume (months 10-12)	4.7	-38.6	4.2	-42.1	5.6	-38.3	1.8	149.9	2.9	22.4	2.7	-5.2	3.4	-9.3	2.9	22.7	2.8	24.3	2.6	22.0	2.5	18.6	1.2	111.0	2.3	28.5	4.0	-27.3	2.4	16.5	2.5	9.8
Winter flow volume (months 1-3)	5.3	-32.5	5.1	-33.0	6.5	-32.5	3.9	92.5	5.3	14.2	5.6	17.8	7.1	8.4	6.0	19.9	5.4	19.3	5.2	9.6	5.7	11.6	4.0	68.7	5.3	14.9	4.7	-0.7	5.3	11.2	5.4	6.3
Spring flow volume (months 4-6)	4.7	-15.7	4.4	-17.6	5.8	-19.0	2.4	162.5	3.4	55.8	3.1	31.2	4.0	26.2	3.8	58.8	3.2	62.0	3.1	52.7	2.8	72.7	2.3	112.8	2.9	62.9	3.6	-46.8	2.9	58.0	3.1	51.7
Monthly NSE		0.49		0.38		0.45		-0.88		0.61		0.63		0.67		0.54		0.53		0.63		0.61		0.11		0.63		-0.87		0.65		0.68

Notes: "Obs" represents the gaged flow, converted to inches per year. "Err" is percentage difference between PRMS and the gaged flow. A positive value of Err indicates over-prediction.

Table 3. Comparison of gaged flow to the Neuse River PRMS model

USGS Gage Name	Flat River at Bahama, NC		Eno River near Durham NC		Little River at SR1461 near Orange Factory, NC		Neuse River near Falls, NC		Crabtree Creek at US1 at Raleigh, NC		Walnut Creek at Sunnybrook Drive near Raleigh, NC		Contentnea Creek near Lucama, NC		Neuse River near Clayton, NC		Neuse River near Clayton, NC (incremental)		Middle Creek near Clayton		Little River near Princeton, NC		Neuse River near Goldsboro, NC		Neuse River near Goldsboro, NC (incremental)		Contentnea Creek at Hookerton, NC		Neuse River at Kinston, NC		Neuse River at Kinston, NC (incremental)		Swift Creek at Hwy 43 near Streets Ferry, NC	
USGS Gage Id	02085500		02085070		020852134		02087183		02087324		02087359		02090380		02087500		02087500		02088000		02088500		02089000		02089000		02091500		02089500		02089500		0209205053	
Drainage Area	149.0		141.0		78.2		771.0		121.0		29.8		161.0		1150.0		1150.0		83.5		232.0		2399.0		2399.0		733		2692.0		2692.0		269.0	
Analysis Period	10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1987 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1990 to 9/30/2016		10/1/1996 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1981 to 9/30/2016		10/1/1996 to 9/30/2007	
Constituent	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)	Obs (in)	Err (%)
Total flow	12.5	23.5	11.9	68.4	11.9	45.7	10.7	60.4	16.9	17.9	16.6	0.5	13.0	34.1	12.4	39.9	13.8	28.4	14.9	30.7	13.9	30.6	13.5	23.9	14.4	15.5	14.6	14.1	13.8	21.5	14.5	15.2	16.6	-40.3
Total lowest 50% flows	0.8	61.2	0.9	149.1	0.7	98.2	1.1	123.9	2.2	37.2	1.9	10.4	1.1	217.1	1.9	52.2	2.5	2.7	1.7	24.2	1.2	73.7	1.9	53.1	2.1	31.4	1.8	75.8	2.2	38.6	2.3	18.3	2.0	-62.9
Total highest 10% flows	7.8	-1.0	6.9	34.3	7.3	15.8	5.6	21.9	8.3	4.5	9.5	-29.6	6.8	1.2	5.0	30.2	5.7	24.0	7.4	22.1	6.8	18.9	4.9	18.6	5.3	13.2	5.9	6.4	4.8	19.7	5.0	19.5	8.0	-28.0
Summer flow volume (months 7-9)	1.5	98.9	1.5	151.7	1.5	103.0	1.4	127.0	4.0	2.2	4.2	-11.1	2.2	67.7	2.1	63.1	2.9	27.2	2.6	46.8	2.4	57.1	2.3	45.6	2.58	32.5	2.7	34.7	2.4	40.3	2.7	29.9	4.5	-41.3
Fall flow volume (months 10-12)	2.4	4.0	2.2	58.1	2.4	21.1	1.8	58.8	3.8	7.4	3.8	-8.6	2.2	50.2	2.3	30.5	2.8	11.0	2.9	1.8	2.5	22.5	2.5	10.2	2.7	1.1	2.7	14.4	2.6	6.1	2.7	-0.9	4.0	-50.2
Winter flow volume (months 1-3)	5.6	-2.9	5.3	41.8	5.2	24.6	4.6	34.4	5.5	33.1	4.8	14.0	5.8	7.3	4.9	29.1	4.8	30.1	6.0	27.2	6.0	14.6	5.4	11.9	5.7	5.3	5.8	-3.7	5.4	12.0	5.5	7.5	4.8	-35.1
Spring flow volume (months 4-6)	3.0	52.0	3.0	81.9	2.8	74.9	2.8	70.5	3.6	23.0	3.9	5.2	2.8	50.2	3.2	48.3	3.3	41.7	3.4	49.2	3.0	48.1	3.3	39.1	3.4	31.6	3.4	28.0	3.4	35.1	3.5	29.0	3.3	-34.7
Monthly NSE		0.69		0.20		0.57		0.42		0.68		0.72		0.71		0.53		0.25		0.54		0.75		0.77		0.80		0.82		0.77		0.78		0.62

Notes: "Obs" represents the gaged flow, converted to inches per year. "Err" is percentage difference between PRMS and the gaged flow. A positive value of Err indicates over-prediction. "Incremental" flows for the USGS gages near Clayton, Goldsboro and Kinston are obtained by subtracting the gaged records at Neuse River near Falls, NC.

4.2 Application to Future Climate Scenarios

The NHM PRMS models for the Cape Fear and Neuse were simulated from 1/1/1950 through 12/31/2070 using HRU level daily precipitation, and maximum and minimum air temperature time-series data developed for the MACA-downscaled output from the following climate models and RCPs.

- CNRM-CM5 (RCP 4.5)
- GFDL-ESM2M (RCP 8.5)
- MIROC-ESM-CHEM (RCP 8.5)

Meteorological time-series development for the climate scenario simulations is discussed in 3.3. The only changes made to the PRMS models for the climate scenario simulations are the meteorological forcing time-series (precipitation and air temperature) and the simulation time-period. The PRMS runoff outputs for the climate scenarios simulations were compared against the USGS National Climate Change Viewer (NCCV) estimates, discussed in the following sections. The water budgets and average monthly total runoff and actual evapotranspiration for the historic (1950-2005) and target future period (2041-2070) are summarized in the subsequent sections.

4.3 Comparison of PRMS and NCCV for Future Climate

Model performance for future climate cannot, of course, be checked against observations. However, a general check for consistency was performed by comparing the PRMS output to predictions obtained from the USGS National Climate Change Viewer (NCCV; Alder and Hostettler, 2013). The NCCV uses a different statistical downscaling method and computes runoff based on a simplified monthly water balance calculation. The results for a given GCM are thus not expected to match PRMS but should show strong correlation.

Annual runoff simulated by the Cape Fear and Neuse PRMS models for the CNRM-CM5 (RCP 4.5), GFDL-ESM2M (RCP 8.5) and MIROC-ESM-CHEM (RCP 8.5) climate scenarios from 1951 to 2099 were compared against estimates of runoff reported by the USGS NCCV. The annual runoff time-series simulated by the PRMS model shows good agreement with the NCCV estimates, as shown in Figure 8 and Figure 9 for the Neuse and Cape Fear rivers. Interestingly, this comparison also suggests that PRMS may be biased high during low flow periods.

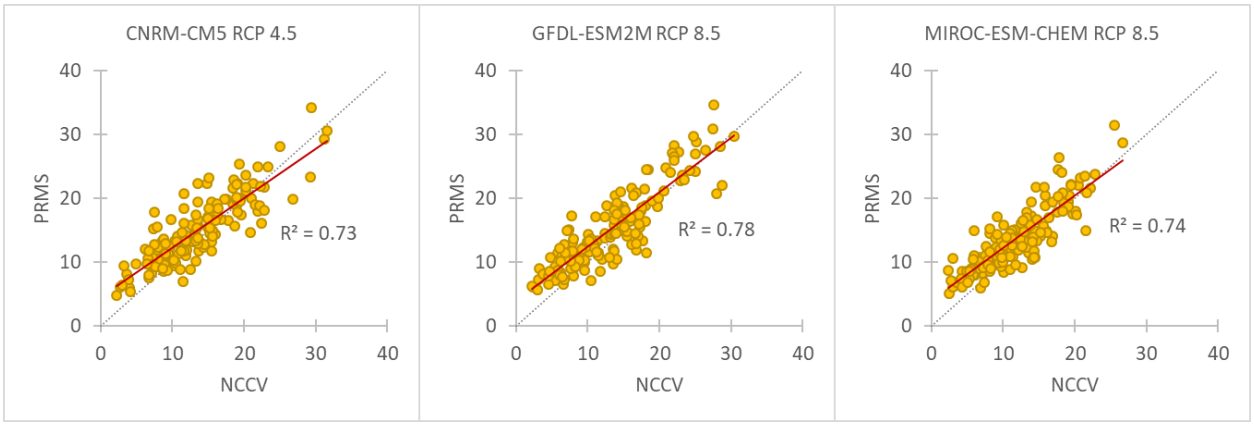

Figure 8. Annual runoff (in/yr) simulated by PRMS vs. NCCV estimates from 1951 to 2099 for the Cape Fear River basin

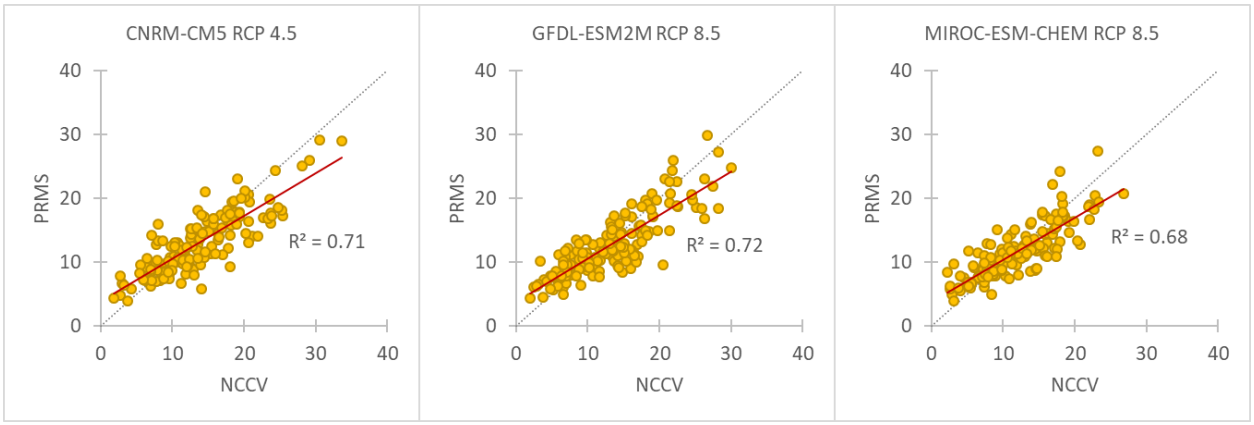

Figure 9. Annual runoff (in/yr) simulated by PRMS vs. NCCV estimates from 1951 to 2099 for the Neuse River basin

4.4 Bias Correction for Flow

The PRMS model provides an imperfect match to gaged flows, including for gages that are not affected by major dams, withdrawals, or discharges. This suggests the presence of some biases in the PRMS output. Comparison of statistics for the incremental inflow timeseries specified for the historical period in OASIS to PRMS output for the same period also reveals differences, typically on the order of 10-20%. These differences suggest that a bias correction step is needed before using PRMS to predict the future water balance in OASIS. Specifically, rather than using the PRMS output directly in OASIS it is preferable to modify the existing OASIS input timeseries based on the difference in runoff distributions between the historical and future time windows in PRMS.

The bias correction for the future incremental inflow timeseries is accomplished using the method of empirical quantile mapping (eQM). The eQM approach (Amengual et al., 2012) is a method developed

and frequently used for adjusting biases in climate model precipitation series. However, it makes no assumption of a specific parametric form of statistical distribution and is applicable to bias adjustment of any time series. Given a model output timeseries for the historical training period (*H*), a model output timeseries for a future prediction period (*F*), and a timeseries of local observations for the historical period (*O*), the approach locates the quantile of the prediction *F* within the cumulative distribution function of the training data *H*, then transfers this position to the same quantile within the cumulative distribution function of the local observations, *O*, thus creating a prediction (*P*) that is bias-corrected to the local observations. In our application, *O* is the historical timeseries of incremental inflows currently used in OASIS, while *H* and *F* are the historic and future periods, respectively, in the PRMS output for the same drainage area. The general method developed by Amengual et al. expresses the quantile adjustment or shift as $P_i = O_i + g\,\bar{\Delta} + f\,\Delta_i$, where $\bar{\Delta}$ is the mean regime shift and Δ_i, is the difference between the future and historic *i*th quantile. The parameters *g* and *f* allow for adjustments that weight the influence between the overall regime shift and the shift in individual quantiles. Typical applications of eQM where a parametric form of the cumulative distribution function is not specified use $g = f = 1$, in which case the equation for P_i is equivalent to applying the quantile shift directly.

A Python implementation of this method is available in bias_correction.py (https://svn.oss.deltares.nl/repos/openearthtools/trunk/python/applications/hydrotools/hydrotools/statistics/bias_correction.py), in turn based on the R package downscaleR, (https://github.com/SantanderMetGroup/downscaleR/wiki/Bias-Correction-and-Model-Output-Statistics-(MOS)). The method is highly efficient and automatable.

For application to the OASIS inflow timeseries an initial approach evaluated applying the bias correction on a regional basis for efficiency (e.g., Neuse Basin, Piedmont geographic province); however, this causes problems because many of the drainage areas intersect the Piedmont and Coastal Plain areas and does not consider specific local variations in runoff conditions. Therefore, the eQM method was applied individually to each of the 61 locations with OASIS inflow timeseries in the Neuse and Cape Fear study areas. The calculations were also done by individual month to account for any seasonal effects. The eQM application used 1,000 bins to characterize the historical cumulative distribution functions, which is near the maximum feasible for a 56-year training data set. Using a large number of bins is desirable to ensure that the high and low tails of the distribution are adequately covered. The large number of bins means that there will be a small number of observations in each bin (average of a little less than 2) and that many bins will be empty. However, the method relies on comparing the cumulative distribution functions, so the presence of empty bins does not cause problems. A large number of bins (even sparsely populated) just gives a more refined step-function approximation of the underlying continuous cumulative distribution.

One modification was made to the bias correction code to address the situation where a future predicted flow falls outside of the range of bins in the historic training data. (This is a rare event with 1,000 bins in use). The original Python and R codes provide two options when this occurs. One is to use the constant value associated with the largest (or smallest) bin of the observed data; the other is to apply the difference between the largest (or smallest) bin in the observed data and the training data. The original R code indicates that the developers also considered a linear extrapolation, but that this was rejected “due to lack of robustness.”

Neither of these approaches is satisfactory for extrapolation of extreme high flow events. Accordingly, the tails of the distribution are addressed by re-introducing a linear extrapolation in which the simulated result is multiplied by the ratio of the highest bins in the training and observed data. This appears to provide

reasonable results and avoids an implausible flattening out of the extreme upper end of the cumulative distribution function.

An example of the resulting shifts in the cumulative distribution function are shown for July for OASIS input node 0820 (downstream end of the Cape Fear River) in Figure 10. This shows a large increase in the biggest runoff events associated with summer convective storm activity. (Less change is predicted for winter months.) Figure 11 shows the same points plotted on a logit scale (LN[p/(1-p)]), which expands the tails of the distribution.

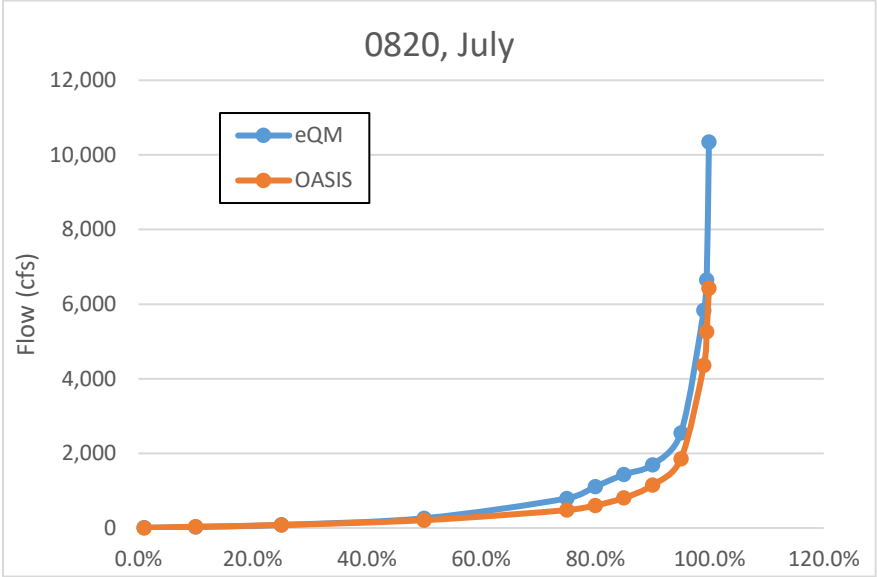

Figure 10. Cumulative distribution functions for node 0820, July, for OASIS historical data and bias-corrected CNRM-CM5 (RCP 4.5) model output centered at 2055

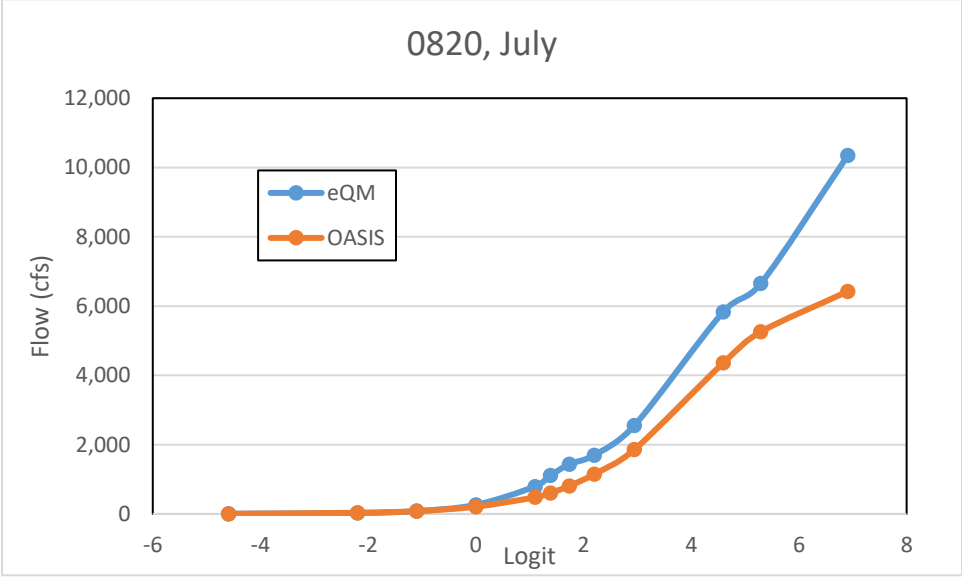

Figure 11. Cumulative distribution functions for node 0820, July, for OASIS historical data and bias-corrected CNRM-CM5 (RCP 4.5) model output centered at 2055, replotted on logit scale

5.0 Results

5.1 Water Budget Summary and Average Monthly Output

The simulated water budgets for historic and future conditions for the Cape Fear PRMS model for the three climate scenarios are summarized in Table 4 and shown in Figure 12. The simulations suggest that the proportions of the components of the overall water budget will not change dramatically between the historic and future (ca. 2055) conditions due to predictions of increased precipitation being balanced by increased evapotranspiration (Figure 17 to Figure 19).

The simulated water budgets for historic and future conditions for the Neuse PRMS model for the three climate scenarios are summarized in Table 5 and shown in Figure 16. The simulation results for the Neuse are similar to the Cape Fear. The proportions of the components of the overall water balance for the future and historic conditions do not show significant difference. Higher evapotranspiration is simulated for the spring and summer months while runoff is higher for the winter months for future compared to the historic time-period (Figure 17 to Figure 19).

Table 4. Simulated water budgets for Cape Fear PRMS model for the historic and future (ca. 2055) conditions for the selected climate scenarios

Constituent	Average Annual Values (inches/year)					
	CNRM-CM5, RCP 4.5		GFDL-ESM2M, RCP 8.5		MIROC-ESM-CHEM, RCP 8.5	
	Historic	Future	Historic	Future	Historic	Future
Precipitation	45.4	50.0	45.4	49.8	45.6	46.9
Evapotranspiration	30.9	33.5	30.6	33.8	31.2	34.0
Runoff	7.0	8.0	7.1	7.8	7.0	6.9
Interflow	2.0	2.5	2.0	2.6	1.9	1.6
Groundwater Outflow	5.6	5.8	5.7	5.8	5.5	4.5

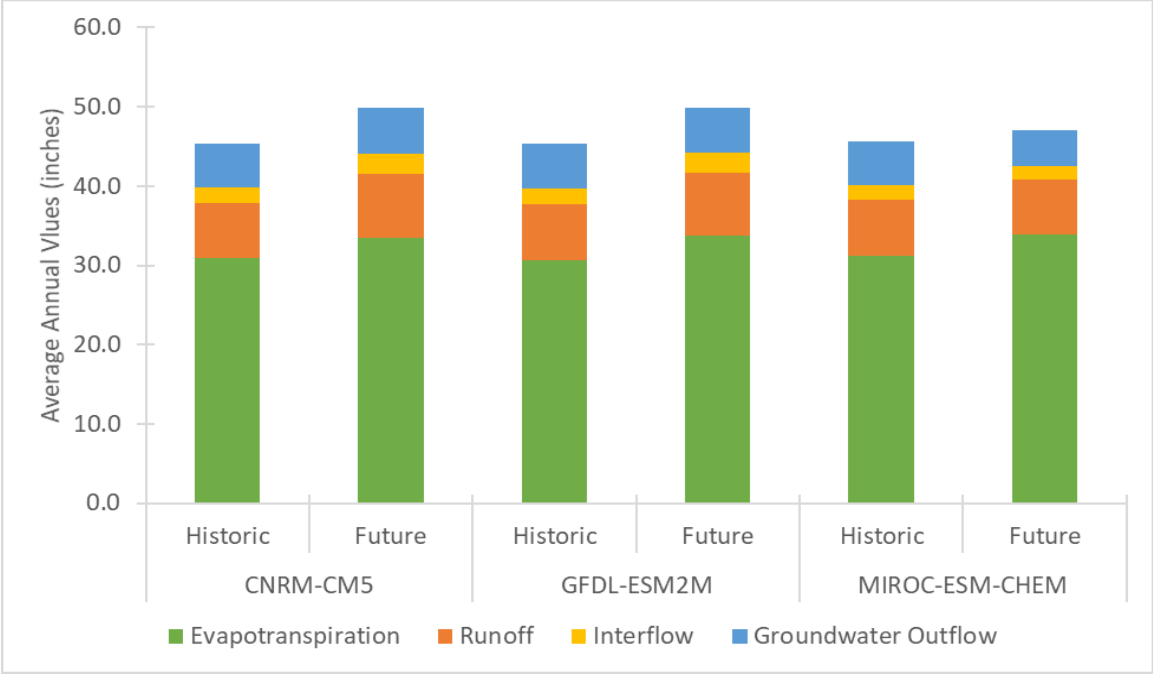

Figure 12. Simulated water budgets for Cape Fear PRMS model for the historic (1951-2005) and future (2041-2070) conditions for the selected climate scenarios

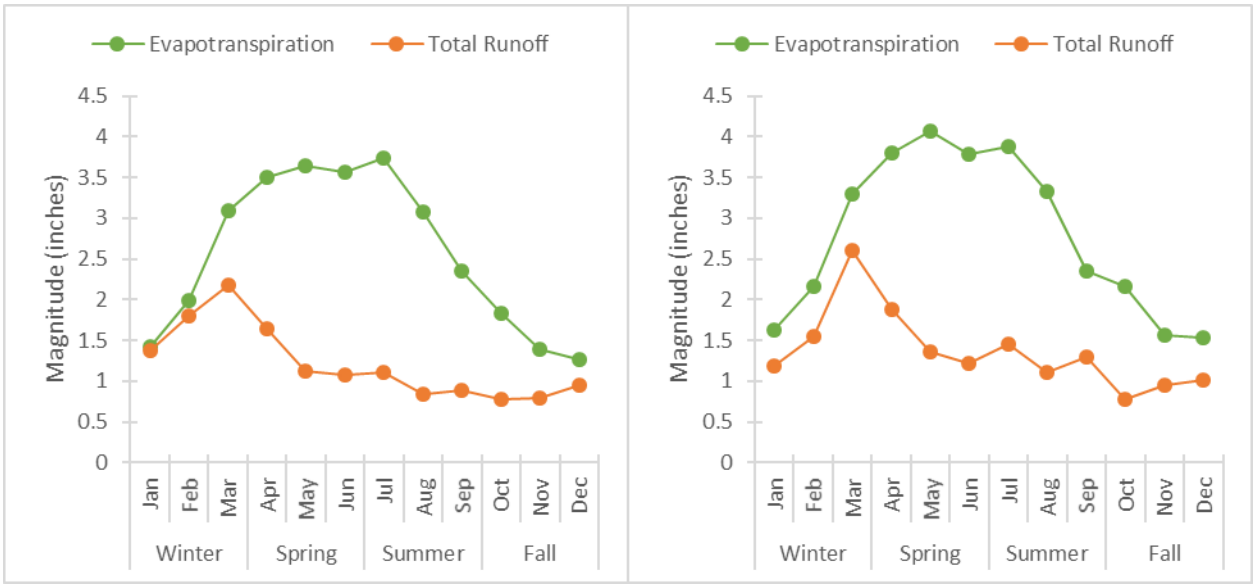

Figure 13. Average monthly simulated evapotranspiration and total runoff for the Cape Fear PRMS model for CNRM-CM5, RCP 4.5, for historic (1951-2005; left) and future (2041-2070; right) conditions

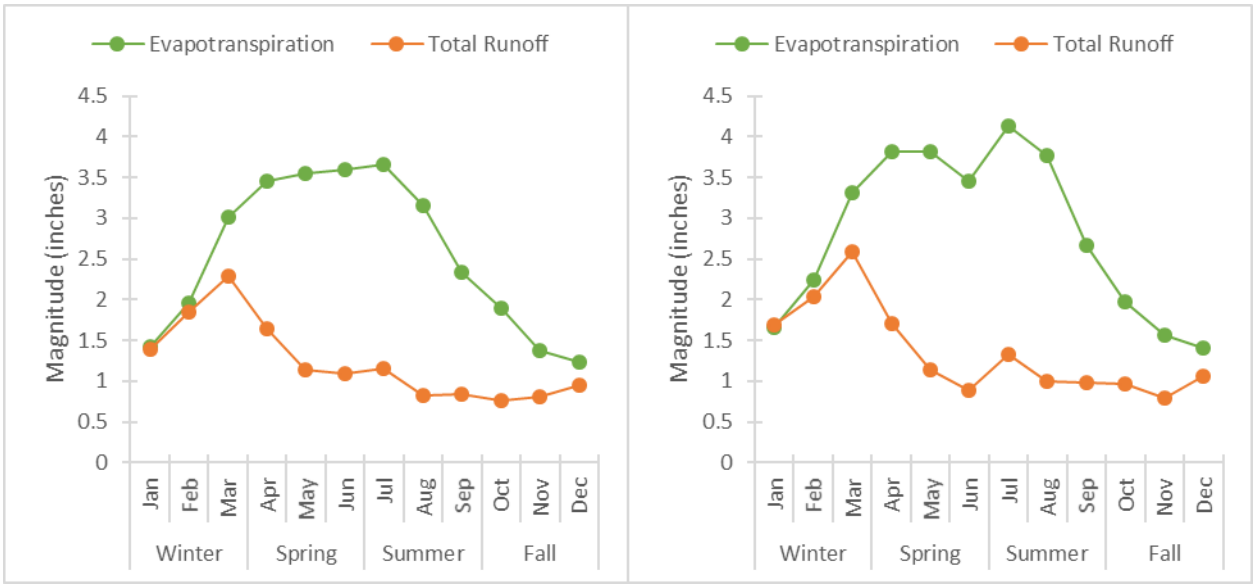

Figure 14. Average monthly simulated evapotranspiration and total runoff for the Cape Fear PRMS model for GFDL-ESM2M RCP 8.5, for historic (1951-2005; left) and future (2041-2070; right) conditions

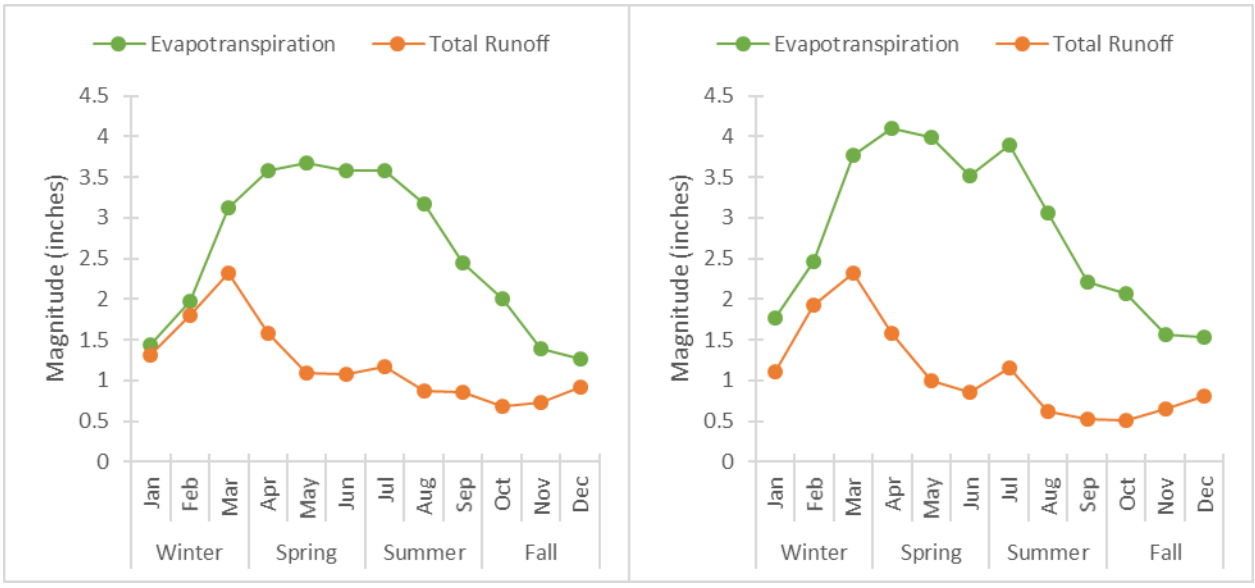

Figure 15. Average monthly simulated evapotranspiration and total runoff for the Cape Fear PRMS model for MIROC-ESM-CHEM RCP 8.5, for historic (1951-2005; left) and future (2041-2070; right) conditions

Table 5. Simulated water budgets for Neuse PRMS model for the historic and future (ca. 2055) conditions for the selected climate scenarios

Constituent	Average Annual Values (inches/year)					
	CNRM-CM5, RCP 4.5		GFDL-ESM2M, RCP 8.5		MIROC-ESM-CHEM, RCP 8.5	
	Historic	Future	Historic	Future	Historic	Future
Precipitation	42.8	47.5	42.9	46.5	43.1	43.7
Evapotranspiration	30.0	32.6	29.9	32.5	30.2	32.3
Runoff	6.8	8.1	6.8	7.6	6.9	6.3
Interflow	1.7	2.2	1.7	2.1	1.6	1.5
Groundwater Outflow	4.3	4.6	4.4	4.5	4.3	3.6

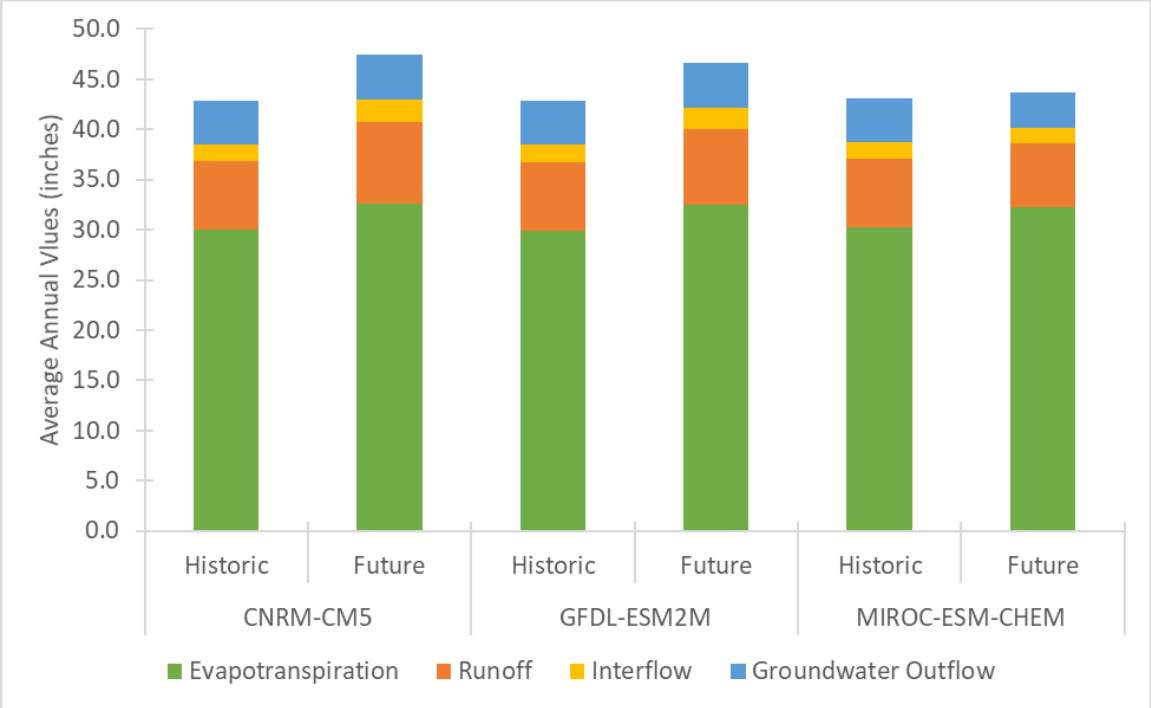

Figure 16. Simulated water budgets for Neuse PRMS model for the historic (1951-2005) and future (2041-2070) conditions for the selected climate scenarios

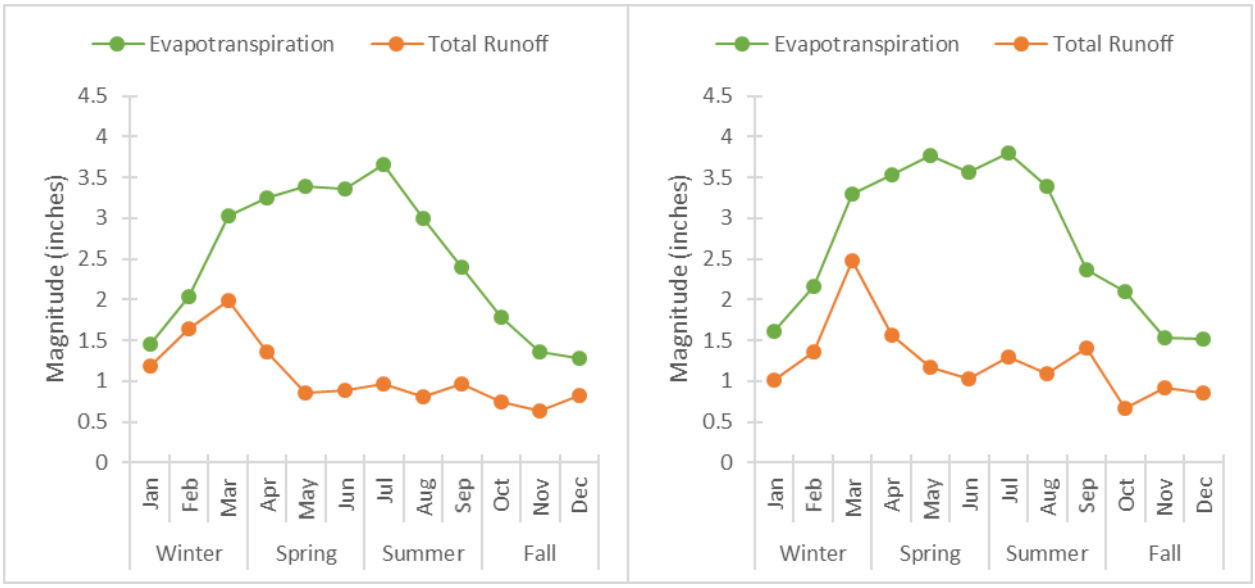

Figure 17. Average monthly simulated evapotranspiration and total runoff for the Neuse PRMS model for CNRM-CM5 RCP 4.5, for historic (1951-2005; left) and future (2041-2070; right) conditions

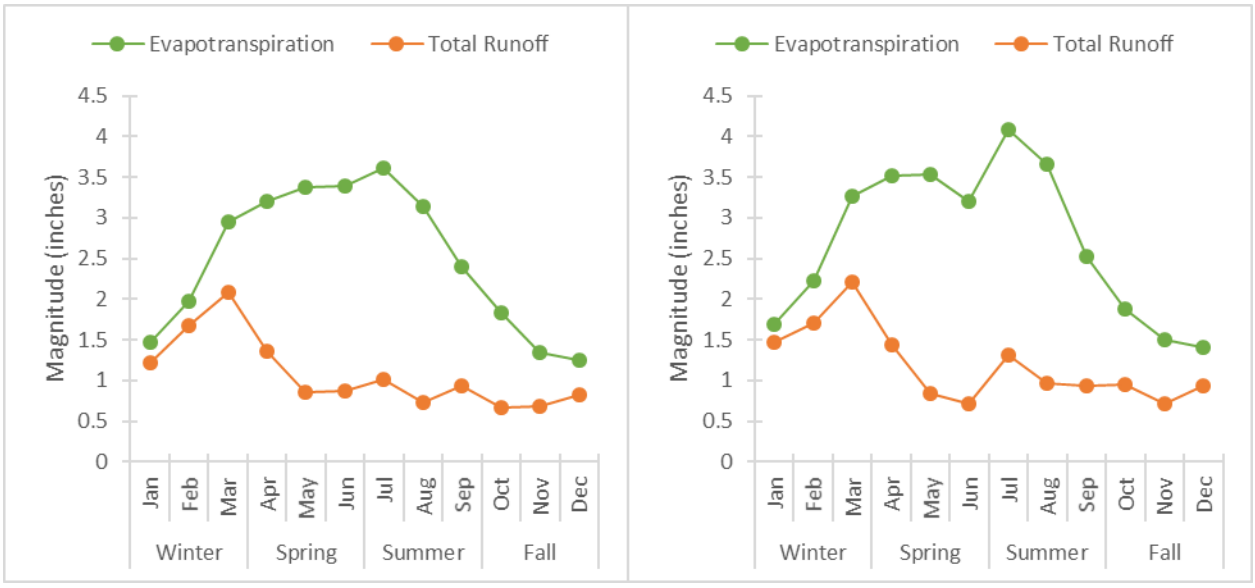

Figure 18. Average monthly simulated evapotranspiration and total runoff for the Neuse PRMS model for GFDL-ESM2M RCP 8.5, for historic (1951-2005; left) and future (2041-2070; right) conditions

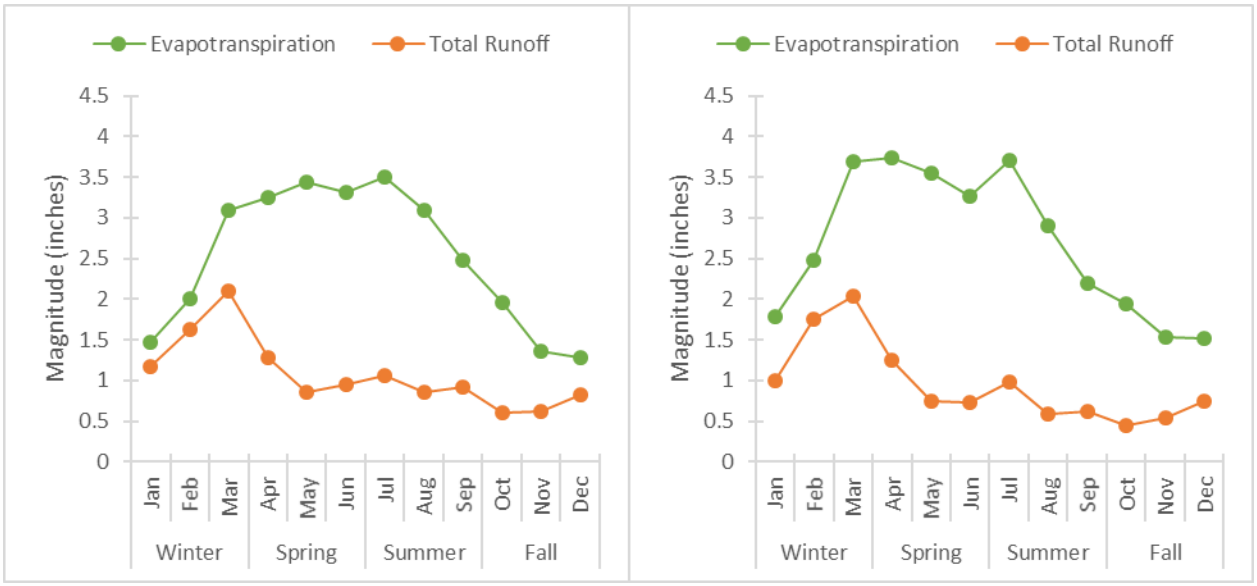

Figure 19. Average monthly simulated evapotranspiration and total runoff for the Neuse PRMS model for MIROC-ESM-CHEM RCP 8.5, for historic (1951-2005; left) and future (2041-2070; right) conditions

5.2 Lake Evaporation Timeseries

The OASIS model estimates lake evaporation rates by applying pan coefficients to continuous measurements of pan evaporation recorded by the Orange Water and Sewer Authority (OWASA) in Carrboro, NC. For application to future climate, lake evaporation could be estimated in OASIS directly from the PET estimates from the Jensen-Haise method used by the PRMS model; however, there is no guarantee that the resulting estimates would be fully consistent with the approach currently used in OASIS. In addition, the PRMS estimates of PET differ across the watersheds. Therefore, an alternative approach to adjust lake evaporation for future climate was adopted.

Adjusted lake evaporation timeseries were calculated using a bias correction method similar to that described for future runoff timeseries in Section 4.4. Specifically, the eQM method was applied to map the relative changes from historic to future conditions in the Jensen-Haise PET estimates at each lake onto the cumulative distribution function of the historic estimate of lake evaporation rates. As with the runoff timeseries, the eQM quantile mapping approach adjusts for systematic differences that are present between observed pan evaporation and Jensen-Haise PET. The revised lake evaporation timeseries were then converted to the net evaporation timeseries (the difference between evaporation and precipitation on the lake surface) used by OASIS, preserving the temporal match between evaporation and precipitation.

5.3 Database

The historic and future, bias-corrected daily simulated runoff and evapotranspiration time-series for each of the HRUs in the Cape Fear and Neuse NHM PRMS models are provided for use in the respective OASIS models to evaluate the impacts on future water supply. The climate-adjusted estimates of lake

evaporation rates along with net evaporation adjusted for precipitation (Section 5.2) are also included in separate files.

The OASIS model requires time-series data in the U.S. Army Corps of Engineers Data Storage System-(DSS) format. A Python script was developed that uses the “pyhecdss” module (https://github.com/CADWRDeltaModeling/pyhecdss) to write the PRMS time-series outputs to the HEC-DSS format. DSS files are provided for each climate scenario and model combination (total of 6) for the historic (1/1/1951 to 12/31/2005) and future (1/1/2041 to 12/31/2070) time-periods.

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ATTACHMENT B

Summary of Withdrawals and Discharges in Cape Fear-Neuse River Combined River Basin Model

General Note: Table values are annual averages and vary seasonally. WTP Process Water (PW) is not included in the withdrawal value when the PW discharge location is sufficiently close to the withdrawal location.

A – Values in millions of gallons per day (mgd) and include purchases from other utilities; excludes sales to other utilities with an OASIS node

B - Values in mgd and include wastewater discharges to other utilities; excludes wastewater discharges from other utilities

				2025 Conditions		2055 Conditions	
OASIS Node	Name of Water Utility (or Company)	PWSID(s)	Ownership	Withdrawals and Purchases[A]	Discharges[B]	Withdrawals and Purchases[A]	Discharges[B]
0031	Reidsville	02-79-020	Municipal	3.93	2.29	4.37	2.45
0075	Haw River	02-01-020	Municipal	0.19	0.16	0.27	0.22
0123	Greensboro	02-41-010	Municipal	35.84	35.67	46.58	46.21
0223	High Point	02-41-020	Municipal	11.22	11.99	13.18	14.08
0261	City of Randleman	02-76-015	Municipal	0.84	0.84	0.94	0.94
0301	Ramseur	02-76-020	Municipal	0.62	0.21	0.82	0.28
0321	Graham & Mebane	02-01-015 & 02-01-018	Municipal	4.18	3.19	7.10	5.42
0327	Siler City	03-19-010	Municipal	2.03	1.84	2.67	2.42
0341	Burlington	02-01-010	Municipal	12.92	11.12	16.13	13.88
0401	Pittsboro	03-19-015	Municipal	1.41	0.81	4.65	3.2
0431	OWASA	03-68-010	Authority	7.17	6.8	10.62	10.07
0471	Cary-Apex (includes RTP and Morrisville)	03-92-020 & 03-92-045	Municipal	24.52	22.39	38.24	34.91
0473	Chatham Co. North System	03-19-126	County	2.84	0.39	3.35	0.46
0476	Chatham Co. Asbury System	40-19-010	Municipal	1.04	0	2.05	0
0483	Performance Fibers / Allied Signal Demand	NA	Industrial	0.20	0.2	0.20	0.2
0491	Sanford	05-53-010	Municipal	6.31	5.51	9.15	5.62
0521	Progress Harris	NA	Industrial	20.00	0	20.00	0
0551	Harnett County	03-43-045	County	16.24	9.28	21.56	12.32
0601	Pilgrims Pride	NA	Industrial	0.97	0.06	0.97	0.06
0605	Goldston-Gulf	03-19-025	District	0.08	0.02	0.07	0.02
0654	Angier	03-43-015	Municipal	0.58	0.51	1.31	1.15
0663	Dunn	03-43-010	Municipal	3.55	2.44	3.48	2.39
0674	Carolina Trace	03-53-101	Industry	0.20	0.2	0.22	0.22
0701	Carthage	03-63-025	Municipal	0.37	0	0.55	0
0719	Spring Lake	03-26-020	Municipal	0.90	0.9	0.91	0.91
0721	Old North Utility Services, Inc.	50-26-019	Business	3.49	3.58	4.13	4.23
0733	Fayetteville	03-26-010	Municipal	26.65	26.54	55.27	55.04
0735	Hoke County	03-47-025	Municipal	0.91	0.88	1.11	1.08
0781	Dupont	NA	Industrial	11.17	11.91	11.17	11.91
0785	LCFWSA Bladen Bluff	50-09-012	Authority	4.04	0	4.04	0
0823	Cape Fear PUA-Wilmington	04-65-010	Authority	15.22	0	24.48	0

OASIS Node	Name of Water Utility (or Company)	PWSID(s)	Ownership	2025 Conditions Withdrawals and Purchases[A]	2025 Conditions Discharges[B]	2055 Conditions Withdrawals and Purchases[A]	2055 Conditions Discharges[B]
0825	LCFWSA Kings Bluff	50-09-013	Authority	21.69	0	40.86	0
0903	Jamestown	02-41-030	Municipal	0.57	0	0.87	0
0904	Archdale	02-76-030	Municipal	0.86	0.83	0.98	0.94
0923	Holly Springs	03-92-050	Municipal	3.68	3.58	9.50	9.25
0940	Broadway	03-53-015	Municipal	0.10	0.06	0.14	0.09
1046	Orange-Alamance	03-68-020	Non-Profit	0.62	0.06	0.70	0.07
1106	Hillsborough	03-68-015	Municipal	1.42	0.91	1.89	1.21
1162	Durham	03-32-010	Municipal	32.93	27.03	38.17	31.33
1256	SGWASA	02-39-107	Authority	1.79	1.1	1.84	1.14
1306	Raleigh	03-92-010	Municipal	59.75	52.4	92.40	81.03
1506	Wilson	04-98-010	Municipal	6.69	5.72	6.59	5.63
1646	Johnston County	03-51-070	County	17.08	8.98	41.59	21.88
1666	Smithfield	03-51-010	Municipal	1.62	1.22	1.69	1.27
1706	Fuquay-Varina	03-92-055	Municipal	3.58	3.27	8.37	7.66
1756	Benson	03-51-025	Municipal	0.86	0.3	1.03	0.36
1766	Progress Lee Steam Plant	NA	Industrial	8.91	0	8.91	0
1786	Goldsboro	04-96-010	Municipal	7.05	9.81	8.82	12.27
1806	Neuse Regional WASA	60-54-001	Authority	8.25	7.07	8.39	7.19
1906	Weyerhauser	NA	Industrial	14.47	14.09	14.47	14.09

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ATTACHMENT C

Fayetteville Public Works Commission Water Shortage Response Trigger Flow Mapping

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Effective July 12, 2023, the Fayetteville PWC adopted changes to their WSRP including the addition of water shortage triggers based off the elevation at their Cape Fear River water supply intake. The CFNCRB model used for hydrological analysis in this EIS is a water accounting model and does not quantify water elevations at specific stream sites. Therefore, to include PWC's updated WSRP triggers in the CFNCRB model analysis, each elevation trigger was mapped to a flow value. No USGS data at the Cape Fear River at Fayetteville gauge exists for gauge heights as low as the proposed PWC WSRP triggers.

To estimate what flows may be observed in the Cape Fear River at Fayetteville for the PWC triggers levels, a relationship was developed based on existing USGS data and HEC-RAS river bathymetry information. Based on comparisons to existing USGS data, the HEC-RAS model overpredicted streamflow at the gauge for low stream flows, so these results could not be used directly. Instead, the shape of HEC-RAS relationship between stage and discharge was mapped onto the USGS data used to develop an equation to project flows between the lowest USGS records and a gauge height of 0 feet.

Table C.1: Fayetteville PWC WSRP Triggers as Flows

PWC Drought Stage	PWC Trigger - River Stage at Fayetteville (feet)	Projected River Flow for Trigger Height (cfs)
1	9.45	527
2	8.9	319
3	8.4	202
4	7.66	103

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ATTACHMENT D

Cape Fear-Neuse River Combined River Basin Model OCL Code

_SafeYield_Constants.ocl

```
1  /* '_SafeYield_Constants.ocl'
2     This file is automatically generated by the OASIS GUI.
3     Any changes you make to this file will be overwritten by the program. */
4
5  :substitute: [SafeYield_IterNum] = 06   /* Iteration number in the safe-yield procedure */
6
```

Agric_Allocation.ocl

```
1  /*  File is Agric_Allocation.ocl. */
2
3  /* This file allocates the agricultural demands by the assumed distribution of
4  demand within each county */
5
6  /*  The county demand is represented by "dem__" that varies by number.  These
7  numbers are established in the agricultural input dialog box, with 01 set for Alamance, 02 for
8  Bladen, and so on.  */
9
10 // For counties in the the Cape Fear Basin
11
12 /*  Note that for Alamance, Chatham, Cumberland, Randolph, and Moore, M&N changed the
13 distribution to reflect demand patterns since 1998 */
14
15 Set  Demand_Alamance_35Pct :    demand0371    {   value     : dem01 * 0.35 }
16 Set  Demand_Alamance_30Pct    : demand0361    {   value     : dem01 * 0.30 }
17 Set  Demand_Alamance_35Pct :    demand0081    {   value     : demand0371 }
18
19 Set  Demand_Bladen_60Pct   : demand0811   { value :  dem02 *  0.60  }
20 Set  Demand_Bladen_20Pct :  demand0801     { value :  dem02 *  0.20}
21 Set  Demand_Bladen_20Pct :  demand0821     { value :  dem02 *  0.20 }
22
23 Set  Demand_Caswell_100% :   demand0083  { value :  dem03 * 1.0  }
24
25 Set  Demand_Chatham_10Pct :   demand0403  {    value     : dem04 *  0.10      }
26 Set  Demand_Chatham_85Pct :   demand0621  {    value     : dem04 *  0.85  }
27 Set  Demand_Chatham_5Pct   :  demand0481  {    value     : dem04 *  0.05   }
28
29 Set  Demand_Cumberland_50Pct :  demand0741  {    value     : dem05 *  0.50  }
30 Set  Demand_Cumberland_10Pct :  demand0775  {    value     : dem05 *  0.10  }
31 Set  Demand_Cumberland_40Pct :  demand0783  {    value     : dem05 *  0.40  }
32
33 Set  Demand_Durham_3Pct  :   demand0461  { value :  dem06 * 0.03  }
34
35 Set  Demand_Forsyth_50Pct :  demand0111   { value :  dem07  }
36 Set  Demand_Forsyth_50Pct :  demand0211   { value :  demand0111  }
37
38 Set  Demand_Guilford_20Pct :  demand0051   { value :  dem08 * 0.20 }
39 Set  Demand_Guilford_15Pct :  demand0331   { value :  dem08 * 0.15 }
40 Set  Demand_Guilford_40Pct :  demand0161   { value :  dem08 * 0.40 }
41 Set  Demand_Guilford_13Pct :  demand0043   { value :  dem08 * 0.13 }
42 Set  Demand_Guilford_12Pct :  demand0231   { value :  dem08 * 0.12 }
43
44
45 Set  Demand_Harnett_15Pct :  demand0691   { value :  dem09     * 0.15 }
46 Set  Demand_Harnett_35Pct :  demand0553   { value :  dem09     * 0.35 }
47 Set  Demand_Harnett_50Pct :  demand0681   { value :  dem09     * 0.50 }
```

```
48
49 Set Demand_Hoke_100% :  demand0773 { value : dem10 * 1.0 }
50
51 Set Demand_Lee_7Pct :  demand0623  { value : dem11 * 0.07 }
52 Set Demand_Lee_55Pct : demand0671  { value : dem11 * 0.55 }
53 Set Demand_Lee_38Pct : demand0511  { value : dem11 * 0.38 }
54
55 Set Demand_Montgomery_100% :  demand0593 { value : dem12 * 1.0 }
56
57 Set Demand_Moore_40Pct : demand0603 {  value   : dem13 *  0.40 }
58 Set Demand_Moore_30Pct : demand0713 {  value   : dem13 *  0.30 }
59 Set Demand_Moore_30Pct : demand0595 {  value   : dem13 *  0.30 }
60
61 // Orange Co. - for CF as a percentage of the acerage (48%) in the basin
62 Set Demand_Orange_36Pct : demand0441  { value : dem14 * 0.36 * 0.48 }
63 Set Demand_Orange_24Pct : demand0381  { value : dem14 * 0.24 * 0.48 }
64 Set Demand_Orange_40Pct : demand0311  { value : dem14 * 0.40 * 0.48 }
65
66 Set Demand_Randolph_50Pct : demand0581 {  value   : dem15 *  0.50 }
67 Set Demand_Randolph_30Pct : demand0281 {  value   : dem15 *  0.30 }
68 Set Demand_Randolph_20Pct : demand0263 {  value   : dem15 * 0.20 }
69
70 Set Demand_Rockingham_40Pct : demand0021  { value : dem16 * 0.40 }
71 Set Demand_Rockingham_60Pct : demand0041  { value : dem16 * 0.60 }
72
73 // Wake Co. - for CF as a percentage of the acerage (13%) in the basin
74 Set Demand_Wake_5Pct :  demand0541  { value : dem17 *  0.05 * 0.13 }
75 Set Demand_Wake_75Pct : demand0411  { value : dem17 *  0.75 * 0.13 }
76 Set Demand_Wake_20Pct : demand0531  { value : dem17 * 0.20 * 0.13 }
77
78
79
80 // For counties in the the Neuse Basin
81
82 Set Demand_Or_Pond_Ag  : demand1062 { value: dem14 * 0.095 }
83 Set Demand_WFER_Ag  : demand1052 { value: dem14 * 0.095 }
84 Set Demand_EnoDurha_Ag : demand1112 { value: dem14 * 0.16 + dem06 * 0.137 }
85 Set Demand_Michie_Ag  : demand1142 { value: dem06 * 0.078 + dem25 * 0.31 }
86 Set Demand_LitRes_Ag  : demand1202 { value: dem14 * 0.03 + dem06 * 0.097 + dem14 * 0.14 }
87 Set Demand_Falls_Ag  : demand1302 { value: dem06 * 0.076 + dem20 * 0.02 + dem06 * 0.488 + dem25 * 0.01 + dem20 * 0.07
88                                    + dem06 * 0.094 + dem17 * 0.05 + dem19 * 0.02 + dem20 * 0.15 }
89 Set Demand_Clayt_Ag  : demand1632 { value:  dem22 * 0.04 +  dem17 * 0.20 + dem19 * 0.01 + dem17 * 0.035 }
90 Set Demand_Middl_Ag  : demand1482 { value:  dem22 * 0.01 +  dem17 * 0.158 }
91 Set Demand_Litpr_Ag  : demand1752 { value:  dem28 * 0.02 +  dem22 * 0.18 + dem17 * 0.158 + dem19 * 0.03 }
92 Set Demand_Golds_Ag  : demand1782 { value:  dem22 * 0.10 + dem17 * 0.053 + dem22 * 0.08 + dem27 * 0.42 + dem22 * 0.39
93           + dem22 * 0.13 }
94 Set Demand_Kinst_Ag  : demand1802 { value:  dem23 * 0.35 + dem21 * 0.05 }
```

Agric_Allocation.ocl

```
95  Set  Demand_Buckhorn_Ag  : demand1502 { value:  dem28 * 0.05 + dem22 * 0.04 + dem24 * 0.13 + dem17 * 0.035 + dem19 * 0.05 }
96  Set  Demand_Hooke_Ag   : demand1562 { value:  dem27 * 0.23 + dem21 * 0.57 + dem28 * 0.70 + dem24 * 0.07 + dem22 * 0.01 }
97  Set  Demand_Weyer_Ag   : demand1902 { value:  dem18 * 0.04 + dem23 * 0.39 + dem23 * 0.09 + dem21 * 0.39 + dem26 * 0.17
98              + dem28 * 0.04 + dem26 * 0.23 }
99
100 /* Adjust Little River Ag Demands to distribute them across the proposed Reservoir's sub-basin*/
101 Set Demand_LitR_sub_Ag   : demand1738 { value: demand1752 * 52.6/232 }
102 Set  Demand_Litpr_Ag     : demand1752 { value: demand1752 - demand1738}
```

Agric_Calculation.ocl

```
/*  File is Agric_Calculation.ocl. */

/*  Note the precip data is contained in the basedata file and for simplicity uses Jordan Lake for the Cape Fear
    and Falls Lake for the Neuse.   */

// The first 17 counties are for the Cape Fear Basin.   The next 11 are for the Neuse.  Three counties are in both basins (Wake, Durham, and Orange).
// For the combined model, the more recent acreages (from the Neuse model) for these counties are used.

// First compute agricultural water demand for Cape Fear counties based on Jordan Lake precip. The counties are
// labeled in the Edit Agricultural Data dialog box in the GUI.  Note - counties in both basins (Durham, Orange, Wake) use the CF precip.
:For:
{   [cty] = {01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17}
}

    RUN_MODULE: AgricDem
    {
      Input:  { [cty],                  // County number
                timesers(CFear/precip),      // Precip for Jordan Lake in inches

                pattern(IrrCoef_Tobacco),    // Water Use Coefficients for Tobacco, etc.
                pattern(IrrCoef_Turf),
                pattern(IrrCoef_Golf),
                pattern(IrrCoef_ContNurs),
                pattern(IrrCoef_FieldNurs),
                pattern(IrrCoef_Cotton),
                pattern(IrrCoef_EarlySoy),
                pattern(IrrCoef_LateSoy),
                pattern(IrrCoef_Corn),
                pattern(IrrCoef_Veg),
                pattern(IrrCoef_PastHay),
                pattern(IrrCoef_Peanut),
                pattern(IrrCoef_Blueberry),
                pattern(IrrCoef_Strawberry),
                pattern(IrrCoef_Fruit),
                pattern(IrrCoef_Beef),
                pattern(IrrCoef_Dairy),
                pattern(IrrCoef_Horse),
                pattern(IrrCoef_Pig),
                pattern(IrrCoef_Chicken),
                pattern(IrrCoef_Turkey),
                pattern(IrrCoef_OtherAnimal)
              }

       Output: { dem[cty] }
    }
:Next:

```

```
/* Then compute agricultural demand for the Neuse counties based on Falls Lake precip.
 Note - counties in both basins (Durham, Orange, Wake) use the CF precip.*/
:For:
{   [cty] = {18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28}
}

   RUN_MODULE: AgricDem
   {
     Input:  { [cty],                  // County number
               timesers(Neuse/precip),      // Precip for Falls Lake in inches

               pattern(IrrCoef_Tobacco),    // Water Use Coefficients for Tobacco, etc.
               pattern(IrrCoef_Turf),
               pattern(IrrCoef_Golf),
               pattern(IrrCoef_ContNurs),
               pattern(IrrCoef_FieldNurs),
               pattern(IrrCoef_Cotton),
               pattern(IrrCoef_EarlySoy),
               pattern(IrrCoef_LateSoy),
               pattern(IrrCoef_Corn),
               pattern(IrrCoef_Veg),
               pattern(IrrCoef_PastHay),
               pattern(IrrCoef_Peanut),
               pattern(IrrCoef_Blueberry),
               pattern(IrrCoef_Strawberry),
               pattern(IrrCoef_Fruit),
               pattern(IrrCoef_Beef),
               pattern(IrrCoef_Dairy),
               pattern(IrrCoef_Horse),
               pattern(IrrCoef_Pig),
               pattern(IrrCoef_Chicken),
               pattern(IrrCoef_Turkey),
               pattern(IrrCoef_OtherAnimal)
             }

      Output: { dem[cty] }
   }
:Next:


/*  The results are in mgd.  Now convert these to acre feet for use in the
agric_allocation.ocl file  */

// For the Cape Fear
Set  :  dem01  {  value  :  convert_units {dem01, mgd, af }  }
Set  :  dem02  {  value  :  convert_units {dem02, mgd, af }  }
Set  :  dem03  {  value  :  convert_units {dem03, mgd, af }  }
```

Agric_Calculation.ocl

```
 95 Set : dem04 { value : convert_units {dem04, mgd, af } }
 96 Set : dem05 { value : convert_units {dem05, mgd, af } }
 97 Set : dem06 { value : convert_units {dem06, mgd, af } }
 98 Set : dem07 { value : convert_units {dem07, mgd, af } }
 99 Set : dem08 { value : convert_units {dem08, mgd, af } }
100 Set : dem09 { value : convert_units {dem09, mgd, af } }
101 Set : dem10 { value : convert_units {dem10, mgd, af } }
102 Set : dem11 { value : convert_units {dem11, mgd, af } }
103 Set : dem12 { value : convert_units {dem12, mgd, af } }
104 Set : dem13 { value : convert_units {dem13, mgd, af } }
105 Set : dem14 { value : convert_units {dem14, mgd, af } }
106 Set : dem15 { value : convert_units {dem15, mgd, af } }
107 Set : dem16 { value : convert_units {dem16, mgd, af } }
108 Set : dem17 { value : convert_units {dem17, mgd, af } }
109
110 // For the Neuse
111 Set : dem18 { value : convert_units {dem18, mgd, af } }
112 Set : dem19 { value : convert_units {dem19, mgd, af } }
113 Set : dem20 { value : convert_units {dem20, mgd, af } }
114 Set : dem21 { value : convert_units {dem21, mgd, af } }
115 Set : dem22 { value : convert_units {dem22, mgd, af } }
116 Set : dem23 { value : convert_units {dem23, mgd, af } }
117 Set : dem24 { value : convert_units {dem24, mgd, af } }
118 Set : dem25 { value : convert_units {dem25, mgd, af } }
119 Set : dem26 { value : convert_units {dem26, mgd, af } }
120 Set : dem27 { value : convert_units {dem27, mgd, af } }
121 Set : dem28 { value : convert_units {dem28, mgd, af } }
```

Benson_ops.ocl

```
1  /* BENSON_OPS.OCL  */
2
3  /*  Operational policy for Bensons's system */
4
5  // Set targets to dictate deliveries from Dunn and Johnston Cos.
6  Target Dunn_Del : dflow0662.1756
7  {   condition : default
8     priority  : 1
9     penalty+  : 75
10    penalty-  : 75
11    Value     : 0.96 * min{_Benson_Consvn_1_Demand, _Benson_Consvn_2_Demand,
12       _Benson_Consvn_3_Demand, _Benson_Consvn_4_Demand,
13       _Benson_Consvn_5_Demand, _Benson_Consvn_6_Demand,
14       demand1756}  // 96% from Dunn, the rest will be from Johnston Co. (arc 1656.1756)
15 }
16
17 Target JC_Del : dflow1656.1756
18 {   condition : default
19    priority  : 1
20    penalty+  : 75
21    penalty-  : 75
22    Value     : 0.04 * min{_Benson_Consvn_1_Demand, _Benson_Consvn_2_Demand,
23       _Benson_Consvn_3_Demand, _Benson_Consvn_4_Demand,
24       _Benson_Consvn_5_Demand, _Benson_Consvn_6_Demand,
25       demand1756} // 4% from  Johnston Co. (arc 1656.1756)
26 }
```

buckhorn_Wilson_ops.ocl

```
1  /*  BUCKHORN_Wilson_OPS.OCL  */
2
3  /*  Minimum release policy for Wilson's Buckhorn Lake - based on storage remaining.
4  Modified by R. Palmer - minimum release needs to be made below the
5  City of Wilson withdrawal point - Wiggon's Mill Lake, not Buckhorn Dam - will add the arc downstream accordingly*/
6
7  Set :  min_flow1520.1560
8  {   condition : storage1500 / max_stor1500 < 0.5
9     Value     : convert_units { 1.4 , cfs , af }
10
11    condition : storage1500 / max_stor1500 < 0.7
12    Value     : convert_units { 5.3 , cfs , af }
13
14    condition : default
15    Value     : convert_units { 7.6 , cfs , af }
16 }
```

constants.ocl

```
1  /* 'constants.ocl'
2    This file is automatically generated by the OASIS GUI.
3    Any changes you make to this file will be overwritten by the program.
4    To edit the Constants table, do not edit this file.  Instead, go to
5    the 'OCL' tab of the GUI and edit the 'OCL Constants' table.  */
6
7  :substitute: [ClaytonTarget_Override] = 0          /* 0 = Normal Clayton target; 1 = Override target when Falls WQ < threshold */
8  :substitute: [ClaytonTarget_SafeFact] = 0          /* Pct. safety factor for Clayton minimum target */
9  :substitute:       [Demand_FV_Neuse] = 0.62        /* Fraction of Fuquay Varina Demand in the Neuse River Basin */
10 :substitute:     [Demand_Multiplier] = 1           /* Multiplication factor used to adjust all demands in the system */
11 :substitute:      [Drought_Plans_On] = 1           /* 1 = Use drought plans, 0 = do not use drought plans */
12 :substitute:     [FLakeMin_SafeFact] = 0           /* Pct. safety factor for Falls minimum releases */
13 :substitute:     [FV_Harnett_Supply] = 2           /* Supply contract from Harnett County to Fuquay Varina */
14 :substitute:    [FV_Johnston_Supply] = 0           /* Supply contract from Johnston County to Fuquay Varina */
15 :substitute:         [FV_Ral_Supply] = 0          /* Supply contract from Raleigh to Fuquay Varina */
16 :substitute:     [FV_Sanford_Supply] = 0           /* Supply contract from Sanford to Fuquay Varina */
17 :substitute:  [Use_Demand_Multiplier] = 0          /* Flag tells whether to adjust all demands in the system with a mult. factor */
```

constants_removed.ocl

```
/* this file was created to contain constants removed from constants table to simplify run
evaluated in beginning of main.ocl so all files can reference values as needed */

//Raleigh constants
:SUBSTITUTE: [Total_Max_WQ_Storage]  = 44022  /*Raleigh total max water quality storage, af */
:SUBSTITUTE: [Total_Max_WS_Storage]  = 62300  /* Raleigh total max water supply storage, af*/
:SUBSTITUTE: [NR_DS_intake]    = 0   /*Neuse River raleigh intake benton mgd*/
:SUBSTITUTE: [DE_Benton_WTP_Capacity]  = 40   /*DE Benton WTP Capacity, mgd*/
// Falls Lake
:SUBSTITUTE: [Falls_upper_rule]   = 251.5  /*Falls Lake upper rule, ft */
:SUBSTITUTE: [Falls_lower_rule]   = 236.5  /*Falls Lake lower rule, ft*/
:SUBSTITUTE: [FLake_WQ_Threshold]   = 20   /*Falls Lake water quality threshold, % */
:SUBSTITUTE: [FLake_WQ_Stor]    = 42110  /*Falls Lake water quality storage, af */
:SUBSTITUTE: [FLake_WS_Stor]    = 59595  /*Falls Lake Water Supply Storage, af */
// Beaverdam Lake
:SUBSTITUTE: [Bdam_WQ_Stor]    = 1912   /*Beaverdam water quality storage, af */
:SUBSTITUTE: [Bdam_WS_Stor]    = 2705   /* Beaverdam water supply storage, af*/
:SUBSTITUTE: [Bdam_WQ_WS_Stor]    = 4617   /*Beaverdam total water quality and water supply storage, af  */

//Jordan Lake constantss
:SUBSTITUTE: [Max_WQ_Storage]    = 94600  /* Jordan max water quality storage, af */
:SUBSTITUTE: [Lillington_Target_Normal] = 600   /* cape Fear Lillington Gage Target, cfs*/
:SUBSTITUTE: [Max_WS_Storage]    = 45800  /* Jordan max ater supply storage, af */
:SUBSTITUTE: [Max_WQ_WS_Storage]   = 140400  /* Jordan lake max total storage, af*/
// allocation fractions
:SUBSTITUTE: [WS_CaryAp_Fraction]   = 0.392  /* Available water supply storage for Cary Apex (as a fraction of the total pool) */
:SUBSTITUTE: [WS_Chatham_Fraction]  = 0.13   /* Available water supply storage for Chatham Co. (as a fraction of the total pool) */
:SUBSTITUTE: [WS_Durham_Fraction]   = 0.165  /* Available water supply storage for Durham (as a fraction of the total pool) */
:SUBSTITUTE: [WS_Holly_Fraction]   = 0.02   /* Available water supply storage for Holly Springs (as a fraction of the total pool) */
:SUBSTITUTE: [WS_Morris_Fraction]   = 0.035  /* Available water supply storage for Morrisville(as a fraction of the total pool) */
:SUBSTITUTE: [WS_Orange_Fraction]   = 0.015  /* Available water supply storage for Orange Co. (as a fraction of the total pool) */
:SUBSTITUTE: [WS_Other_Fraction]   = 0.088  /* Available water supply storage for unallocated (as a fraction of the total pool) */
:SUBSTITUTE: [WS_OWASA_Fraction]   = 0.05   /* Available water supply storage for OWASA (as a fraction of the total pool) */
:SUBSTITUTE: [WS_RTP_Fraction]    = 0.035  /* Available water supply storage for RTP (as a fraction of the total pool) */
:SUBSTITUTE: [WS_Pitt_Fraction]   = 0.06   /* Available water supply storage for Pittsboro (as a fraction of the total pool) */
:SUBSTITUTE: [WS_Hillsb_Fraction]   = 0.01   /* Available water supply storage for Hillsborough (as a fraction of the total pool) */

//Durham constants
:SUBSTITUTE: [TQ_Max_LM_Refill_Rate]   = 20   /* Teer Quarry max Lake Michie refill, mgd*/
:SUBSTITUTE: [Max_Quarry_refill_rate]  = 0   /* Maximum Raleigh quarry refill rate, mgd*/
```

Crabtree_ops.ocl

```
1  /* CRABTREE.OCL */
2
3  /* Set the Crabtree Creek inflows and net evap for the individual flood control impoundments
4    Instead of having 11 inflow and evap records in the basedata file, base all of them
5    the inflow1400/evap1400 from the main basedata.dss */
6
7
8  /* Variables for the incremental DA into each reservoir */
9  :Substitute: [1400] = 2.1
10 :Substitute: [1402] = 1.4
11 :Substitute: [1404] = 2.3
12 :Substitute: [1406] = 8.9
13 :Substitute: [1408] = 5.2
14 :Substitute: [1410] = 8.2
15 :Substitute: [1412] = 2.5
16 :Substitute: [1414] = 11.5
17 :Substitute: [1416] = 3.7
18 :Substitute: [1418] = 23.1
19 :Substitute: [1422] = 24.8
20 :Substitute: [CrabtreeTotal] = 93.7
21
22 /* Filter the total inflow (in case there are any negative provisional inflows) */
23 Set : _TempInfCrabtree { Value : timesers(1400/inflow) }
24 Set : _TotInfCrabtree  { Value : max{0, _TempInfCrabtree - _InfDeficitCrabtree(-1) } }
25 Set : _InfDeficitCrabtree { Value : max{0, _InfDeficitCrabtree(-1) - _TempInfCrabtree } }
26
27 /* Set the inflows - proportion by drainage area the total inflow to Crabtree Creek */
28 Set : inflow1400  { value :  _TotInfCrabtree / [CrabtreeTotal] * [1400]  }
29 Set : inflow1402  { value :  _TotInfCrabtree / [CrabtreeTotal] * [1402]  }
30 Set : inflow1404  { value :  _TotInfCrabtree / [CrabtreeTotal] * [1404]  }
31 Set : inflow1406  { value :  _TotInfCrabtree / [CrabtreeTotal] * [1406]  }
32 Set : inflow1408  { value :  _TotInfCrabtree / [CrabtreeTotal] * [1408]  }
33 Set : inflow1410  { value :  _TotInfCrabtree / [CrabtreeTotal] * [1410]  }
34 Set : inflow1412  { value :  _TotInfCrabtree / [CrabtreeTotal] * [1412]  }
35 Set : inflow1414  { value :  _TotInfCrabtree / [CrabtreeTotal] * [1414]  }
36 Set : inflow1416  { value :  _TotInfCrabtree / [CrabtreeTotal] * [1416]  }
37 Set : inflow1418  { value :  _TotInfCrabtree / [CrabtreeTotal] * [1418]  }
38 Set : inflow1422  { value :  _TotInfCrabtree / [CrabtreeTotal] * [1422]  }
39
40 /* Set the evap for all nodes */
41 :For:
42 {   [node] = { 1400, 1402, 1404, 1406, 1408, 1410, 1412, 1414, 1416, 1418, 1422 }
43 }
44    Set : evap[node]  { value : stor_to_area { [node], storage[node] } * timesers(1400/evap) / 11 }
45
46 :Next:
47
```

```
/* Set the spillway rating curves for the Crabtree Creek impoundments.  Prevent releases from drawing pond below spill elevation  */
Target 1400_release: dflow1400.1412
{  Condition  : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
    Value     : min {convert_units { Lookup{ 1400Outflow, elevation1400 }, cfs, af}, storage1400 - elev_to_stor {1400, 305} }
}

Target 1402_release: dflow1402.1412
{  Condition  : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
    Value     : min {convert_units { Lookup{ 1402Outflow, elevation1402 }, cfs, af}, storage1402 - elev_to_stor {1402, 326} }
}

Target 1404_release: dflow1404.1412
{  Condition  : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
    Value     : min {convert_units { Lookup{ 1404Outflow, elevation1404 }, cfs, af}, storage1404 - elev_to_stor {1404, 342.5} }
}

Target 1406_release: dflow1406.1412
{  Condition  : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
    Value     : min {convert_units { Lookup{ 1406Outflow, elevation1406 }, cfs, af}, storage1406 - elev_to_stor {1406, 306.5} }
}

Target 1408_release: dflow1408.1412
{  Condition  : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
    Value     : min {convert_units { Lookup{ 1408Outflow, elevation1408 }, cfs, af}, storage1408 - elev_to_stor {1408, 313} }
}

Target 1410_release: dflow1410.1412
{  Condition  : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
    Value     : min {convert_units { Lookup{ 1410Outflow, elevation1410 }, cfs, af}, storage1410 - elev_to_stor {1410, 306.5} }
```

```
}

Target 1412_release: dflow1412.1416
{   Condition  : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
    Value     : min {convert_units { Lookup{ 1412Outflow, elevation1412 }, cfs, af}, storage1412 - elev_to_stor {1412, 276} }
}

Target 1414_release: dflow1414.1416
{  Condition  : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
    Value     : min {convert_units { Lookup{ 1414Outflow, elevation1414 }, cfs, af}, storage1414 - elev_to_stor {1414, 301 } }
}

Target 1416_release: dflow1416.1424
{  Condition  : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
    Value     : min {convert_units { Lookup{ 1416Outflow, elevation1416 }, cfs, af}, storage1416 - elev_to_stor {1416, 230} }
}

Target 1418_release: dflow1418.1424
{  Condition  : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
    Value     : min {convert_units { Lookup{ 1418Outflow, elevation1418 }, cfs, af}, storage1418 - elev_to_stor {1418, 335} }
}

Target 1422_release: dflow1422.1424
{  Condition  : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
    Value     : min {convert_units { Lookup{ 1422Outflow, elevation1422 }, cfs, af}, storage1422 - elev_to_stor {1422, 252} }
}
```

drought_plan_durham.ocl

```
/* durham_drought_plan.ocl
   Forecast-based triggers and demand reductions based on Durham's Water Shortage Response Plan */

:If: {[Drought_Plans_On] = 1} // First check if drought plan variable is on

/* Compute Durham's usable storage */

Set : _Durham_usable_stor { Value : (storage1140 - lower_rule1140) + (storage1200 - lower_rule1200) }

Set : _Max_Durham_usable_stor { Value : (upper_rule1140 - lower_rule1140) + (upper_rule1200 - lower_rule1200) }

Set : _Durham_usable_pct { Value : 100 * (_Durham_usable_stor / _Max_Durham_usable_stor) }


/*  This section computes the projected demand, inflow, and net evap for each forecast horizon.
 The forecast horizon # is the forecast used to help establish when level # (same number) restrictions are imposed.
 The min flow requirement is small compared to the demand, so ignore; plus min flow is lowest when forecasts are likely to show
 any triggering */


    /* First Trigger Horizon */
Set : _Proj_1_Demand
{   Condition : weekday{year, month, day} <= 1
    Value     : accumulate { demand1162, 0, +[Forecast_1_Horizon_Days] }

    Condition : default
    Value     : _Proj_1_Demand(-1)
}

Set : _Proj_1_Evap
{   condition  :  weekday{year, month, day} <= 1
 value :  stor_to_area { 1140 , storage1140 } * 7 * (timesers(1140/Evap_[ForcCode_1]) / 12 )
   + stor_to_area { 1200 , storage1200 } * 7 * (timesers(1200/Evap_[ForcCode_1]) / 12 )

 Condition : default
    Value     : _Proj_1_Evap(-1)
}

/* Since timestep is daily and forecasts in dss file are weekly, the forecast must be multiplied by 7 */

Set :  _Proj_1_Inflow
{  value :  7 * (timesers(1140/[ForcCode_1]) ) + 7 * (timesers(1200/[ForcCode_1]) )
}


    /* Second Trigger Horizon */
Set : _Proj_2_Demand
```

```
{   Condition : weekday{year, month, day} <= 1
    Value     : accumulate { demand1162, 0, +[Forecast_2_Horizon_Days] }  * ( 1 -  pattern(Stage_1_Dem_Red)  )
    // Note:  demand reductions in each stage are cumulative!

    Condition : default
    Value     : _Proj_2_Demand(-1)
}


Set : _Proj_2_Evap
{   condition  :  weekday{year, month, day} <= 1
 value :  stor_to_area { 1140 , storage1140 } * 7 * (timesers(1140/Evap_[ForcCode_2]) / 12 )
   + stor_to_area { 1200 , storage1200 } * 7 * (timesers(1200/Evap_[ForcCode_2]) / 12 )

 Condition : default
    Value     : _Proj_2_Evap(-1)
}

Set :  _Proj_2_Inflow
{  value :  7 * (timesers(1140/[ForcCode_2]) ) + 7 * (timesers(1200/[ForcCode_2]) )
}

    /* Third Trigger Horizon */
Set : _Proj_3_Demand
{   Condition : weekday{year, month, day} <= 1
    Value     : accumulate { demand1162, 0, +[Forecast_3_Horizon_Days] }  * ( 1 -  pattern(Stage_2_Dem_Red)  )

    Condition : default
    Value     : _Proj_3_Demand(-1)
}


Set : _Proj_3_Evap
{   condition  :  weekday{year, month, day} <= 1
 value :  stor_to_area { 1140 , storage1140 } * 7 * (timesers(1140/Evap_[ForcCode_3]) / 12 )
   + stor_to_area { 1200 , storage1200 } * 7 * (timesers(1200/Evap_[ForcCode_3]) / 12 )

 Condition : default
    Value     : _Proj_3_Evap(-1)
}


Set :  _Proj_3_Inflow
{  value :  7 * (timesers(1140/[ForcCode_3]) ) + 7 * (timesers(1200/[ForcCode_3]) )
}

```

```
95     /* Fourth Trigger Horizon */
96  Set : _Proj_4_Demand
97  {   Condition : weekday{year, month, day} <= 1
98     Value     : accumulate { demand1162, 0, +[Forecast_4_Horizon_Days] }  * ( 1 -  pattern(Stage_3_Dem_Red)  )
99
100    Condition : default
101    Value     : _Proj_4_Demand(-1)
102 }
103
104
105 Set : _Proj_4_Evap
106 {   condition  :  weekday{year, month, day} <= 1
107  value :  stor_to_area { 1140 , storage1140 } * 7 * (timesers(1140/Evap_[ForcCode_4]) / 12 )
108    + stor_to_area { 1200 , storage1200 } * 7 * (timesers(1200/Evap_[ForcCode_4]) / 12 )
109
110  Condition : default
111    Value     : _Proj_4_Evap(-1)
112 }
113
114
115 Set :  _Proj_4_Inflow
116 {  value :  7 * (timesers(1140/[ForcCode_4]) ) + 7 * (timesers(1200/[ForcCode_4]) )
117 }
118
119
120 // Use this for the refill calculation later on.
121 Set :  _Proj_5_Inflow
122 {  value :  7 * (timesers(1140/[ForcCode_5]) ) + 7 * (timesers(1200/[ForcCode_5]) )
123 }
124
125
126
127 /*  This section computes the projected water supply storage based on the the demand, inflow, and net
128  evaporation for the forecast horizon. Note these udefs are volumetric */
129
130 Set : _Proj_1_WSPool
131 {   Condition : weekday{year, month, day} <= 1
132    Value     : min{_Durham_usable_stor(-1) + _Proj_1_Inflow -
133              _Proj_1_Evap - _Proj_1_Demand, _Max_Durham_usable_stor}
134
135    Condition : default
136    Value     : _Proj_1_WSPool(-1)
137 }
138
139 Set : _Proj_2_WSPool
140 {   Condition : weekday{year, month, day} <= 1
141    Value     : min{_Durham_usable_stor(-1) + _Proj_2_Inflow -
```

```
142             _Proj_2_Evap - _Proj_2_Demand, _Max_Durham_usable_stor}
143
144     Condition : default
145     Value     : _Proj_2_WSPool(-1)
146 }
147
148
149 Set : _Proj_3_WSPool
150 {   Condition : weekday{year, month, day} <= 1
151     Value     : min{_Durham_usable_stor(-1) + _Proj_3_Inflow -
152             _Proj_3_Evap - _Proj_3_Demand, _Max_Durham_usable_stor}
153
154     Condition : default
155     Value     : _Proj_3_WSPool(-1)
156 }
157
158
159 Set : _Proj_4_WSPool
160 {   Condition : weekday{year, month, day} <= 1
161     Value     : min{_Durham_usable_stor(-1) + _Proj_4_Inflow -
162             _Proj_4_Evap - _Proj_4_Demand, _Max_Durham_usable_stor}
163
164     Condition : default
165     Value     : _Proj_4_WSPool(-1)
166 }
167
168 /* USE JUST ONE REFILL TRIGGER (PROJ_REFILL) AND ASSUME ALL RESTRICTIONS STAY ON UNTIL TRIGGER IS MET OR
169  USABLE STORAGE HITS 95%.  USE INFLOW ASSOCIATED WITH TRIG 5 PARAMETERS.
170  USE FULL UNRESTRICTED DEMAND TO BE CONSERVATIVE.  */
171 Set : _Proj_WSPool_Refill
172 {   Condition : weekday{year, month, day} <= 1
173     Value     : min{_Durham_usable_stor(-1) + _Proj_5_Inflow - _Proj_4_Evap - _Proj_1_Demand, _Max_Durham_usable_stor}
174
175     Condition : default
176     Value     : _Proj_WSPool_Refill(-1)
177 }
178
179
180
181 /*Set : _Proj_3_WSPool_Refill
182 {   Condition : weekday{year, month, day} <= 1
183     Value     : min{_Durham_usable_stor(-1) + _Proj_4_Inflow - _Proj_3_Evap - _Proj_1_Demand, _Max_Durham_usable_stor}
184
185     Condition : default
186     Value     : _Proj_3_WSPool_Refill(-1)
187 }
188
```

```
189
190 Set : _Proj_2_WSPool_Refill
191 {   Condition : weekday{year, month, day} <= 1
192     Value     : min{_Durham_usable_stor(-1) + _Proj_4_Inflow - _Proj_3_Evap - _Proj_1_Demand, _Max_Durham_usable_stor}
193
194     Condition : default
195     Value     : _Proj_2_WSPool_Refill(-1)
196 }
197
198 Set :  _Proj_1_WSPool_Refill
199 {   Condition : weekday{year, month, day} <= 1
200     Value     : min{_Durham_usable_stor(-1) + _Proj_4_Inflow - _Proj_3_Evap - _Proj_1_Demand, _Max_Durham_usable_stor}
201
202     Condition : default
203     Value     : _Proj_1_WSPool_Refill(-1)
204 }
205 */
206
207
208 /*  This section evaluates whether the two triggers were on during the
209     last time step.  If so, it checks to see whether the water supply pool has refilled,
210  in which case the triggers are released.  If the trigger was not on in the last timestep,
211  it compares the projected storage with the threshold to determine whether it should be turned on.
212
213
214     Use 28 day waiting period between restrictions */
215
216
217
218
219 Set : _Durham_Trigger_4_On
220 {
221     Condition : _Durham_Trigger_4_On(-1) = 1
222     {
223         Condition : _Proj_WSPool_Refill >= [Trigger_5_Stor] / 100 * _Max_Durham_usable_stor or _Durham_usable_pct >= 95
224         Value     : 0
225
226         Condition : default
227         Value     : _Durham_Trigger_4_On(-1)
228     }
229
230  Condition : _Durham_Stage_3_Counter(-1) >= 28
231   {   Condition : weekday{year, month, day} <= 1
232       {
233           Condition : _Proj_4_WSPool <= [Trigger_4_Stor] / 100 * _Max_Durham_usable_stor
234           Value     : 1
235     }
```

```
236
237     Condition : default
238       Value     : _Durham_Trigger_4_On(-1)
239      }
240
241     Condition : default
242     Value     : _Durham_Trigger_4_On(-1)
243  }
244
245
246
247  Set : _Durham_Trigger_3_On
248  {
249     Condition : _Durham_Trigger_3_On(-1) = 1
250     {
251        Condition : _Proj_WSPool_Refill >= [Trigger_5_Stor] / 100 * _Max_Durham_usable_stor or _Durham_usable_pct >= 95
252        Value     : 0
253
254        Condition : default
255        Value     : _Durham_Trigger_3_On(-1)
256     }
257
258   Condition : _Durham_Stage_2_Counter(-1) >= 28
259    {    Condition : weekday{year, month, day} <= 1
260        {
261           Condition : _Proj_3_WSPool <= [Trigger_3_Stor] / 100 * _Max_Durham_usable_stor
262           Value     : 1
263     }
264
265    Condition : default
266       Value     : _Durham_Trigger_3_On(-1)
267      }
268
269     Condition : default
270     Value     : _Durham_Trigger_3_On(-1)
271  }
272
273
274
275
276
277  Set : _Durham_Trigger_2_On
278  {
279     Condition : _Durham_Trigger_2_On(-1) = 1
280     {
281        Condition : _Proj_WSPool_Refill >= [Trigger_5_Stor] / 100 * _Max_Durham_usable_stor or _Durham_usable_pct >= 95
282        Value     : 0
```

```
283
284         Condition : default
285         Value     : _Durham_Trigger_2_On(-1)
286      }
287
288   Condition : _Durham_Stage_1_Counter(-1) >= 28
289    {    Condition : weekday{year, month, day} <= 1
290         {
291            Condition : _Proj_2_WSPool <= [Trigger_2_Stor] / 100 * _Max_Durham_usable_stor
292            Value     : 1
293      }
294
295     Condition : default
296        Value     : _Durham_Trigger_2_On(-1)
297       }
298
299      Condition : default
300      Value     : _Durham_Trigger_2_On(-1)
301   }
302
303
304   Set : _Durham_Trigger_1_On
305   {
306      Condition : _Durham_Trigger_1_On(-1) = 1
307      {
308         Condition : _Proj_WSPool_Refill >= [Trigger_5_Stor] / 100 * _Max_Durham_usable_stor or _Durham_usable_pct >= 95
309         Value     : 0
310
311         Condition : default
312         Value     : _Durham_Trigger_1_On(-1)
313      }
314
315      Condition : weekday{year, month, day} <= 1
316      {
317         Condition : _Proj_1_WSPool <= [Trigger_1_Stor] / 100 * _Max_Durham_usable_stor or  _Durham_usable_pct < 40
318         Value     : 1
319      }
320
321      Condition : default
322      Value     : _Durham_Trigger_1_On(-1)
323   }
324
325
326   :FOR:
327   {   [num] = { 1, 2, 3, 4 }
328   }
329
```

```
Set : _Durham_Stage_[num]_Counter
{
    Condition : _Durham_Trigger_[num]_On = 1
    Value     : _Durham_Stage_[num]_Counter(-1) + 1


    Condition : default
    Value     : 0
}

/* When Teer Quarry is active (assumed to be the case in this 2055 run), it is assumed that if in stage 1 drought phase, there would
   be no demand reductions. Teer Quarry supply would allow us to avoid that. */

Set : _Durham_Consvn_[num]_Demand
{
    Condition : _Durham_Trigger_2_On = 1 or _Durham_Trigger_3_On = 1 or _Durham_Trigger_4_On = 1
    Value     : demand1162 * ( 1 -  pattern(Stage_[num]_Dem_Red) )

    Condition : default
    Value     : demand1162
}


Constraint   Durham_Demand_Limit_Consvn_[num] :
           {   Condition  :  _Durham_Trigger_[num]_On = 1
               Expression :  ddelivery1162 <= _Durham_Consvn_[num]_Demand }


Set : _Durham_Ph_[num]_event_counter
{   Condition : _Durham_Stage_[num]_Counter = 5 and _Durham_Stage_[num]_Counter(-1) = 4
    Value     : _Durham_Ph_[num]_event_counter(-1) + 1

    Condition : default
    Value     : _Durham_Ph_[num]_event_counter(-1)
}

:NEXT:

Set :  _Trig_Level_Durham
{  condition  :  _Durham_Trigger_4_On = 1
   value      :  4

   condition  :  _Durham_Trigger_3_On = 1
   value      :  3

   condition  :  _Durham_Trigger_2_On = 1
   value      :  2
```

```
377
378    condition  :  _Durham_Trigger_1_On = 1
379    value      :  1
380
381    condition  :  default
382    value      :  0
383  }
384
385  :else:
386
387  // Otherwise, set the triggers to zero and trig level to 0.  The quarry operations refer to the triggers. This will allow the trig level to be plotted to
388  // confirm plan was off.
389
390
391  :For: {   [trig] = {1, 2, 3, 4}}
392
393  Set : _Durham_Trigger_[trig]_On  {  value  :  0   }
394
395  :Next:
396
397
398  Set :  _Trig_Level_Durham   {  value :  0  }
399
400
401  :endif:
402
```

drought_plans_cf.ocl

```
1  /* File is drought_plans_cf.ocl.  Computes trigger levels and demand reductions. */
2
3  :If: {[Drought_Plans_On] = 1} // First check if drought plan variable is on
4
5  :Include: ocl\OWASA_wsrp.ocl // OWASA's forecast-based plan is in a separate OCL file
6
7  /* Burlington */
8  Set : _Burl_Max_Usable_Stor { Value: (upper_rule0070 - lower_rule0070) + (upper_rule0340 - lower_rule0340) }
9  Set : _Burl_Usable_Stor { Value : min { _Burl_Max_Usable_Stor, storage0070 - lower_rule0070 + storage0340 - lower_rule0340 } }
10 Set : _Burl_Usable_Stor_Pct { Value : 100 * _Burl_Usable_Stor / _Burl_Max_Usable_Stor }
11
12 Set : _Burl_Trigger_6_On { Value : 0 }
13
14 Set : _Burl_Trigger_5_On
15 {   Condition : _Burl_Trigger_5_On(-1) = 1
16    {   Condition : _Burl_Usable_Stor_Pct >= 100
17        Value     : 0
18
19        Condition : default
20        Value     : _Burl_Trigger_5_On(-1)
21    }
22
23    Condition : _Burl_Stage_4_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 5
24    {   Condition : weekday{year, month, day} <= 1
25        {     Condition : _Burl_Usable_Stor_Pct <= 15
26              Value     : 1
27        }
28        Condition : default
29        Value     : _Burl_Trigger_5_On(-1)
30    }
31    Condition : default
32    Value     : _Burl_Trigger_5_On(-1)
33 }
34
35 Set : _Burl_Trigger_4_On
36 {   Condition : _Burl_Trigger_4_On(-1) = 1
37    {   Condition : _Burl_Usable_Stor_Pct >= 100
38        Value     : 0
39
40        Condition : default
41        Value     : _Burl_Trigger_4_On(-1)
42    }
43
44    Condition : _Burl_Stage_3_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 4
45    {   Condition : weekday{year, month, day} <= 1
46        {     Condition : _Burl_Usable_Stor_Pct < 30
47              Value     : 1
```

```
48        }
49        Condition : default
50        Value     : _Burl_Trigger_4_On(-1)
51     }
52     Condition : default
53     Value     : _Burl_Trigger_4_On(-1)
54  }
55
56  Set : _Burl_Trigger_3_On
57  {   Condition : _Burl_Trigger_3_On(-1) = 1
58     {   Condition : _Burl_Usable_Stor_Pct >= 100
59        Value     : 0
60
61        Condition : default
62        Value     : _Burl_Trigger_3_On(-1)
63     }
64
65     Condition : _Burl_Stage_2_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 3
66     {   Condition : weekday{year, month, day} <= 1
67        {     Condition : _Burl_Usable_Stor_Pct < 45
68              Value     : 1
69        }
70        Condition : default
71        Value     : _Burl_Trigger_3_On(-1)
72     }
73     Condition : default
74     Value     : _Burl_Trigger_3_On(-1)
75  }
76
77
78  Set : _Burl_Trigger_2_On
79  {   Condition : _Burl_Trigger_2_On(-1) = 1
80     {   Condition : _Burl_Usable_Stor_Pct >= 100
81        Value     : 0
82
83        Condition : default
84        Value     : _Burl_Trigger_2_On(-1)
85     }
86
87     Condition : _Burl_Stage_1_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 2
88     {   Condition : weekday{year, month, day} <= 1
89        {     Condition : _Burl_Usable_Stor_Pct < 60
90           Value     : 1
91        }
92        Condition : default
93        Value     : _Burl_Trigger_2_On(-1)
94     }
```

```
    Condition : default
    Value     : _Burl_Trigger_2_On(-1)
}


Set : _Burl_Trigger_1_On
{   Condition : _Burl_Trigger_1_On(-1) = 1
    {   Condition : _Burl_Usable_Stor_Pct >= 100
        Value     : 0

        Condition : default
        Value     : _Burl_Trigger_1_On(-1)
    }

    Condition : weekday{year, month, day} <= 1
    {   Condition : _Burl_Usable_Stor_Pct < 75
        Value     : 1

        Condition : default
        Value     : _Burl_Trigger_1_On(-1)
    }
    Condition : default
    Value     : _Burl_Trigger_1_On(-1)
}

/* Grensboro */
Set : _Gree_Max_Usable_Stor { Value: (upper_rule0120 - lower_rule0120) + (upper_rule0140 - lower_rule0140) }
Set : _Gree_Usable_Stor { Value : min { _Gree_Max_Usable_Stor, (storage0120 - lower_rule0120) + (storage0140 - lower_rule0140) } }
Set : _Gree_Usable_Stor_Pct { Value : 100 * _Gree_Usable_Stor / _Gree_Max_Usable_Stor }
Set : _Gree_DSR { Value :_Gree_Usable_Stor / demand0123 }

Set : _Gree_Trigger_6_On { Value : 0 }

Set : _Gree_Trigger_5_On
{   Condition : _Gree_Trigger_5_On(-1) = 1
    {   Condition : _Gree_Usable_Stor_Pct >= 100
        Value     : 0

        Condition : default
        Value     : _Gree_Trigger_5_On(-1)
    }

    Condition : _Gree_Stage_4_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 5
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : _Gree_DSR <= 75
              Value     : 1
        }
```

```
142         Condition : default
143         Value     : _Gree_Trigger_5_On(-1)
144     }
145     Condition : default
146     Value     : _Gree_Trigger_5_On(-1)
147 }
148
149 Set : _Gree_Trigger_4_On
150 {   Condition : _Gree_Trigger_4_On(-1) = 1
151     {   Condition : _Gree_Usable_Stor_Pct >= 100
152         Value     : 0
153
154         Condition : default
155         Value     : _Gree_Trigger_4_On(-1)
156     }
157
158     Condition : _Gree_Stage_3_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 4
159     {   Condition : weekday{year, month, day} <= 1
160         {     Condition : _Gree_DSR <= 100
161               Value     : 1
162         }
163         Condition : default
164         Value     : _Gree_Trigger_4_On(-1)
165     }
166     Condition : default
167     Value     : _Gree_Trigger_4_On(-1)
168 }
169
170 Set : _Gree_Trigger_3_On
171 {   Condition : _Gree_Trigger_3_On(-1) = 1
172     {   Condition : _Gree_Usable_Stor_Pct >= 100
173         Value     : 0
174
175         Condition : default
176         Value     : _Gree_Trigger_3_On(-1)
177     }
178
179     Condition : _Gree_Stage_2_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 3
180     {   Condition : weekday{year, month, day} <= 1
181         {     Condition : _Gree_DSR <= 125
182               Value     : 1
183         }
184         Condition : default
185         Value     : _Gree_Trigger_3_On(-1)
186     }
187     Condition : default
188     Value     : _Gree_Trigger_3_On(-1)
```

```
189 }
190
191
192 Set : _Gree_Trigger_2_On
193 {   Condition : _Gree_Trigger_2_On(-1) = 1
194     {   Condition : _Gree_Usable_Stor_Pct >= 100
195         Value     : 0
196
197         Condition : default
198         Value     : _Gree_Trigger_2_On(-1)
199     }
200
201     Condition : _Gree_Stage_1_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 2
202     {   Condition : weekday{year, month, day} <= 1
203         {     Condition : _Gree_DSR <= 150
204             Value     : 1
205         }
206         Condition : default
207         Value     : _Gree_Trigger_2_On(-1)
208     }
209     Condition : default
210     Value     : _Gree_Trigger_2_On(-1)
211 }
212
213
214 Set : _Gree_Trigger_1_On
215 {   Condition : _Gree_Trigger_1_On(-1) = 1
216     {   Condition : _Gree_Usable_Stor_Pct >= 100
217         Value     : 0
218
219         Condition : default
220         Value     : _Gree_Trigger_1_On(-1)
221     }
222
223     Condition : weekday{year, month, day} <= 1
224     {   Condition : _Gree_DSR <= 200 // Note - Drought plan only references 'water levels ... do not conform to
225           //seasonal expectation' - subbed in 200 DSR so trigger would activate
226         Value     : 1
227
228         Condition : default
229         Value     : _Gree_Trigger_1_On(-1)
230     }
231     Condition : default
232     Value     : _Gree_Trigger_1_On(-1)
233 }
234
235 /* High Point */
```

```
Set : _High_Max_Usable_Stor { Value: (upper_rule0220- lower_rule0220) }
Set : _High_Usable_Stor { Value : min { _High_Max_Usable_Stor, storage0220 - lower_rule0220  } }
Set : _High_Usable_Stor_Pct { Value : 100 * _High_Usable_Stor / _High_Max_Usable_Stor }

Set : _High_Trigger_6_On  { Value : 0 }

Set : _High_Trigger_5_On  { Value : 0 }

Set : _High_Trigger_4_On
{   Condition : _High_Trigger_4_On(-1) = 1
    {   Condition : _High_Usable_Stor_Pct >= 100
        Value     : 0

        Condition : default
        Value     : _High_Trigger_4_On(-1)
    }

    Condition : _High_Stage_3_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 4
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : _High_Usable_Stor_Pct < 40
              Value     : 1
        }
        Condition : default
        Value     : _High_Trigger_4_On(-1)
    }
    Condition : default
    Value     : _High_Trigger_4_On(-1)
}

Set : _High_Trigger_3_On
{   Condition : _High_Trigger_3_On(-1) = 1
    {   Condition : _High_Usable_Stor_Pct >= 100
        Value     : 0

        Condition : default
        Value     : _High_Trigger_3_On(-1)
    }

    Condition : _High_Stage_2_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 3
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : _High_Usable_Stor_Pct < 50
              Value     : 1
        }
        Condition : default
        Value     : _High_Trigger_3_On(-1)
    }
    Condition : default
```

```
283     Value     : _High_Trigger_3_On(-1)
284  }
285
286
287  Set : _High_Trigger_2_On
288  {   Condition : _High_Trigger_2_On(-1) = 1
289     {   Condition : _High_Usable_Stor_Pct >= 100
290         Value     : 0
291
292         Condition : default
293         Value     : _High_Trigger_2_On(-1)
294     }
295
296     Condition : _High_Stage_1_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 2
297     {   Condition : weekday{year, month, day} <= 1
298         {     Condition : _High_Usable_Stor_Pct < 60
299               Value     : 1
300         }
301         Condition : default
302         Value     : _High_Trigger_2_On(-1)
303     }
304     Condition : default
305     Value     : _High_Trigger_2_On(-1)
306  }
307
308
309  Set : _High_Trigger_1_On
310  {   Condition : _High_Trigger_1_On(-1) = 1
311     {   Condition : _High_Usable_Stor_Pct >= 100
312         Value     : 0
313
314         Condition : default
315         Value     : _High_Trigger_1_On(-1)
316     }
317
318     Condition : weekday{year, month, day} <= 1
319     {   Condition : _High_Usable_Stor_Pct < 80
320         Value     : 1
321
322         Condition : default
323         Value     : _High_Trigger_1_On(-1)
324     }
325     Condition : default
326     Value     : _High_Trigger_1_On(-1)
327  }
328
329  /* Reidsville */
```

```
Set : _Reid_Max_Usable_Stor { Value : upper_rule0030 - lower_rule0030 }
Set : _Reid_Usable_Stor { Value : min { _Reid_Max_Usable_Stor, storage0030 - lower_rule0030 } }
Set : _Reid_Usable_Stor_Pct { Value : 100 * _Reid_Usable_Stor / _Reid_Max_Usable_Stor }
Set : _Reid_DSR { Value :_Reid_Usable_Stor / (demand0031) }

Set : _Reid_Trigger_6_On { Value : 0 }

Set : _Reid_Trigger_5_On
{   Condition : _Reid_Trigger_5_On(-1) = 1
    {   Condition : _Reid_Usable_Stor_Pct >= 100
        Value     : 0

        Condition : default
        Value     : _Reid_Trigger_5_On(-1)
    }

    Condition : _Reid_Stage_4_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 5
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : _Reid_DSR <= 50
              Value     : 1
        }
        Condition : default
        Value     : _Reid_Trigger_5_On(-1)
    }
    Condition : default
    Value     : _Reid_Trigger_5_On(-1)
}

Set : _Reid_Trigger_4_On
{   Condition : _Reid_Trigger_4_On(-1) = 1
    {   Condition : _Reid_Usable_Stor_Pct >= 100
        Value     : 0

        Condition : default
        Value     : _Reid_Trigger_4_On(-1)
    }

    Condition : _Reid_Stage_3_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 4
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : _Reid_DSR <= 75
              Value     : 1
        }
        Condition : default
        Value     : _Reid_Trigger_4_On(-1)
    }
    Condition : default
    Value     : _Reid_Trigger_4_On(-1)
```

```
}

Set : _Reid_Trigger_3_On
{   Condition : _Reid_Trigger_3_On(-1) = 1
    {   Condition : _Reid_Usable_Stor_Pct >= 100
        Value     : 0

        Condition : default
        Value     : _Reid_Trigger_3_On(-1)
    }

    Condition : _Reid_Stage_2_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 3
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : _Reid_DSR <= 100
              Value     : 1
        }
        Condition : default
        Value     : _Reid_Trigger_3_On(-1)
    }
    Condition : default
    Value     : _Reid_Trigger_3_On(-1)
}


Set : _Reid_Trigger_2_On
{   Condition : _Reid_Trigger_2_On(-1) = 1
    {   Condition : _Reid_Usable_Stor_Pct >= 100
        Value     : 0

        Condition : default
        Value     : _Reid_Trigger_2_On(-1)
    }

    Condition : _Reid_Stage_1_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 2
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : _Reid_DSR <= 125
            Value     : 1
        }
        Condition : default
        Value     : _Reid_Trigger_2_On(-1)
    }
    Condition : default
    Value     : _Reid_Trigger_2_On(-1)
}


Set : _Reid_Trigger_1_On
```

```
{   Condition : _Reid_Trigger_1_On(-1) = 1
    {   Condition : _Reid_Usable_Stor_Pct >= 100
        Value     : 0

        Condition : default
        Value     : _Reid_Trigger_1_On(-1)
    }

    Condition : weekday{year, month, day} <= 1
    {   Condition : _Reid_DSR <= 150
        Value     : 1

        Condition : default
        Value     : _Reid_Trigger_1_On(-1)
    }
    Condition : default
    Value     : _Reid_Trigger_1_On(-1)
}

/* Ramseur */
Set : _Rams_Max_Usable_Stor { Value : upper_rule0300- lower_rule0300 }
Set : _Rams_Usable_Stor { Value : min { _Rams_Max_Usable_Stor, storage0300- lower_rule0300 } }
Set : _Rams_Usable_Stor_Pct { Value : 100 * _Rams_Usable_Stor / _Rams_Max_Usable_Stor }

Set : _Rams_Trigger_6_On {Value : 0 }

Set : _Rams_Trigger_5_On
{   Condition : _Rams_Trigger_5_On(-1) = 1
    {   Condition : _Rams_Usable_Stor_Pct >= 100
        Value     : 0

        Condition : default
        Value     : _Rams_Trigger_5_On(-1)
    }

    Condition : _Rams_Stage_4_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 5
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : _Rams_Usable_Stor_Pct <= 0
              Value     : 1
        }
        Condition : default
        Value     : _Rams_Trigger_5_On(-1)
    }
    Condition : default
    Value     : _Rams_Trigger_5_On(-1)
}

```

```
Set : _Rams_Trigger_4_On
{   Condition : _Rams_Trigger_4_On(-1) = 1
    {   Condition : _Rams_Usable_Stor_Pct >= 100
        Value     : 0

        Condition : default
        Value     : _Rams_Trigger_4_On(-1)
    }

    Condition : _Rams_Stage_3_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 4
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : _Rams_Usable_Stor_Pct < 67
              Value     : 1
        }
        Condition : default
        Value     : _Rams_Trigger_4_On(-1)
    }
    Condition : default
    Value     : _Rams_Trigger_4_On(-1)
}

Set : _Rams_Trigger_3_On
{   Condition : _Rams_Trigger_3_On(-1) = 1
    {   Condition : _Rams_Usable_Stor_Pct >= 100
        Value     : 0

        Condition : default
        Value     : _Rams_Trigger_3_On(-1)
    }

    Condition : _Rams_Stage_2_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 3
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : _Rams_Usable_Stor_Pct < 75
              Value     : 1
        }
        Condition : default
        Value     : _Rams_Trigger_3_On(-1)
    }
    Condition : default
    Value     : _Rams_Trigger_3_On(-1)
}


Set : _Rams_Trigger_2_On
{   Condition : _Rams_Trigger_2_On(-1) = 1
    {   Condition : _Rams_Usable_Stor_Pct >= 100
        Value     : 0
```

```
518
519         Condition : default
520         Value     : _Rams_Trigger_2_On(-1)
521     }
522
523     Condition : _Rams_Stage_1_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 2
524     {   Condition : weekday{year, month, day} <= 1
525         {     Condition : _Rams_Usable_Stor_Pct < 83
526             Value     : 1
527         }
528         Condition : default
529         Value     : _Rams_Trigger_2_On(-1)
530     }
531     Condition : default
532     Value     : _Rams_Trigger_2_On(-1)
533 }
534
535
536 Set : _Rams_Trigger_1_On
537 {   Condition : _Rams_Trigger_1_On(-1) = 1
538     {   Condition : _Rams_Usable_Stor_Pct >= 100
539         Value     : 0
540
541         Condition : default
542         Value     : _Rams_Trigger_1_On(-1)
543     }
544
545     Condition : weekday{year, month, day} <= 1
546     {   Condition : _Rams_Usable_Stor_Pct < 91
547         Value     : 1
548
549         Condition : default
550         Value     : _Rams_Trigger_1_On(-1)
551     }
552     Condition : default
553     Value     : _Rams_Trigger_1_On(-1)
554 }
555
556 /* Graham-Mebane */
557 Set : _GramMeb_Max_Usable_Stor { Value : upper_rule0320 - lower_rule0320 }
558 Set : _GramMeb_Usable_Stor { Value : min { _GramMeb_Max_Usable_Stor, storage0320 - lower_rule0320 } }
559 Set : _GramMeb_Usable_Stor_Pct { Value : 100 * _GramMeb_Usable_Stor / _GramMeb_Max_Usable_Stor }
560 Set : _GramMeb_DSR { Value :_GramMeb_Usable_Stor / (demand0321) }
561
562 Set : _GramMeb_Trigger_6_On { Value : 0 }
563
564 Set : _GramMeb_Trigger_5_On
```

```
565  {   Condition : _GramMeb_Trigger_5_On(-1) = 1
566      {   Condition : _GramMeb_Usable_Stor_Pct >= 100
567          Value     : 0
568
569          Condition : default
570          Value     : _GramMeb_Trigger_5_On(-1)
571      }
572
573      Condition : _GramMeb_Stage_4_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 5
574      {   Condition : weekday{year, month, day} <= 1
575          {     Condition : _GramMeb_DSR <= 30
576                Value     : 1
577          }
578          Condition : default
579          Value     : _GramMeb_Trigger_5_On(-1)
580      }
581      Condition : default
582      Value     : _GramMeb_Trigger_5_On(-1)
583  }
584
585  Set : _GramMeb_Trigger_4_On
586  {   Condition : _GramMeb_Trigger_4_On(-1) = 1
587      {   Condition : _GramMeb_Usable_Stor_Pct >= 100
588          Value     : 0
589
590          Condition : default
591          Value     : _GramMeb_Trigger_4_On(-1)
592      }
593
594      Condition : _GramMeb_Stage_3_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 4
595      {   Condition : weekday{year, month, day} <= 1
596          {     Condition : _GramMeb_DSR <= 60
597                Value     : 1
598          }
599          Condition : default
600          Value     : _GramMeb_Trigger_4_On(-1)
601      }
602      Condition : default
603      Value     : _GramMeb_Trigger_4_On(-1)
604  }
605
606  Set : _GramMeb_Trigger_3_On
607  {   Condition : _GramMeb_Trigger_3_On(-1) = 1
608      {   Condition : _GramMeb_Usable_Stor_Pct >= 100
609          Value     : 0
610
611          Condition : default
```

```
612         Value     : _GramMeb_Trigger_3_On(-1)
613     }
614
615     Condition : _GramMeb_Stage_2_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 3
616     {   Condition : weekday{year, month, day} <= 1
617         {     Condition : _GramMeb_DSR <= 90
618               Value     : 1
619         }
620         Condition : default
621         Value     : _GramMeb_Trigger_3_On(-1)
622     }
623     Condition : default
624     Value     : _GramMeb_Trigger_3_On(-1)
625 }
626
627
628 Set : _GramMeb_Trigger_2_On
629 {   Condition : _GramMeb_Trigger_2_On(-1) = 1
630     {   Condition : _GramMeb_Usable_Stor_Pct >= 100
631         Value     : 0
632
633         Condition : default
634         Value     : _GramMeb_Trigger_2_On(-1)
635     }
636
637     Condition : _GramMeb_Stage_1_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 2
638     {   Condition : weekday{year, month, day} <= 1
639         {     Condition : _GramMeb_DSR <= 120
640               Value     : 1
641         }
642         Condition : default
643         Value     : _GramMeb_Trigger_2_On(-1)
644     }
645     Condition : default
646     Value     : _GramMeb_Trigger_2_On(-1)
647 }
648
649
650 Set : _GramMeb_Trigger_1_On
651 {   Condition : _GramMeb_Trigger_1_On(-1) = 1
652     {   Condition : _GramMeb_Usable_Stor_Pct >= 100
653         Value     : 0
654
655         Condition : default
656         Value     : _GramMeb_Trigger_1_On(-1)
657     }
658
```

```
659     Condition : weekday{year, month, day} <= 1
660     {   Condition : _GramMeb_DSR <= 150
661         Value     : 1
662
663         Condition : default
664         Value     : _GramMeb_Trigger_1_On(-1)
665     }
666     Condition : default
667     Value     : _GramMeb_Trigger_1_On(-1)
668 }
669
670 /* Siler City */
671
672 Set : _Siler_Trigger_6_On  { Value : 0 }
673 Set : _Siler_Trigger_5_On  { Value : 0 }
674
675 Set : _Siler_Trigger_4_On
676 {   Condition : _Siler_Trigger_4_On(-1) = 1
677     {   Condition : _SilerCity_UsableStorPct >= 100
678         Value     : 0
679
680         Condition : default
681         Value     : _Siler_Trigger_4_On(-1)
682     }
683
684     Condition : _Siler_Stage_3_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 4
685     {   Condition : weekday{year, month, day} <= 1
686         {     Condition : _SilerCity_UsableStorPct < 10
687               Value     : 1
688         }
689         Condition : default
690         Value     : _Siler_Trigger_4_On(-1)
691     }
692     Condition : default
693     Value     : _Siler_Trigger_4_On(-1)
694 }
695
696 Set : _Siler_Trigger_3_On
697 {   Condition : _Siler_Trigger_3_On(-1) = 1
698     {   Condition : _SilerCity_UsableStorPct >= 100
699         Value     : 0
700
701         Condition : default
702         Value     : _Siler_Trigger_3_On(-1)
703     }
704
705     Condition : _Siler_Stage_2_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 3
```

```
706     {   Condition : weekday{year, month, day} <= 1
707         {     Condition : _SilerCity_UsableStorPct < 20
708               Value     : 1
709         }
710         Condition : default
711         Value     : _Siler_Trigger_3_On(-1)
712     }
713     Condition : default
714     Value     : _Siler_Trigger_3_On(-1)
715 }
716
717
718 Set : _Siler_Trigger_2_On
719 {   Condition : _Siler_Trigger_2_On(-1) = 1
720     {   Condition : _SilerCity_UsableStorPct >= 100
721         Value     : 0
722
723         Condition : default
724         Value     : _Siler_Trigger_2_On(-1)
725     }
726
727     Condition : _Siler_Stage_1_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 2
728     {   Condition : weekday{year, month, day} <= 1
729         {     Condition : _SilerCity_UsableStorPct < 40
730               Value     : 1
731         }
732         Condition : default
733         Value     : _Siler_Trigger_2_On(-1)
734     }
735     Condition : default
736     Value     : _Siler_Trigger_2_On(-1)
737 }
738
739
740 Set : _Siler_Trigger_1_On
741 {   Condition : _Siler_Trigger_1_On(-1) = 1
742     {   Condition : _SilerCity_UsableStorPct >= 100
743         Value     : 0
744
745         Condition : default
746         Value     : _Siler_Trigger_1_On(-1)
747     }
748
749     Condition : weekday{year, month, day} <= 1
750     {   Condition : _SilerCity_UsableStorPct < 70
751         Value     : 1
752
```

```
753         Condition : default
754         Value     : _Siler_Trigger_1_On(-1)
755       }
756       Condition : default
757       Value     : _Siler_Trigger_1_On(-1)
758   }
759
760   /* Pittsboro - based on intake pool elevation, cannot model without more information */
761
762   /* Cary-Apex */
763   Set : _Cary_DSR
764   {   Condition : abs_period <= 2
765       Value     : ([Starting_Storage_CaryAp] + [Starting_Storage_RTP] + [Starting_Storage_Morris]) / (demand0471 + demand0474 + demand0477)
766
767       Condition : default
768       Value     : (_Storage_CaryAp(-1) + _Storage_RTP(-1) + _Storage_Morris(-1))
769       / ( ( accumulate {demand0471, -30,-1} + accumulate{demand0474, -30, -1} + accumulate {demand0477, -30, -1} ) / 30 )
770   }
771
772   Set : _Cary_Trigger_6_On  { Value : 0 }
773   Set : _Cary_Trigger_5_On  { Value : 0 }
774
775   Set : _Cary_Trigger_4_On
776   {   Condition : _Cary_Trigger_4_On(-1) = 1
777       {   // condition needs to be met for 14 consecutive days
778     Condition : _Cary_DSR(-14) >= 60 and _Cary_DSR(-13) >= 60 and _Cary_DSR(-12) >= 60  and _Cary_DSR(-11) >= 60
779       and _Cary_DSR(-10) >= 60  and _Cary_DSR(-9) >= 60 and _Cary_DSR(-8) >= 60 and _Cary_DSR(-7) >= 60
780       and _Cary_DSR(-6) >= 60  and _Cary_DSR(-5) >= 60  and _Cary_DSR(-4) >= 60   and _Cary_DSR(-3) >= 60
781       and _Cary_DSR(-2) >= 60 and _Cary_DSR(-1) >= 60
782         Value     : 0
783
784         Condition : default
785         Value     : _Cary_Trigger_4_On(-1)
786       }
787
788       Condition : _Cary_Stage_3_Counter(-1) >= 1   // No waiting period required for stage 4
789       {   Condition : weekday{year, month, day} <= 1
790         {     Condition : _Cary_DSR <= 30
791               Value     : 1
792         }
793         Condition : default
794         Value     : _Cary_Trigger_4_On(-1)
795       }
796       Condition : default
797       Value     : _Cary_Trigger_4_On(-1)
798   }
799
```

```
Set : _Cary_Trigger_3_On
{   Condition : _Cary_Trigger_3_On(-1) = 1
    { // condition needs to be met for 14 consecutive days
   Condition : _Cary_DSR(-14) >= 90 and _Cary_DSR(-13) >= 90 and _Cary_DSR(-12) >= 90  and _Cary_DSR(-11) >= 90
     and _Cary_DSR(-10) >= 90  and _Cary_DSR(-9) >= 90 and _Cary_DSR(-8) >= 90 and _Cary_DSR(-7) >= 90
     and _Cary_DSR(-6) >= 90  and _Cary_DSR(-5) >= 90  and _Cary_DSR(-4) >= 90   and _Cary_DSR(-3) >= 90
     and _Cary_DSR(-2) >= 90 and _Cary_DSR(-1) >= 90
       Value     : 0


       Condition : default
       Value     : _Cary_Trigger_3_On(-1)
    }

    Condition : _Cary_Stage_2_Counter(-1) >= 1   // No waiting period required for stage 3
    {   Condition : weekday{year, month, day} <= 1
       {     Condition : _Cary_DSR <= 60
            Value     : 1
       }
       Condition : default
       Value     : _Cary_Trigger_3_On(-1)
    }
    Condition : default
    Value     : _Cary_Trigger_3_On(-1)
}


Set : _Cary_Trigger_2_On
{   Condition : _Cary_Trigger_2_On(-1) = 1
    {   // condition needs to be met for 14 consecutive days
   Condition : _Cary_DSR(-14) >= 120 and _Cary_DSR(-13) >= 120 and _Cary_DSR(-12) >= 120  and _Cary_DSR(-11) >= 120
     and _Cary_DSR(-10) >= 120 and _Cary_DSR(-9) >= 120 and _Cary_DSR(-8) >= 120 and _Cary_DSR(-7) >= 120
     and _Cary_DSR(-6) >= 120  and _Cary_DSR(-5) >= 120 and _Cary_DSR(-4) >= 120   and _Cary_DSR(-3) >= 120
     and _Cary_DSR(-2) >= 120 and _Cary_DSR(-1) >= 120
       Value     : 0

       Condition : default
       Value     : _Cary_Trigger_2_On(-1)
    }

    Condition : _Cary_Stage_1_Counter(-1) >= 28   // Require a 28 day waiting period before going into phase 2
    {   Condition : weekday{year, month, day} <= 1
       {     Condition : _Cary_DSR <= 90
          Value     : 1
       }
       Condition : default
       Value     : _Cary_Trigger_2_On(-1)
```

```
847     }
848     Condition : default
849     Value     : _Cary_Trigger_2_On(-1)
850  }
851
852
853  Set : _Cary_Trigger_1_On
854  {   Condition : _Cary_Trigger_1_On(-1) = 1
855     {   /* condition needs to be met for 14 consecutive days.  WSRP refers to "Jordan Lake Water Supply allocation has been 100% full"
856     -  assume that is each of the three accounts that go into the calculation of DSR.*/
857    Condition : (_Stor_Final_Pct_CaryAp(-14) >= 100  and _Stor_Final_Pct_CaryAp(-13) >= 100 and _Stor_Final_Pct_CaryAp(-12) >= 100
858       and _Stor_Final_Pct_CaryAp(-11) >= 100 and _Stor_Final_Pct_CaryAp(-10) >= 100 and  _Stor_Final_Pct_CaryAp(-9) >= 100
859       and _Stor_Final_Pct_CaryAp(-8) >= 100  and _Stor_Final_Pct_CaryAp(-7) >= 100  and _Stor_Final_Pct_CaryAp(-6) >= 100
860       and _Stor_Final_Pct_CaryAp(-5) >= 100  and _Stor_Final_Pct_CaryAp(-4) >= 100  and _Stor_Final_Pct_CaryAp(-3) >= 100
861       and _Stor_Final_Pct_CaryAp(-2) >= 100  and _Stor_Final_Pct_CaryAp(-1) >= 100 )
862      and (_Stor_Final_Pct_RTP(-14) >= 100  and _Stor_Final_Pct_RTP(-13) >= 100 and _Stor_Final_Pct_RTP(-12) >= 100
863       and _Stor_Final_Pct_RTP(-11) >= 100 and _Stor_Final_Pct_RTP(-10) >= 100 and _Stor_Final_Pct_RTP(-9) >= 100
864       and _Stor_Final_Pct_RTP(-8) >= 100  and _Stor_Final_Pct_RTP(-7) >= 100  and _Stor_Final_Pct_RTP(-6) >= 100
865       and _Stor_Final_Pct_RTP(-5) >= 100  and _Stor_Final_Pct_RTP(-4) >= 100   and _Stor_Final_Pct_RTP(-3) >= 100
866       and _Stor_Final_Pct_RTP(-2) >= 100  and _Stor_Final_Pct_RTP(-1) >= 100 )
867      and (_Stor_Final_Pct_Morris(-14) >= 100  and _Stor_Final_Pct_Morris(-13) >= 100 and _Stor_Final_Pct_Morris(-12) >= 100
868       and _Stor_Final_Pct_Morris(-11) >= 100 and _Stor_Final_Pct_Morris(-10) >= 100 and _Stor_Final_Pct_Morris(-9) >= 100
869       and _Stor_Final_Pct_Morris(-8) >= 100  and _Stor_Final_Pct_Morris(-7) >= 100  and _Stor_Final_Pct_Morris(-6) >= 100
870       and _Stor_Final_Pct_Morris(-5) >= 100  and _Stor_Final_Pct_Morris(-4) >= 100   and _Stor_Final_Pct_Morris(-3) >= 100
871       and _Stor_Final_Pct_Morris(-2) >= 100  and _Stor_Final_Pct_Morris(-1) >= 100 )
872         Value     : 0
873
874         Condition : default
875         Value     : _Cary_Trigger_1_On(-1)
876     }
877
878     Condition : weekday{year, month, day} <= 1
879     {   /* the plan calls for turning on trigger 1 if DSR <= 120 days.  However, for the 2055 demand year, the demands are high enough
880    to cause the trigger to be met even if the storage account is full.So add in a condition that trigger can only turn on if
881    the DSR condition is met and storage in the Cary account is <= 80%.  */
882    Condition : _Cary_DSR <= 120 and _Stor_Final_Pct_CaryAp(-1) < 80
883         Value     : 1
884
885         Condition : default
886         Value     : _Cary_Trigger_1_On(-1)
887     }
888     Condition : default
889     Value     : _Cary_Trigger_1_On(-1)
890  }
891
892  /* Chatham North */
893  Set : _ChatNo_Usable_Stor_Pct
```

```
{   Condition : abs_period <= 1
    Value     : 100

    Condition : default
    Value     : _Stor_Final_Pct_Chatham(-1)
}

Set : _ChatNo_Trigger_6_On  {Value : 0 }

Set : _ChatNo_Trigger_5_On
{   Condition : _ChatNo_Trigger_5_On(-1) = 1
    {   Condition : _ChatNo_Usable_Stor_Pct >= 100
        Value     : 0

        Condition : default
        Value     : _ChatNo_Trigger_5_On(-1)
    }

    Condition : _ChatNo_Stage_4_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 5
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : _ChatNo_Usable_Stor_Pct < 0
              Value     : 1
        }
        Condition : default
        Value     : _ChatNo_Trigger_5_On(-1)
    }
    Condition : default
    Value     : _ChatNo_Trigger_5_On(-1)
}

Set : _ChatNo_Trigger_4_On
{   Condition : _ChatNo_Trigger_4_On(-1) = 1
    {   Condition : _ChatNo_Usable_Stor_Pct >= 100
        Value     : 0

        Condition : default
        Value     : _ChatNo_Trigger_4_On(-1)
    }

    Condition : _ChatNo_Stage_3_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 4
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : _ChatNo_Usable_Stor_Pct < 30
              Value     : 1
        }
        Condition : default
        Value     : _ChatNo_Trigger_4_On(-1)
    }
```

```
941     Condition : default
942     Value     : _ChatNo_Trigger_4_On(-1)
943  }
944
945  Set : _ChatNo_Trigger_3_On
946  {   Condition : _ChatNo_Trigger_3_On(-1) = 1
947     {   Condition : _ChatNo_Usable_Stor_Pct >= 100
948        Value     : 0
949
950        Condition : default
951        Value     : _ChatNo_Trigger_3_On(-1)
952     }
953
954     Condition : _ChatNo_Stage_2_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 3
955     {   Condition : weekday{year, month, day} <= 1
956        {     Condition : _ChatNo_Usable_Stor_Pct < 50
957              Value     : 1
958        }
959        Condition : default
960        Value     : _ChatNo_Trigger_3_On(-1)
961     }
962     Condition : default
963     Value     : _ChatNo_Trigger_3_On(-1)
964  }
965
966
967  Set : _ChatNo_Trigger_2_On
968  {   Condition : _ChatNo_Trigger_2_On(-1) = 1
969     {   Condition : _ChatNo_Usable_Stor_Pct >= 100
970        Value     : 0
971
972        Condition : default
973        Value     : _ChatNo_Trigger_2_On(-1)
974     }
975
976     Condition : _ChatNo_Stage_1_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 2
977     {   Condition : weekday{year, month, day} <= 1
978        {     Condition : _ChatNo_Usable_Stor_Pct < 65
979           Value     : 1
980        }
981        Condition : default
982        Value     : _ChatNo_Trigger_2_On(-1)
983     }
984     Condition : default
985     Value     : _ChatNo_Trigger_2_On(-1)
986  }
987
```

```
988
989 Set : _ChatNo_Trigger_1_On
990 {   Condition : _ChatNo_Trigger_1_On(-1) = 1
991     {   Condition : _ChatNo_Usable_Stor_Pct >= 100
992         Value     : 0
993
994         Condition : default
995         Value     : _ChatNo_Trigger_1_On(-1)
996     }
997
998     Condition : weekday{year, month, day} <= 1
999     {   Condition : _ChatNo_Usable_Stor_Pct < 75
1000        Value     : 1
1001
1002        Condition : default
1003        Value     : _ChatNo_Trigger_1_On(-1)
1004    }
1005    Condition : default
1006    Value     : _ChatNo_Trigger_1_On(-1)
1007 }
1008
1009 /* Sanford - demand/production based - not modeled */
1010
1011 /* Harnett Co. - mostly demand based - not modeled */
1012
1013
1014 /* Dunn */
1015
1016 Set : _Dunn_Trigger_6_On
1017 {   Condition : _Dunn_Trigger_5_On(-1) = 1
1018    {   Condition : flow0555.0650 > convert_units { 100, cfs, af }
1019        Value     : 0
1020
1021        Condition : default
1022        Value     : _Dunn_Trigger_6_On(-1)
1023    }
1024
1025    Condition : _Dunn_Stage_5_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 4
1026    {   Condition : weekday{year, month, day} <= 1
1027        {     Condition : flow0555.0650 < convert_units { 100, cfs, af } and flow0555.0650(-1) < convert_units { 100, cfs, af } and
1028                    flow0555.0650(-2) < convert_units { 100, cfs, af } and flow0555.0650(-3) < convert_units { 100, cfs, af } and
1029                    flow0555.0650(-4) < convert_units { 100, cfs, af }
1030            Value     : 1
1031        }
1032        Condition : default
1033        Value     : _Dunn_Trigger_6_On(-1)
1034    }
```

```
1035     Condition : default
1036     Value     : _Dunn_Trigger_6_On(-1)
1037  }
1038
1039  Set : _Dunn_Trigger_5_On
1040  {   Condition : _Dunn_Trigger_5_On(-1) = 1
1041     {   Condition : flow0555.0650 > convert_units { 125, cfs, af }
1042        Value     : 0
1043
1044        Condition : default
1045        Value     : _Dunn_Trigger_5_On(-1)
1046     }
1047
1048     Condition : _Dunn_Stage_4_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 4
1049     {   Condition : weekday{year, month, day} <= 1
1050        {     Condition : flow0555.0650 < convert_units { 125, cfs, af } and flow0555.0650(-1) < convert_units { 125, cfs, af } and
1051                    flow0555.0650(-2) < convert_units { 125, cfs, af } and flow0555.0650(-3) < convert_units { 125, cfs, af } and
1052                    flow0555.0650(-4) < convert_units { 125, cfs, af }
1053           Value     : 1
1054        }
1055        Condition : default
1056        Value     : _Dunn_Trigger_5_On(-1)
1057     }
1058     Condition : default
1059     Value     : _Dunn_Trigger_5_On(-1)
1060  }
1061
1062  Set : _Dunn_Trigger_4_On
1063  {   Condition : _Dunn_Trigger_4_On(-1) = 1
1064     {   Condition : flow0555.0650 > convert_units { 150, cfs, af }
1065        Value     : 0
1066
1067        Condition : default
1068        Value     : _Dunn_Trigger_4_On(-1)
1069     }
1070
1071     Condition : _Dunn_Stage_3_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 4
1072     {   Condition : weekday{year, month, day} <= 1
1073        {     Condition : flow0555.0650 < convert_units { 150, cfs, af } and flow0555.0650(-1) < convert_units { 150, cfs, af } and
1074                    flow0555.0650(-2) < convert_units { 150, cfs, af } and flow0555.0650(-3) < convert_units { 150, cfs, af } and
1075                    flow0555.0650(-4) < convert_units { 150, cfs, af }
1076           Value     : 1
1077        }
1078        Condition : default
1079        Value     : _Dunn_Trigger_4_On(-1)
1080     }
1081     Condition : default
```

```
    Value     : _Dunn_Trigger_4_On(-1)
}

Set : _Dunn_Trigger_3_On
{   Condition : _Dunn_Trigger_3_On(-1) = 1
    {   Condition : flow0555.0650 > convert_units { 175, cfs, af }
        Value     : 0

        Condition : default
        Value     : _Dunn_Trigger_3_On(-1)
    }

    Condition : _Dunn_Stage_2_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 3
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : flow0555.0650 < convert_units { 175, cfs, af } and flow0555.0650(-1) < convert_units { 175, cfs, af } and
                    flow0555.0650(-2) < convert_units { 175, cfs, af } and flow0555.0650(-3) < convert_units { 175, cfs, af } and
                    flow0555.0650(-4) < convert_units { 175, cfs, af }
            Value     : 1
        }
        Condition : default
        Value     : _Dunn_Trigger_3_On(-1)
    }
    Condition : default
    Value     : _Dunn_Trigger_3_On(-1)
}


Set : _Dunn_Trigger_2_On
{   Condition : _Dunn_Trigger_2_On(-1) = 1
    {   Condition : flow0555.0650 > convert_units { 200, cfs, af }
        Value     : 0

        Condition : default
        Value     : _Dunn_Trigger_2_On(-1)
    }

    Condition : _Dunn_Stage_1_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 2
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : flow0555.0650 < convert_units { 200, cfs, af } and flow0555.0650(-1) < convert_units { 200, cfs, af } and
                    flow0555.0650(-2) < convert_units { 200, cfs, af } and flow0555.0650(-3) < convert_units { 200, cfs, af } and
                    flow0555.0650(-4) < convert_units { 200, cfs, af }
            Value     : 1
        }
        Condition : default
        Value     : _Dunn_Trigger_2_On(-1)
    }
    Condition : default
```

```
    Value     : _Dunn_Trigger_2_On(-1)
}


Set : _Dunn_Trigger_1_On
{   Condition : _Dunn_Trigger_1_On(-1) = 1
    {   Condition : flow0555.0650 > convert_units { 225, cfs, af }
        Value     : 0

        Condition : default
        Value     : _Dunn_Trigger_1_On(-1)
    }

    // Assume no waiting period since Dunn_Trigger 1 only drought alert
    Condition : weekday{year, month, day} <= 1
    {   Condition : flow0555.0650 < convert_units { 225, cfs, af } and flow0555.0650(-1) < convert_units { 225, cfs, af } and
                    flow0555.0650(-2) < convert_units { 225, cfs, af } and flow0555.0650(-3) < convert_units { 225, cfs, af } and
                    flow0555.0650(-4) < convert_units { 225, cfs, af }
        Value     : 1

        Condition : default
        Value     : _Dunn_Trigger_1_On(-1)
    }
    Condition : default
    Value     : _Dunn_Trigger_1_On(-1)
}

/* Benson - triggers follow those of Dunn - their main supplier */

Set : _Benson_Trigger_6_On
{       Condition : default
        Value     : _Dunn_Trigger_6_On
}

Set : _Benson_Trigger_5_On
{       Condition : default
        Value     : _Dunn_Trigger_5_On
}

Set : _Benson_Trigger_4_On
{       Condition : default
        Value     : _Dunn_Trigger_4_On
}

Set : _Benson_Trigger_3_On
{       Condition : default
        Value     : _Dunn_Trigger_3_On
```

```
}

Set : _Benson_Trigger_2_On
{       Condition : default
        Value     : _Dunn_Trigger_2_On
}

Set : _Benson_Trigger_1_On
{       Condition : default
        Value     : _Dunn_Trigger_1_On
}




/* Carthage - Trigger based on Nicks Creek - using arc 700.710 Little River_Linden gage in model since that is where their WD is from */
Set : _Carth_Trigger_6_On  {Value : 0}
Set : _Carth_Trigger_5_On  {Value : 0}

Set : _Carth_Trigger_4_On
{   Condition : _Carth_Trigger_4_On(-1) = 1
    {   Condition : flow0700.0710 > convert_units { 0.50, cfs, af }
        Value     : 0

        Condition : default
        Value     : _Carth_Trigger_4_On(-1)
    }

    Condition : _Carth_Stage_3_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 4
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : flow0700.0710 < convert_units { 0.50, cfs, af }
              Value     : 1
        }
        Condition : default
        Value     : _Carth_Trigger_4_On(-1)
    }
    Condition : default
    Value     : _Carth_Trigger_4_On(-1)
}

Set : _Carth_Trigger_3_On
{   Condition : _Carth_Trigger_3_On(-1) = 1
    {   Condition : flow0700.0710 > convert_units { 1.50, cfs, af }
        Value     : 0

        Condition : default
```

```
      Value     : _Carth_Trigger_3_On(-1)
   }

   Condition : _Carth_Stage_2_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 3
   {   Condition : weekday{year, month, day} <= 1
      {     Condition : flow0700.0710 < convert_units { 1.50, cfs, af } and flow0700.0710(-1) < convert_units { 1.50, cfs, af } and
                  flow0700.0710(-2) < convert_units { 1.50, cfs, af }
         Value     : 1
      }
      Condition : default
      Value     : _Carth_Trigger_3_On(-1)
   }
   Condition : default
   Value     : _Carth_Trigger_3_On(-1)
}


Set : _Carth_Trigger_2_On
{   Condition : _Carth_Trigger_2_On(-1) = 1
   {   Condition : flow0700.0710 > convert_units { 2.40, cfs, af }
      Value     : 0

      Condition : default
      Value     : _Carth_Trigger_2_On(-1)
   }

   Condition : _Carth_Stage_1_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 2
   {   Condition : weekday{year, month, day} <= 1
      {     Condition : flow0700.0710 < convert_units { 2.40, cfs, af } and flow0700.0710(-1) < convert_units { 2.40, cfs, af } and
                  flow0700.0710(-2) < convert_units { 2.40, cfs, af }
         Value     : 1
      }
      Condition : default
      Value     : _Carth_Trigger_2_On(-1)
   }
   Condition : default
   Value     : _Carth_Trigger_2_On(-1)
}


Set : _Carth_Trigger_1_On
{   Condition : _Carth_Trigger_1_On(-1) = 1
   {   Condition : flow0700.0710 > convert_units { 3, cfs, af }
      Value     : 0

      Condition : default
      Value     : _Carth_Trigger_1_On(-1)
```

```
1270     }
1271
1272     // Assume no waiting period since Carth_Trigger 1 only drought alert
1273     Condition : weekday{year, month, day} <= 1
1274     {   Condition : flow0700.0710 < convert_units { 3, cfs, af } and flow0700.0710(-1) < convert_units { 3, cfs, af } and
1275                 flow0700.0710(-2) < convert_units { 3, cfs, af } and flow0700.0710(-3) < convert_units { 3, cfs, af } and
1276                 flow0700.0710(-4) < convert_units { 3, cfs, af } and flow0700.0710(-5) < convert_units { 3, cfs, af } and
1277                 flow0700.0710(-6) < convert_units { 3, cfs, af }
1278         Value     : 1
1279
1280         Condition : default
1281         Value     : _Carth_Trigger_1_On(-1)
1282     }
1283     Condition : default
1284     Value     : _Carth_Trigger_1_On(-1)
1285 }
1286
1287 /* Fayetteville - mostly demand based (w/ one Lillington trigger), so leaving out for now */
1288
1289
1290
1291 /*  This section sets/resets the counters used to maintain the proper spacing of conservation stages */
1292
1293 :For:
1294 { [Util] = { Burl, Gree, High, Reid, Rams, GramMeb, Siler, Cary, ChatNo, Dunn, Carth, Benson }
1295 }
1296
1297 :For:
1298 {   [trig] = {1, 2, 3, 4, 5, 6}
1299 }
1300
1301 Set : _[Util]_Stage_[trig]_Counter
1302 {   Condition : _[Util]_Stage_[trig]_Counter(-1) > 0 and _[Util]_Trigger_[trig]_On = 0
1303     Value     : 0
1304
1305     Condition : _[Util]_Trigger_[trig]_On = 1
1306     Value     : _[Util]_Stage_[trig]_Counter(-1) + 1
1307
1308     Condition : default
1309     Value     : _[Util]_Stage_[trig]_Counter(-1)
1310 }
1311
1312 /*  Count all trigger events lasting at least 7 days */
1313
1314 Set : _[Util]_Ph_[trig]_event_counter
1315 {   Condition : _[Util]_Stage_[trig]_Counter = 7 and _[Util]_Stage_[trig]_Counter(-1) = 6
1316     Value     : _[Util]_Ph_[trig]_event_counter(-1) + 1
```

```
1317
1318     Condition : default
1319     Value     : _[Util]_Ph_[trig]_event_counter(-1)
1320  }
1321
1322  :Next:
1323
1324  :Next:
1325
1326
1327  // Set conservation demand and delivery constraints for each trigger level in effect.
1328
1329  // Set demand reduction factors
1330  :SUBSTITUTE: [Dem_1_Red_Factor] = 5
1331  :SUBSTITUTE: [Dem_2_Red_Factor] = 10
1332  :SUBSTITUTE: [Dem_3_Red_Factor] = 20
1333  :SUBSTITUTE: [Dem_4_Red_Factor] = 25
1334  :SUBSTITUTE: [Dem_5_Red_Factor] = 35
1335  :SUBSTITUTE: [Dem_6_Red_Factor] = 50
1336
1337  :For:
1338  {   [trig] = {1, 2, 3, 4, 5, 6}
1339  }
1340
1341
1342
1343  // Burlington
1344  Set : _Burl2_Consvn_[trig]_Demand
1345  {   Condition : _Burl_Trigger_[trig]_On = 1
1346     Value     : Demand0341 *  ( 1 - [Dem_[trig]_Red_Factor] / 100 )
1347
1348     Condition : default
1349     Value     : Demand0341
1350  }
1351
1352  Constraint   Burl2_Demand_Limit_Consvn_[trig] :
1353            {   Condition  :  _Burl_Trigger_[trig]_On = 1
1354               Expression :  dflow0071.0341 <= _Burl2_Consvn_[trig]_Demand }
1355
1356  // Greensboro
1357  Set : _Gree2_Consvn_[trig]_Demand
1358  {   Condition : _Gree_Trigger_[trig]_On = 1
1359     Value     : Demand0123 *  ( 1 - [Dem_[trig]_Red_Factor] / 100 )
1360
1361     Condition : default
1362     Value     : Demand0123
1363  }
```

```
1364
1365 Constraint   Gree2_Demand_Limit_Consvn_[trig] :
1366           {   Condition  :  _Gree_Trigger_[trig]_On = 1
1367               Expression :  dflow0121.0123 <= _Gree2_Consvn_[trig]_Demand }
1368
1369 // High Point
1370 Set : _High_Consvn_[trig]_Demand
1371 {   Condition : _High_Trigger_[trig]_On = 1
1372     Value     : Demand0223 *  ( 1 - [Dem_[trig]_Red_Factor] / 100 )
1373
1374     Condition : default
1375     Value     : Demand0223
1376 }
1377
1378 Constraint   High_Demand_Limit_Consvn_[trig] :
1379           {   Condition  :  _High_Trigger_[trig]_On = 1
1380               Expression :  dflow0220.0221 <= _High_Consvn_[trig]_Demand }
1381
1382 // Reidsville
1383 Set : _Reid_Consvn_[trig]_Demand
1384 {   Condition : _Reid_Trigger_[trig]_On = 1
1385     Value     : Demand0031 *  ( 1 - [Dem_[trig]_Red_Factor] / 100 )
1386
1387     Condition : default
1388     Value     : Demand0031
1389 }
1390
1391 Constraint   Reid_Demand_Limit_Consvn_[trig] :
1392           {   Condition  :  _Reid_Trigger_[trig]_On = 1
1393               Expression :  dflow0029.0031 <= _Reid_Consvn_[trig]_Demand }
1394
1395 // Ramseur
1396 Set : _Rams_Consvn_[trig]_Demand
1397 {   Condition : _Rams_Trigger_[trig]_On = 1
1398     Value     : Demand0301 *  ( 1 - [Dem_[trig]_Red_Factor] / 100 )
1399
1400     Condition : default
1401     Value     : Demand0301
1402 }
1403
1404 Constraint   Rams_Demand_Limit_Consvn_[trig] :
1405           {   Condition  :  _Rams_Trigger_[trig]_On = 1
1406               Expression :  dflow0300.0301 <= _Rams_Consvn_[trig]_Demand }
1407
1408 // Graham-Mebane
1409 Set : _GramMeb_Consvn_[trig]_Demand
1410 {   Condition : _GramMeb_Trigger_[trig]_On = 1
```

```
    Value     : Demand0321 *  ( 1 - [Dem_[trig]_Red_Factor] / 100 )

    Condition : default
    Value     : Demand0321
}

Constraint   GramMeb_Demand_Limit_Consvn_[trig] :
          {   Condition  :  _GramMeb_Trigger_[trig]_On = 1
              Expression :  dflow0319.0321 <= _GramMeb_Consvn_[trig]_Demand }

// Siler City
Set : _Siler_Consvn_[trig]_Demand
{   Condition : _Siler_Trigger_[trig]_On = 1
    Value     : Demand0327 *  ( 1 - [Dem_[trig]_Red_Factor] / 100 )

    Condition : default
    Value     : Demand0327
}

Constraint   Siler_Demand_Limit_Consvn_[trig] :
          {   Condition  :  _Siler_Trigger_[trig]_On = 1
              Expression :  dflow0325.0327 <= _Siler_Consvn_[trig]_Demand }

// Chatham-North
Set : _ChatNo_Consvn_[trig]_Demand
{   Condition : _ChatNo_Trigger_[trig]_On = 1
    Value     : Demand0473 *  ( 1 - [Dem_[trig]_Red_Factor] / 100 )

    Condition : default
    Value     : Demand0473
}

Constraint   ChatNo_Demand_Limit_Consvn_[trig] :
          {   Condition  :  _ChatNo_Trigger_[trig]_On = 1
              Expression :  dflow0470.0473 <= _ChatNo_Consvn_[trig]_Demand }

// Dunn
Set : _Dunn_Consvn_[trig]_Demand
{   Condition : _Dunn_Trigger_[trig]_On = 1
    Value     : Demand0663 *  ( 1 - [Dem_[trig]_Red_Factor] / 100 )

    Condition : default
    Value     : Demand0663
}

Constraint   Dunn_Demand_Limit_Consvn_[trig] :
          {   Condition  :  _Dunn_Trigger_[trig]_On = 1
```

```
1458              Expression :  dflow0662.0663 <= _Dunn_Consvn_[trig]_Demand }
1459
1460  //Benson
1461  Set : _Benson_Consvn_[trig]_Demand
1462  {   Condition : _Benson_Trigger_[trig]_On = 1
1463      Value     : Demand1756 *  ( 1 - [Dem_[trig]_Red_Factor] / 100 )
1464
1465      Condition : default
1466      Value     : Demand1756
1467  }
1468
1469  Constraint   Benson_Demand_Limit_Consvn_[trig] :
1470            {   Condition  :  _Benson_Trigger_[trig]_On = 1
1471                Expression :  dflow0662.1756 <= _Benson_Consvn_[trig]_Demand }
1472
1473  // Carthage
1474  Set : _Carth_Consvn_[trig]_Demand
1475  {   Condition : _Carth_Trigger_[trig]_On = 1
1476      Value     : Demand0701 *  ( 1 - [Dem_[trig]_Red_Factor] / 100 )
1477
1478      Condition : default
1479      Value     : Demand0701
1480  }
1481
1482  Constraint   Carth_Demand_Limit_Consvn_[trig] :
1483            {   Condition  :  _Carth_Trigger_[trig]_On = 1
1484                Expression :  dflow0700.0701 <= _Carth_Consvn_[trig]_Demand }
1485
1486
1487  :Next:
1488
1489  // Set Cary's Consv Demand - differs seasonally
1490
1491  Set : _Cary_Consvn_1_Demand
1492  {
1493      Condition : month > 4 and month < 11 and _Cary_Trigger_1_On = 1
1494      Value     : Demand0471 * ( 1 - 13 / 100 )
1495
1496      Condition : _Cary_Trigger_1_On = 1
1497      Value     : Demand0471 * ( 1 - 6 / 100 )
1498
1499      Condition : default
1500      Value     : Demand0471
1501  }
1502
1503  Set : _Cary_Consvn_2_Demand
1504  {
```

```
    Condition : month > 4 and month < 11 and _Cary_Trigger_2_On = 1
    Value     : Demand0471 * ( 1 - 32 / 100 )

    Condition : _Cary_Trigger_2_On = 1
    Value     : Demand0471 * ( 1 - 10 / 100 )

    Condition : default
    Value     : Demand0471
}

Set : _Cary_Consvn_3_Demand
{
    Condition : month > 4 and month < 11 and _Cary_Trigger_3_On = 1
    Value     : Demand0471 * ( 1 - 38 / 100 )

    Condition : _Cary_Trigger_3_On = 1
    Value     : Demand0471 * ( 1 - 17 / 100 )

    Condition : default
    Value     : Demand0471
}

Set : _Cary_Consvn_4_Demand
{
    Condition : month > 4 and month < 11 and _Cary_Trigger_4_On = 1
    Value     : Demand0471 * ( 1 - 46 / 100 )

    Condition : _Cary_Trigger_4_On = 1
    Value     : Demand0471 * ( 1 - 29 / 100 )

    Condition : default
    Value     : Demand0471
}

:For:
{   [trig] = {1, 2, 3, 4}
}

Constraint   Cary_Demand_Limit_Consvn_[trig] :
{   Condition  :  _Cary_Trigger_[trig]_On = 1
    Expression :  dflow0479.0471 <= _Cary_Consvn_[trig]_Demand }

:Next:

// Includes Morrisville & RTP

Set : _RTP_Consvn_1_Demand
```

```
{
    Condition : month > 4 and month < 11 and _Cary_Trigger_1_On = 1
    Value     : Demand0474 * ( 1 - 13 / 100 )

    Condition : _Cary_Trigger_1_On = 1
    Value     : Demand0474 * ( 1 - 6 / 100 )

    Condition : default
    Value     : Demand0474
}

Set : _RTP_Consvn_2_Demand
{
    Condition : month > 4 and month < 11 and _Cary_Trigger_2_On = 1
    Value     : Demand0474 * ( 1 - 32 / 100 )

    Condition : _Cary_Trigger_2_On = 1
    Value     : Demand0474 * ( 1 - 10 / 100 )

    Condition : default
    Value     : Demand0474
}

Set : _RTP_Consvn_3_Demand
{
    Condition : month > 4 and month < 11 and _Cary_Trigger_3_On = 1
    Value     : Demand0474 * ( 1 - 38 / 100 )

    Condition : _Cary_Trigger_3_On = 1
    Value     : Demand0471 * ( 1 - 17 / 100 )

    Condition : default
    Value     : Demand0474
}

Set : _RTP_Consvn_4_Demand
{
    Condition : month > 4 and month < 11 and _Cary_Trigger_4_On = 1
    Value     : Demand0474 * ( 1 - 46 / 100 )

    Condition : _Cary_Trigger_4_On = 1
    Value     : Demand0474 * ( 1 - 29 / 100 )

    Condition : default
    Value     : Demand0474
}

```

```
1599  :For:
1600  {   [trig] = {1, 2, 3, 4}
1601  }
1602
1603  Constraint   RTP_Demand_Limit_Consvn_[trig] :
1604  {   Condition  :  _Cary_Trigger_[trig]_On = 1
1605      Expression :  dflow0479.0474 <= _RTP_Consvn_[trig]_Demand }
1606
1607  :Next:
1608
1609  Set : _Morris_Consvn_1_Demand
1610  {
1611      Condition : month > 4 and month < 11 and  _Cary_Trigger_1_On = 1
1612      Value     : Demand0477 * ( 1 - 13 / 100 )
1613
1614      Condition :  _Cary_Trigger_1_On = 1
1615      Value     : Demand0477 * ( 1 - 6 / 100 )
1616
1617      Condition : default
1618      Value     : Demand0471
1619  }
1620
1621  Set : _Morris_Consvn_2_Demand
1622  {
1623      Condition : month > 4 and month < 11 and  _Cary_Trigger_2_On = 1
1624      Value     : Demand0477 * ( 1 - 32 / 100 )
1625
1626      Condition :  _Cary_Trigger_2_On = 1
1627      Value     : Demand0477 * ( 1 - 10 / 100 )
1628
1629      Condition : default
1630      Value     : Demand0477
1631  }
1632
1633  Set : _Morris_Consvn_3_Demand
1634  {
1635      Condition : month > 4 and month < 11 and  _Cary_Trigger_3_On = 1
1636      Value     : Demand0477 * ( 1 - 38 / 100 )
1637
1638      Condition :  _Cary_Trigger_3_On = 1
1639      Value     : Demand0477 * ( 1 - 17 / 100 )
1640
1641      Condition : default
1642      Value     : Demand0477
1643  }
1644
1645  Set : _Morris_Consvn_4_Demand
```

```
{
    Condition : month > 4 and month < 11 and  _Cary_Trigger_4_On = 1
    Value     : Demand0477 * ( 1 - 46 / 100 )

    Condition :  _Cary_Trigger_4_On = 1
    Value     : Demand0477 * ( 1 - 29 / 100 )

    Condition : default
    Value     : Demand0477
}

:For:
{   [trig] = {1, 2, 3, 4}
}

Constraint   Morris_Demand_Limit_Consvn_[trig] :
{   Condition  :   _Cary_Trigger_[trig]_On = 1
    Expression :  dflow0479.0477 <= _Morris_Consvn_[trig]_Demand }

:Next:




:else:
// Do nothing if not using drought plans
:endif:

```

drought_plans_neuse.ocl

```
/* File is drought_plans_neuse.ocl.  Computes trigger levels and demand reductions. */

:If: {[Drought_Plans_On] = 1} // First check if drought plan variable is on

//Note - Hillsborough and Orange-Alamance drought restrictions are handled in upper_eno_ops.ocl



// Raleigh -Turn triggers on based on monthly curves. Triggers are lifted when storage is above the trigger storage + 20% */
Set : _Ral_Trigger_1_On
{
   Condition : _Ral_Trigger_1_On(-1) = 1
   {
      Condition : _Total_WS_Stor(-1) >= min { (lookup{ Ral_Trig1, month } + 20) / 100 *  [Total_Max_WS_Storage], [Total_Max_WS_Storage] }
      Value     : 0

      Condition : default
      Value     : _Ral_Trigger_1_On(-1)
   }

   Condition : weekday{year, month, day} <= 1
   {
      Condition : _Total_WS_Stor(-1)  <= lookup{ Ral_Trig1, month } / 100 *  [Total_Max_WS_Storage]
      Value     : 1
   }

   Condition : default
   Value     : _Ral_Trigger_1_On(-1)
}

Set : _Ral_Trigger_2_On
{
   Condition : _Ral_Trigger_2_On(-1) = 1
   {
      Condition : _Total_WS_Stor(-1) >= (lookup{ Ral_Trig2, month } + 20) / 100 *  [Total_Max_WS_Storage] //Total max ws storage
      Value     : 0

      Condition : default
      Value     : _Ral_Trigger_2_On(-1)
   }

  Condition : _Ral_Stage_1_Counter(-1) >= 30
   {    Condition : weekday{year, month, day} <= 1
       {
          Condition : _Total_WS_Stor(-1) <= lookup{ Ral_Trig2, month } / 100 *  [Total_Max_WS_Storage]
          Value     : 1
```

```
48      }
49
50     Condition : default
51       Value     : _Ral_Trigger_2_On(-1)
52      }
53
54     Condition : default
55     Value     : _Ral_Trigger_2_On(-1)
56  }
57
58  Set : _Ral_Trigger_3_On
59  {
60     Condition : _Ral_Trigger_3_On(-1) = 1
61     {
62        Condition : _Total_WS_Stor(-1) >= (lookup{ Ral_Trig3, month } + 20) / 100 *  [Total_Max_WS_Storage]
63        Value     : 0
64
65        Condition : default
66        Value     : _Ral_Trigger_3_On(-1)
67     }
68
69   Condition : _Ral_Stage_2_Counter(-1) >= 30
70    {    Condition : weekday{year, month, day} <= 1
71        {
72           Condition : _Total_WS_Stor(-1) <= lookup{ Ral_Trig3, month } / 100 *  [Total_Max_WS_Storage]
73           Value     : 1
74     }
75
76    Condition : default
77       Value     : _Ral_Trigger_3_On(-1)
78      }
79
80     Condition : default
81     Value     : _Ral_Trigger_3_On(-1)
82  }
83
84  /*  This section sets/resets the counters used to maintain the proper spacing
85     of conservation stages */
86
87  Set : _Ral_Stage_1_Counter
88  {
89     Condition : _Ral_Stage_1_Counter(-1) > 0
90     {
91        Condition : _Total_WS_Stor(-1) >= min { (lookup{ Ral_Trig1, month } + 20) / 100 *  [Total_Max_WS_Storage], [Total_Max_WS_Storage] }
92        Value     : 0
93     }
94
```

```
    Condition : _Ral_Trigger_1_On = 1
    Value     : _Ral_Stage_1_Counter(-1) + 1


    Condition : default
    Value     : _Ral_Stage_1_Counter(-1)
}


Set : _Ral_Stage_2_Counter
{
    Condition : _Ral_Stage_2_Counter(-1) > 0
    {
       Condition : _Total_WS_Stor(-1) >= (lookup{ Ral_Trig2, month } + 20) / 100 *  [Total_Max_WS_Storage]
       Value     : 0
    }

    Condition : _Ral_Trigger_2_On = 1
    Value     : _Ral_Stage_2_Counter(-1) + 1


    Condition : default
    Value     : _Ral_Stage_2_Counter(-1)
}

Set : _Ral_Stage_3_Counter
{
    Condition : _Ral_Stage_3_Counter(-1) > 0
    {
       Condition : _Total_WS_Stor(-1) >= (lookup{ Ral_Trig3, month } + 20) / 100 *  [Total_Max_WS_Storage]
       Value     : 0
    }

    Condition : _Ral_Trigger_3_On = 1
    Value     : _Ral_Stage_3_Counter(-1) + 1


    Condition : default
    Value     : _Ral_Stage_3_Counter(-1)
}



/*  This section determines the demand depending upon which level of conservation
    is in place. */

Set : _Ral_Consvn_1_Demand
```

```
{
   Condition : _Ral_Trigger_1_On = 1
   Value     : Demand1306 * ( 1 - ( lookup { Raleigh_Stage1_Red, month } ) / 100 )

   Condition : default
   Value     : Demand1306
}

Set : _Ral_Consvn_2_Demand
{
 Condition : _Ral_Trigger_2_On = 1
   Value     : Demand1306 * ( 1 - ( lookup { Raleigh_Stage1_Red, month } + lookup { Raleigh_Stage2_Red, month } ) / 100 )

   Condition : default
   Value     : Demand1306
}

Set : _Ral_Consvn_3_Demand
{
 Condition : _Ral_Trigger_3_On = 1
   Value     : Demand1306 * ( 1 - ( lookup { Raleigh_Stage1_Red, month } + lookup { Raleigh_Stage2_Red, month }
   + lookup { Raleigh_Stage3_Red, month } ) / 100 )

   Condition : default
   Value     : Demand1306
}

/* Constrain the water supply withdrawal to implement the desired conservation */

Constraint   Demand_Limit_Consvn_1 :
          {   Condition  :  _Ral_Trigger_1_On = 1
              Expression :  ddelivery1306 <= _Ral_Consvn_1_Demand }

Constraint   Demand_Limit_Consvn_2 :
          {   Condition  :  _Ral_Trigger_2_On = 1
              Expression :  ddelivery1306 <= _Ral_Consvn_2_Demand }

Constraint   Demand_Limit_Consvn_3 :
          {   Condition  :  _Ral_Trigger_3_On = 1
              Expression :  ddelivery1306 <= _Ral_Consvn_3_Demand }


/*  Turn on event counter whenever duration exceeds 4 days */

Set : _Ral_Ph_1_event_counter
{   Condition : _Ral_Stage_1_Counter = 5 and _Ral_Stage_1_Counter(-1) = 4
   Value     : _Ral_Ph_1_event_counter(-1) + 1
```

```
189
190     Condition : default
191     Value     : _Ral_Ph_1_event_counter(-1)
192  }
193
194  Set : _Ral_Ph_2_event_counter
195  {   Condition : _Ral_Stage_2_Counter = 5  and _Ral_Stage_2_Counter(-1) = 4
196     Value     : _Ral_Ph_2_event_counter(-1) + 1
197
198     Condition : default
199     Value     : _Ral_Ph_2_event_counter(-1)
200  }
201
202  Set : _Ral_Ph_3_event_counter
203  {   Condition : _Ral_Stage_3_Counter = 5  and _Ral_Stage_3_Counter(-1) = 4
204     Value     : _Ral_Ph_3_event_counter(-1) + 1
205
206     Condition : default
207     Value     : _Ral_Ph_3_event_counter(-1)
208  }
209
210  // SGWASA
211
212  Set : _SGWASA_Trigger_5_On
213  {   Condition : _SGWASA_Trigger_5_On(-1) = 1
214     {   Condition : elevation1250 >= 356
215        Value     : 0
216
217        Condition : default
218        Value     : _SGWASA_Trigger_5_On(-1)
219     }
220
221     Condition : _SGWASA_Stage_4_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 5
222     {   Condition : weekday{year, month, day} <= 1
223        {     Condition : elevation1250<= 320
224              Value     : 1
225        }
226        Condition : default
227        Value     : _SGWASA_Trigger_5_On(-1)
228     }
229     Condition : default
230     Value     : _SGWASA_Trigger_5_On(-1)
231  }
232
233  Set : _SGWASA_Trigger_4_On
234  {   Condition : _SGWASA_Trigger_4_On(-1) = 1
235     {   Condition : elevation1250 >= 356
```

```
236         Value     : 0
237
238         Condition : default
239         Value     : _SGWASA_Trigger_4_On(-1)
240     }
241
242     Condition : _SGWASA_Stage_3_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 4
243     {   Condition : weekday{year, month, day} <= 1
244         {     Condition : elevation1250< 340.5
245               Value     : 1
246         }
247         Condition : default
248         Value     : _SGWASA_Trigger_4_On(-1)
249     }
250     Condition : default
251     Value     : _SGWASA_Trigger_4_On(-1)
252 }
253
254 Set : _SGWASA_Trigger_3_On
255 {   Condition : _SGWASA_Trigger_3_On(-1) = 1
256     {   Condition : elevation1250 >= 356
257         Value     : 0
258
259         Condition : default
260         Value     : _SGWASA_Trigger_3_On(-1)
261     }
262
263     Condition : _SGWASA_Stage_2_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 3
264     {   Condition : weekday{year, month, day} <= 1
265         {     Condition : elevation1250< 343.08
266               Value     : 1
267         }
268         Condition : default
269         Value     : _SGWASA_Trigger_3_On(-1)
270     }
271     Condition : default
272     Value     : _SGWASA_Trigger_3_On(-1)
273 }
274
275
276 Set : _SGWASA_Trigger_2_On
277 {   Condition : _SGWASA_Trigger_2_On(-1) = 1
278     {   Condition : elevation1250 >= 356
279         Value     : 0
280
281         Condition : default
282         Value     : _SGWASA_Trigger_2_On(-1)
```

```
283     }
284
285     Condition : _SGWASA_Stage_1_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 2
286     {   Condition : weekday{year, month, day} <= 1
287         {     Condition : elevation1250< 345.25
288          Value     : 1
289         }
290         Condition : default
291         Value     : _SGWASA_Trigger_2_On(-1)
292     }
293     Condition : default
294     Value     : _SGWASA_Trigger_2_On(-1)
295 }
296
297
298 Set : _SGWASA_Trigger_1_On
299 {   Condition : _SGWASA_Trigger_1_On(-1) = 1
300     {   Condition : elevation1250 >= 356
301         Value     : 0
302
303         Condition : default
304         Value     : _SGWASA_Trigger_1_On(-1)
305     }
306
307     Condition : weekday{year, month, day} <= 1
308     {   Condition : elevation1250< 349.67
309         Value     : 1
310
311         Condition : default
312         Value     : _SGWASA_Trigger_1_On(-1)
313     }
314     Condition : default
315     Value     : _SGWASA_Trigger_1_On(-1)
316 }
317
318 // Wilson
319
320 Set : _Wilson_Trigger_5_On
321 {   Condition : _Wilson_Trigger_5_On(-1) = 1
322     {   Condition : elevation1500 >= 148
323         Value     : 0
324
325         Condition : default
326         Value     : _Wilson_Trigger_5_On(-1)
327     }
328
329     Condition : _Wilson_Stage_4_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 5
```

```
330     {   Condition : weekday{year, month, day} <= 1
331         {     Condition : elevation1500<= 135
332               Value     : 1
333         }
334         Condition : default
335         Value     : _Wilson_Trigger_5_On(-1)
336     }
337     Condition : default
338     Value     : _Wilson_Trigger_5_On(-1)
339 }
340
341 Set : _Wilson_Trigger_4_On
342 {   Condition : _Wilson_Trigger_4_On(-1) = 1
343     {   Condition : elevation1500 >= 148
344         Value     : 0
345
346         Condition : default
347         Value     : _Wilson_Trigger_4_On(-1)
348     }
349
350     Condition : _Wilson_Stage_3_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 4
351     {   Condition : weekday{year, month, day} <= 1
352         {     Condition : elevation1500< 138
353               Value     : 1
354         }
355         Condition : default
356         Value     : _Wilson_Trigger_4_On(-1)
357     }
358     Condition : default
359     Value     : _Wilson_Trigger_4_On(-1)
360 }
361
362 Set : _Wilson_Trigger_3_On
363 {   Condition : _Wilson_Trigger_3_On(-1) = 1
364     {   Condition : elevation1500 >= 148
365         Value     : 0
366
367         Condition : default
368         Value     : _Wilson_Trigger_3_On(-1)
369     }
370
371     Condition : _Wilson_Stage_2_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 3
372     {   Condition : weekday{year, month, day} <= 1
373         {     Condition : elevation1500< 140
374      Value     : 1
375         }
376         Condition : default
```

```
        Value     : _Wilson_Trigger_3_On(-1)
    }
    Condition : default
    Value     : _Wilson_Trigger_3_On(-1)
}


Set : _Wilson_Trigger_2_On
{   Condition : _Wilson_Trigger_2_On(-1) = 1
    {   Condition : elevation1500 >= 148
        Value     : 0

        Condition : default
        Value     : _Wilson_Trigger_2_On(-1)
    }

    Condition : _Wilson_Stage_1_Counter(-1) >= 14   // Require a 14 day waiting period before going into phase 2
    {   Condition : weekday{year, month, day} <= 1
        {     Condition : elevation1500< 142
     Value     : 1
        }
        Condition : default
        Value     : _Wilson_Trigger_2_On(-1)
    }
    Condition : default
    Value     : _Wilson_Trigger_2_On(-1)
}


Set : _Wilson_Trigger_1_On
{   Condition : _Wilson_Trigger_1_On(-1) = 1
    {   Condition : elevation1500 >= 148
        Value     : 0

        Condition : default
        Value     : _Wilson_Trigger_1_On(-1)
    }

    Condition : weekday{year, month, day} <= 1
    {   Condition : elevation1500< 144
        Value     : 1

        Condition : default
        Value     : _Wilson_Trigger_1_On(-1)
    }
    Condition : default
    Value     : _Wilson_Trigger_1_On(-1)
```

```
}

/*  This section sets/resets the counters used to maintain the proper spacing of conservation stages */

:For:
{ [Util] = { SGWASA, Wilson }
}

:For:
{   [trig] = {1, 2, 3, 4, 5}
}

Set : _[Util]_Stage_[trig]_Counter
{   Condition : _[Util]_Stage_[trig]_Counter(-1) > 0 and _[Util]_Trigger_[trig]_On = 0
    Value     : 0

    Condition : _[Util]_Trigger_[trig]_On = 1
    Value     : _[Util]_Stage_[trig]_Counter(-1) + 1

    Condition : default
    Value     : _[Util]_Stage_[trig]_Counter(-1)
}

/*  Count all trigger events lasting at least 7 days */

Set : _[Util]_Ph_[trig]_event_counter
{   Condition : _[Util]_Stage_[trig]_Counter = 7 and _[Util]_Stage_[trig]_Counter(-1) = 6
    Value     : _[Util]_Ph_[trig]_event_counter(-1) + 1

    Condition : default
    Value     : _[Util]_Ph_[trig]_event_counter(-1)
}

:Next:

:Next:


// Set conservation demand and delivery constraints for each trigger level in effect.

// Set demand reduction factors
:SUBSTITUTE: [Dem_1_Red_Factor] = 5
:SUBSTITUTE: [Dem_2_Red_Factor] = 10
:SUBSTITUTE: [Dem_3_Red_Factor] = 20
:SUBSTITUTE: [Dem_4_Red_Factor] = 25
:SUBSTITUTE: [Dem_5_Red_Factor] = 35
:SUBSTITUTE: [Dem_6_Red_Factor] = 50
```

```
471
472 :For:
473 {   [trig] = {1, 2, 3, 4, 5}
474 }
475
476
477
478 // SGWASA
479 Set : _SGWASA_Consvn_[trig]_Demand
480 {   Condition : _SGWASA_Trigger_[trig]_On = 1
481     Value     : Demand1256 *  ( 1 - [Dem_[trig]_Red_Factor] / 100 )
482
483     Condition : default
484     Value     : Demand1256
485 }
486
487 Constraint   SGWASA_Demand_Limit_Consvn_[trig] :
488           {   Condition  :  _SGWASA_Trigger_[trig]_On = 1
489               Expression :  dflow1250.1256 <= _SGWASA_Consvn_[trig]_Demand }
490
491 //Wilson
492 Set : _Wilson_Consvn_[trig]_Demand
493 {   Condition : _Wilson_Trigger_[trig]_On = 1
494     Value     : Demand1506*  ( 1 - [Dem_[trig]_Red_Factor] / 100 )
495
496     Condition : default
497     Value     : Demand1506
498 }
499
500 Constraint   Wilson_Demand_Limit_Consvn_[trig] :
501           {   Condition  :  _Wilson_Trigger_[trig]_On = 1
502               Expression :  dflow1520.1505 <= _Wilson_Consvn_[trig]_Demand }
503
504 :Next:
505
506 :else:
507 // Do nothing if not using drought plans
508 :endif:
```

drought_protocol_Jordan.ocl

```
1  // Drought protocol
2
3  :SUBSTITUTE: [WQ_Pct_Remaining_Stage_1] = 80
4  :SUBSTITUTE: [WQ_Pct_Remaining_Stage_2] = 60
5  :SUBSTITUTE: [WQ_Pct_Remaining_Stage_3] = 40
6  :SUBSTITUTE: [WQ_Pct_Remaining_Stage_4] = 20
7  :SUBSTITUTE: [Jordan_Minimum_Release_Normal] = 40
8  :SUBSTITUTE: [Jordan_Minimum_Release_Stage_1] = 40
9  :SUBSTITUTE: [Jordan_Minimum_Release_Stage_2] = 40
10 :SUBSTITUTE: [Jordan_Minimum_Release_Stage_3] = 200
11 :SUBSTITUTE: [Jordan_Minimum_Release_Stage_4] = 100
12
13 :SUBSTITUTE: [Level_Change_Time_Interval] = 7
14
15
16
17 // Determine average inflow to WQ account over the last 14 days
18 Set :  _Avg_JLake_Inflow
19 {    condition  :  abs_period = 1
20   value      :  inflow0470
21
22   condition  :  abs_period <= 14
23     value :       _JLake_WQ_Inf(-1)
24
25     condition  :  default
26     value      :  accumulate{ _JLake_WQ_Inf(-1) , -14, -1 } / 14
27 }
28
29
30 /* Determine which zone of the WQ pool the lake is in.  In the udef list, initialize the WQ storage to the starting storage as defined
31    in the constants table.*/
32 Set :  _WQZone
33 {    condition   : _WQ_Storage(-1) / [Max_WQ_Storage] * 100  <= [WQ_Pct_Remaining_Stage_4] /* WQ Zone 4  */
34     value       : 4
35
36     condition   : _WQ_Storage(-1) / [Max_WQ_Storage] * 100  <= [WQ_Pct_Remaining_Stage_3] /* WQ Zone 3  */
37     value       : 3
38
39     condition   : _WQ_Storage(-1) / [Max_WQ_Storage] * 100  <= [WQ_Pct_Remaining_Stage_2] /* WQ Zone 2  */
40     value       : 2
41
42     condition   : _WQ_Storage(-1) / [Max_WQ_Storage] * 100  <= [WQ_Pct_Remaining_Stage_1] /* WQ Zone 1 */
43     value       : 1
44
45     condition   : default                                   /* WQ Zone 0 (Normal Operations) [right now, 80% and above) */
46     value       : 0
47 }
```

```
48
49 /*  This is to set the triggers.  In all cases, the triggers and associated level counters are reset to zero when the elevation reaches 216 feet.
50
51 For the first trigger, activate it when the water quality zone reaches 1.
52 The triggers for other levels activate whenever the pond hits that water quality zone (or lower) and a specified number of days in the prior level
53 has elapsed. The specified number of days (specified in the OCL constants) is the minimum interval between levels. In other words, the trigger will
54 stay in place for at least a specified number of days (even if the zone drops below that level) at which time the next trigger goes on.
55
56 Each level # is associated with the water quality zone.
57
58 Note that on refill, no skipping of levels is allowed.  The WQ Zone must improve two levels before turning off the next level trigger.   */
59
60 Set : _Trigger_1_On
61 {   //  For first day of simulation, set to the initial value in the udef list as defined in the constants table.  User may wish to simulate conditions
62  //  starting with a certain trigger condition.  Setting the WQ zone would not be adequate since there is generally a waiting period between triggers.
63  //  The trigger condition is important since it sets the minimum release from Jordan and target flow at Lillington.
64  condition  :  abs_period = 1
65  value      :  _Trigger_1_On(-1)
66
67  // Turning off trigger
68  condition  :  _Count_Trigger_1(-1) > 0 and elevation0470 < 216
69   {   condition  :  _Trigger_2_On(-1) = 1   // during drawdown
70    value      :  0
71
72    condition  :  default                // during refill, trigger will stay on as long as pond has not refilled to 216 feet
73    value      :  _Trigger_1_On(-1)
74   }
75
76  // Turning on trigger
77
78   // The first condition is during drawdown.  WQ zone could drop to zones 2 through 4, but those triggers cannot go on until passing through the
79   // first trigger. Once we've gotten to the second and higher triggers, the 1st trigger will turn off, as there is no waiting period.
80      condition  : _WQZone >= 1 and elevation0470 < 216 and _Trigger_2_On(-1) = 0 and _Trigger_3_On(-1) = 0 and _Trigger_4_On(-1) = 0
81      Value      : 1
82
83   //  for turning on trigger during refill. It cannot turn on again if pond has refilled to 216 feet.
84   condition  :  _Trigger_2_On(-1) = 1 and _WQZone = 0 and elevation0470 < 216
85      Value      : 1
86
87  // Otherwise, trigger is off
88  Condition : default
89     Value     : 0
90 }
91
92 // Logic is similar for the other triggers.
93 Set : _Trigger_2_On
94 {   condition  :  abs_period = 1
```

```
 value     : _Trigger_2_On(-1)

// Turning off trigger
condition  :  _Count_Trigger_2(-1) > 0 and elevation0470 < 216
 {   condition  :  _Trigger_3_On(-1) = 1   // during drawdown
  value     : 0

  condition  :  _WQZone <= 0  // during refill.
  value     : 0

  condition  :  default
  value     : _Trigger_2_On(-1)
 }

// Turning on trigger

 // The first condition is during drawdown
 condition  :  _Count_Trigger_1(-1) >= [Level_Change_Time_Interval] and _WQZone >= 2 and elevation0470 < 216
    Value     : 1

 // The second condition is during refill. It cannot turn on again unless WQ zone is two zones higher than yesterday.
 condition  : _Trigger_3_On(-1) = 1 and _WQZone <= 1  and elevation0470 < 216
 value     :  1

// Otherwise, trigger is off
Condition : default
   Value     : 0
}


Set : _Trigger_3_On
{   condition  :  abs_period = 1
 value     : _Trigger_3_On(-1)

// Turning off trigger
condition  :  _Count_Trigger_3(-1) > 0 and elevation0470 < 216
 {   condition  :  _Trigger_4_On(-1) > 0   // during drawdown
  value     : 0

  condition  :  _WQZone <= 1  // during refill
  value     : 0

  condition  :  default
  value     : _Trigger_3_On(-1)
 }

// Turning on trigger
```

```
142
143   // The first condition is during drawdown
144   condition  :  _Count_Trigger_2(-1) >= [Level_Change_Time_Interval] and _WQZone >= 3 and elevation0470 < 216
145       Value      : 1
146
147   // The second condition is during refill.
148   condition  : _Trigger_4_On(-1) = 1 and _WQZone <= 2  and elevation0470 < 216
149   value      :  1
150
151   // Otherwise, trigger is off
152   Condition : default
153      Value     : 0
154  }
155
156  Set : _Trigger_4_On
157  {   condition  :  abs_period = 1
158   value      :  _Trigger_4_On(-1)
159
160   // Turning off trigger
161   condition  :  _Count_Trigger_4(-1) > 0 and elevation0470 < 216
162    {   condition  :  _WQZone <= 2  // during refill.
163     value      :  0
164
165     condition  :  default
166     value      :  _Trigger_4_On(-1)
167    }
168
169   // Turning on trigger
170
171    // During drawdown
172    condition  :  _Count_Trigger_3(-1) >= [Level_Change_Time_Interval] and _WQZone >= 4 and elevation0470 < 216
173       Value      : 1
174
175      // Otherwise, trigger is off
176   Condition : default
177      Value     : 0
178  }
179
180
181
182
183  /*  The following lines set the drought stage according to which triggers are on and for how long.*/
184  Set :  _Drought_Stage
185  {   condition : _Trigger_4_On = 1
186      value     : 4
187
188      condition : _Trigger_3_On = 1
```

```
    value     : 3

    condition : _Trigger_2_On = 1
    value     : 2

    condition : _Trigger_1_On = 1
    value     : 1

    condition : _Trigger_1_On(-1) = 1 or _Trigger_2_On(-1) = 1 or _Trigger_3_On(-1) = 1 or _Trigger_4_On(-1) = 1
    value     : _WQZone

    condition : default
    value     : 0
}


// This is for determining whether the lake is drawing down based on changing WQ zones (rather than just day to day change in WQ storage
// while in that zone). Turn the index off only if the WQ zone increases during refill.
Set :  _Level_Drawdown
{    condition  :  _Level_Drawdown(-1) = 1
       {  condition  :  _Drought_Stage < _Drought_Stage(-1)
          value      :  0

          condition  :  default
          value      :  _Level_Drawdown(-1)
       }

     condition  :  _Drought_Stage > _Drought_Stage(-1)
     value      :  1

     condition  :  default
     value      :  0
}


//  These are the counters associated with each trigger

// Do FOR:NEXT loop since the counters are the same for all Jordan Lake trigger levels.  Here, DWR has chosen
// to end a trigger level when the next has been reached rather than keeping it on for the entire drought.

:FOR:
{  [Level] = { 1, 2, 3, 4}  }

 // Number of days in which counter is on and the number of days in each drought stage
 Set : _Count_Trigger_[Level]
 {
    Condition : _Count_Trigger_[Level](-1) >= 1
```

```
236     {
237        Condition : _Trigger_[Level]_On = 0
238        Value     : 0
239
240        Condition : default
241        Value     : _Count_Trigger_[Level](-1) + 1
242     }
243
244     Condition : _Trigger_[Level]_On = 1
245     Value     : 1
246
247     Condition : default
248     Value     : 0
249  }
250
251  //  DWR included this counter for determining total # of days at each level over the simulation period.  Here the
252  // trigger stays on and is counted even if another trigger has been reached.
253  Set :  _Total_Count_Trigger_[Level]
254  {   Condition :  _Count_Trigger_[Level] > 0
255        Value     :  _Total_Count_Trigger_[Level](-1) + 1
256
257        Condition : default
258        Value     : 0
259  }
260
261
262  // Establish a day counter which resets after _ days have elapsed as defined by the user for the [Level Change Time Interval].
263  // This will be used to determine adjustments to the Lillington target after the day counter reaches the time interval
264  Set :  _CumDayWithinInt_[Level]
265  {   condition  :   _CumDayWithinInt_[Level](-1) = [Level_Change_Time_Interval]
266   {   condition :  _Trigger_[Level]_On = 1
267       value      :  1
268
269    condition  :  default
270    value      :  0
271   }
272
273   condition  :  _Trigger_[Level]_On = 1
274   value      :  _CumDayWithinInt_[Level](-1) + 1
275
276   condition  :  default
277   value      :  0
278  }
279
280
281  :NEXT:
282
```

```
/*  These are counters to track the number of times (events) in the record each trigger level would have activated.  This is not the same as tracking
as how often a zone is reached due to the criteria for switching levels (which include a waiting period).  Events are arbitrarily selected to last
at least 5 days. In other words, the phase 1 counter will solve to 2 if in 2 drought years, trigger 1 is activated twice, each time lasting at least 5 days.
If the trigger is reactivated during refill, and if it lasts for 5 days, the phase event will be counted here.  To get a better representation of the actual
number of drought events, not the drawdown and refill events, may need to adjust this code.  */

:FOR:
{  [Level] = { 1, 2, 3, 4 }  }

 Set : _Ph_[Level]_event_count
 {   Condition : _Count_Trigger_[level]  = 5 and _Count_Trigger_[level](-1) = 4
     Value     : _Ph_[Level]_event_count(-1) + 1

     Condition : default
     Value     : _Ph_[Level]_event_count(-1)
 }

:NEXT:


/* The following lines determine the Lillington target according to the drought level and the number of days at that drought level.
   The target at Lillington steps down (on drawdown) or up (on refill) by a specified amount every specified number of
 days (Level_Change_Time_Interval).*/
:substitute:    [Lillington_Increment_Stage_1] = 50            /* In cfs */
:substitute:    [Lillington_Increment_Stage_2] = 50            /* In cfs */
:substitute:    [Lillington_Increment_Stage_3] = 0             /* In cfs */
:substitute:    [Lillington_Increment_Stage_4] = 0             /* In cfs */
:substitute: [Lillington_Lower_Target_Stage_1] = 450           /* In cfs */
:substitute: [Lillington_Lower_Target_Stage_2] = 300           /* In cfs */
:substitute: [Lillington_Lower_Target_Stage_3] = 0             /* In cfs */
:substitute: [Lillington_Lower_Target_Stage_4] = 0             /* In cfs */
:substitute: [Lillington_Upper_Target_Stage_1] = 600           /* In cfs */
:substitute: [Lillington_Upper_Target_Stage_2] = 450           /* In cfs */
:substitute: [Lillington_Upper_Target_Stage_3] = 0             /* In cfs */
:substitute: [Lillington_Upper_Target_Stage_4] = 0             /* In cfs */


:FOR:
{  [Level] = { 1, 2, 3, 4 }  }

 Set :   _Lill_Target_[Level]
 {   /* for moving into more restrictive drought phases (based on trigger conditions) during drawdown.  On the first day of entering
   the more restrictive trigger, set the target to the upper end of the target range associated with that trigger.  Do not do
   this if in the previous phase (as expressed by yesterday's Lillington target value, or min_flow0550.0555(-1)), the target
   was at the lower end of the lower phase.  In this case, drop down by the user-defined increment right away.  */
       condition  :  _Drought_Stage > _Drought_Stage(-1)
           {   condition  :  min_flow0550.0555(-1) = convert_units {[Lillington_Upper_Target_Stage_[Level]], cfs, af}
```

```
330          value     : convert_units {[Lillington_Upper_Target_Stage_[Level]] - [Lillington_Increment_Stage_[Level]], cfs, af}
331
332             condition : default
333             value     : convert_units {[Lillington_Upper_Target_Stage_[Level]], cfs, af}
334           }
335
336   /* For moving into less restrictive drought phases during refill.  Only apply the lower end of the target range to be conservative.
337    For example, if the range is 450 to 600 cfs, keep the target at 450 cfs throughout that period (even if longer than 7 days).  */
338   condition : _Drought_Stage < _Drought_Stage(-1)
339        value     : convert_units {[Lillington_Lower_Target_Stage_[Level]], cfs, af}
340
341   // if drawdown is continuing, but the drought phase has not changed
342        condition : _Level_Drawdown = 1
343     {   // reduce target by user-defined increments, but only when the user-defined time interval has been reached.  The lowest value it
344      // can reach is the lower range of the target.  The target will be reduced even if WQ storage is increasing while in this drought
345      // level, again to be conservative.
346      condition : _CumDayWithinInt_[Level] =  [Level_Change_Time_Interval]
347        value     : max { convert_units {[Lillington_Lower_Target_Stage_[Level]], cfs, af},
348          _Lill_Target_[Level](-1) -  convert_units { [Lillington_Increment_Stage_[Level]], cfs, af} }
349
350      condition : default
351      value     : _Lill_Target_[Level](-1)
352     }
353
354   // if refill is occuring, but the drought phase has not changed.  Set to the lower end of the target range throughout that particular drought phase.
355   condition : _Level_Drawdown = 0
356        value     : _Lill_Target_[Level](-1)
357
358      // default condition is to set the target to its upper level
359   condition :   default
360   value     :   convert_units {[Lillington_Upper_Target_Stage_[Level]], cfs, af}
361   }
362
363  :NEXT:
364
365  // Now set the min flow at Lillington based on the computed target
366  Set : min_flow0550.0555
367  {   condition : _Trigger_4_On = 1
368   value     : _Lill_Target_4
369
370   condition : _Trigger_3_On = 1
371   value     : _Lill_Target_3
372
373   condition : _Trigger_2_On = 1
374   value     : _Lill_Target_2
375
376   condition : _Trigger_1_On = 1
```

```
  value     : _Lill_Target_1

    condition  :  _Trigger_1_On(-1) = 1 or _Trigger_2_On(-1) = 1 or _Trigger_3_On(-1) = 1 or _Trigger_4_On(-1) = 1
    value      :  min_flow0550.0555(-1)

  condition  :  default  // which will apply if the lake refills
  value      :  convert_units {[Lillington_Target_Normal], cfs, af}
 }

 //  Adjust the min release from Jordan depending on drought trigger condition.

 Set  :  min_flow0470.0480
 {   /* For trigger 3 and 4 conditions, reduce the minimum release if there is enough local inflow to provide a minimum
  of 300 cfs at Lillington.The net withdrawal in this reach (between Deep River Moncure gage, Jordan Lake, and
  Lillington gage) can be approximated using the largest withdrawals (Sanford and Harnett County) and WW returns
  (Western Wake) using yesterday's flows.   Factor this in to meet the 300 cfs minimum; Releases will be higher to
  meet local net withdrawals down to Lillington due to weighting.  Never release less than 40 cfs. */
    condition  :  _Trigger_4_On = 1
    value      :  max { convert_units{40, cfs, af},
                      min {convert_units{ [Jordan_Minimum_Release_Stage_4], cfs, af},  convert_units {300, cfs, af}
       + flow0550.0549 + flow0490.0489 - flow0930.0510
                           - (inflow0550 + inflow0490 + flow0527.0510 + flow0640.0480 ) } }

    condition  :  _Trigger_3_On = 1
    value      :  max { convert_units{40, cfs, af},
                      min {convert_units{ [Jordan_Minimum_Release_Stage_3], cfs, af},  convert_units {300, cfs, af}
       + flow0550.0549 + flow0490.0489 - flow0930.0510
                          - (inflow0550 + inflow0490 + flow0527.0510 + flow0640.0480 ) } }

    condition  :  _Trigger_2_On = 1
    value      :  convert_units{ [Jordan_Minimum_Release_Stage_2], cfs, af}

    condition  :  _Trigger_1_On = 1
    value      :  convert_units{ [Jordan_Minimum_Release_Stage_1], cfs, af}

    condition  :  _Trigger_1_On(-1) = 1 or _Trigger_2_On(-1) = 1 or _Trigger_3_On(-1) = 1 or _Trigger_4_On(-1) = 1
    value      :  min_flow0470.0480(-1)

    condition  :  default
    value      :  convert_units{ [Jordan_Minimum_Release_Normal], cfs, af}
 }
```

Durham_ops.ocl

```
1  /*  DURHAM_OPS.OCL  */
2
3  /*  Operational policy for Durham's system */
4
5  Set: _Durham_Tot_Use_Stor { value: max_stor1140 + max_stor1200 - (lower_rule1140 + lower_rule1200)}
6  Set: _Durham_Stor { value: storage1140 + storage1200}
7  Set: _Durham_Use_Stor { value: _Durham_Stor - (lower_rule1140 + lower_rule1200)}
8  Set: _Durham_Pct_Use_Stor { value: 100 * _Durham_Use_Stor/_Durham_Tot_Use_Stor }
9  Set: _Durham_TQ_Pct_Use_Stor { value: ( storage1120 - lower_rule1120 ) / (max_stor1120 - lower_rule1120 ) * 100 }
10
11
12 /*  Sets the Little River Reservoir (Durham) minimum release - based on usable storage (per SEPA/NEPA [EIS] process) and time of year.
13 Lake Michie min release also is tied to usable storage.  Note reference is to dead_stor since that defines the bottom of the usable
14 storage and will change with sedimentation associated with demand year.  It is not tied to lower rule since the lower rule embeds
15 a reserve in the calculation and would artificially reduce the usable storage for making the min release.      */
16
17 Set LittleRiverRelease : min_flow1200.1205
18 {   condition : ( storage1200 - dead_stor1200) / (max_stor1200 - dead_stor1200) < 0.7
19    value     : convert_units {0.64,cfs,af}
20
21    condition : month > 5 and month < 12
22    value     : convert_units {2.0,cfs,af}
23
24    condition : default
25    value     : convert_units {6.0,cfs,af}
26 }
27
28
29 // For this 2055 year scenario, no planned use of the Eno to refill Teer Quarry, so shut off.  Quarry would be refilled from Lake Michie.
30
31 Set Teer_Quarry_Eno_River_Refill : max_flow1115.1120   {  value  :  0   }
32
33 Set: _Durham_estim_spill  // Used to determine Lake Michie min release and refill of Teer Quarry
34 {
35    condition :  default
36    value      :  max { 0,
37      (storage1140 + inflow1140 - evap1140 - demand1142)
38       + (storage1200 + inflow1200 - evap1200 - min_flow1200.1205 - demand1202)
39       - demand1162 - (max_stor1140 + max_stor1200),
40      (storage1140 + inflow1140 - evap1140 - demand1142 - demand1162 - max_stor1140) }
41       // This last term anticipates when LM will spill unavoidably when LRR is not yet near full
42 }
43
44 // For refill of quarry from Michie, contain same transfer provisions on the deadband and the Falls upper rule 1-inch allowance.
45 Set Teer_Quarry_Lake_Michie_Refill : max_flow1140.1120
46 {
47    condition : convert_units{_Durham_estim_spill, af, cfs} >= 11.75
```

```
    and (storage1120 + 10) < max_stor1120
    and elevation1300 >= ( [Falls_upper_rule] - 0.083 )
   value    : convert_units{ [TQ_Max_LM_Refill_Rate] , mgd , af }

   condition : default
   value    : 0

}

// Assume no supply from Little River to the quarry
Constraint : {dFlow1200.1120 = 0 }


Set TeerQuarrySupply: max_flow1120.1151
{
   condition : (_Durham_Trigger_2_On(-1) = 1 or _Durham_Trigger_3_On(-1) = 1 or _Durham_Trigger_4_On(-1) = 1)
    and storage1120 > lower_rule1120
    and _Durham_TQ_Pct_Use_Stor > _Durham_Pct_Use_Stor //After reaching Stage 2
   value    : convert_units {20, mgd, af}

 condition : _Durham_Trigger_1_On(-1) = 1 and storage1120 > lower_rule1120
    and _Durham_TQ_Pct_Use_Stor > _Durham_Pct_Use_Stor
    and (Month >10 or Month <4)
   value    : convert_units {5, mgd, af}

 condition : _Durham_Trigger_1_On(-1) = 1 and storage1120 > lower_rule1120
    and _Durham_TQ_Pct_Use_Stor > _Durham_Pct_Use_Stor
    and (Month >3 or Month <11)
   value    : convert_units {10, mgd, af}

   condition : default
   value    : 0
}


// Set the new minimum release for Lake Michie.
Set LakeMichie_min_release : min_flow1140.1205
{   // One of the conditions for pumping from Michie to the quarry is a minimum flowby of 11.75 cfs below the dam.
 condition : convert_units{_Durham_estim_spill, af, cfs} > 11.75
    and (storage1120 + 10) < max_stor1120 and elevation1300 >= ([Falls_upper_rule] - 0.083)
 value    : convert_units {11.75 ,cfs,af}

 // when below 40% storage (assume usable storage)
 condition :  (storage1140 - dead_stor1140) / ( upper_rule1140 - dead_stor1140) <= 0.4
   value    :   convert_units {0.61,cfs,af}

 // 40% - 70% storage release tier
```

```
    condition : (storage1140 - dead_stor1140) / ( upper_rule1140 - dead_stor1140) <= 0.7
    value     :  convert_units {1.2,cfs,af}

    condition : default
    value     : convert_units {1.75,cfs,af}
}


// Assume baseloading from the WIP of 16.5 mgd assuming sufficient storage in Durham and OWASA Jordan Lake accounts.
Target Jordan_Lake_usage  :  dFlow0468.1151
{   condition :default
    priority  : 1
    penalty+  : 500
    penalty-  : 500
    Value     : min { demand1162, convert_units {16.5,  mgd, af}, _Storage_Durham(-1) + _Storage_OWASA(-1)}
}



/*  Turn off interconnects from Durham for base case - transfers can be simulated
    with an operating policy in alternative scenarios */
Constraint : {dFlow0479.1151 = 0} //After WIP WTP is on-line, Durham would only buy water from Cary in an emergency
/*Constraint : {dFlow1151.0431 = 0}  Durham-OWASA Interconnect */
Constraint : {dFlow1151.0471 = 0}  /* Durham-Cary Interconnect */
Constraint : {dFlow1151.1106 = 0} /* Durham-Hillsborough Interconnect */
Constraint : {dFlow1151.1305 = 0}  /* Durham-Raleigh Interconnect */


/*  RESERVOIR BALANCING -- Durham
    With a very low penalty in Priority 1, balance the water (usable stor pct) between the
    reservoirs. This will draw Michie and Little River Res. down proportionally.
    This can be replaced with a more comprehensive operating policy from Durham
    in alternative scenarios */

Constraint Balance1200 : { d_StorRatio > ( Dstorage1200 - lower_rule1200 ) / (upper_rule1200 - lower_rule1200 ) }

Constraint Balance1140 : { d_StorRatio > ( Dstorage1140 - lower_rule1140 ) / (upper_rule1140 - lower_rule1140 ) }

Minimax : d_StorRatio
{   priority  : 1
    penalty   : 2
    tolerance : .02
}
```

falls_bdam_ops.ocl

```
1  /*  FALLS_BDAM_OPS.OCL  */
2  /* Operational policies for Falls and Beaverdam */
3
4  //Set the Seasonal increase in Falls Lake Normal Pool
5
6  set Falls_Lake_upper_rule : upper_rule1300
7  {
8      Condition  :   default
9      value      :   elev_to_stor{1300, [Falls_upper_rule]}
10 }
11
12 set Falls_Lake_lower_rule : lower_rule1300
13 {    Condition  :   Default
14     value      :   elev_to_stor{1300,[Falls_lower_rule]}
15 }
16
17 set Beaver_Dam_upper_rule : upper_rule1230
18 {
19     Condition  :   default
20     value      :   elev_to_stor{1230, [Falls_upper_rule]}
21 }
22
23 set Beaver_Dam_lower_rule : lower_rule1230
24 {
25     Condition  :   default
26     value      :   elev_to_stor{1230, [Falls_lower_rule]}
27 }
28
29 /*  Sets the Falls minimum release - seasonal pattern (100/60 cfs) with user-defined safety factor (only when using service gates)
30    The safety factor can be set in the ocl constants table. */
31 Set FallsRelease : min_flow1300.1304
32 {   condition : month > 3 and month < 11
33    value     : convert_units { 100, cfs, af } * ( 1 + [FLakeMin_SafeFact] / 100 )
34
35    condition : default
36    /*  Winter min. release based on amount from Piggyback gates, which is approx. 60 cfs depending on stage. */
37    value     : convert_units { lookup { PiggybackGate, elevation1300 }, cfs, af }
38 }
39
40 /*  Sets the Clayton minimum flow target - seasonal pattern (254/184 cfs) with user-defined safety factor
41    Also can be overridden if user chooses, when WQ storage drops below 20%; this can be truned on in the ocl constants table. */
42 Set Clayt_Target: min_flow1630.1640
43 {   condition : [ClaytonTarget_Override] = 1 and ( _Total_WQ_Pct(-1) < [FLake_WQ_Threshold] or elevation1300 <= 245 )
44    value     : 0
45
46    condition : month > 3 and month < 11
47    value     : convert_units { 254, cfs, af } * ( 1 + [ClaytonTarget_SafeFact] / 100 )
```

```
48
49      condition : default
50      value     : convert_units { 184, cfs, af } * ( 1 + [ClaytonTarget_SafeFact] / 100 )
51  }
52
53  /*  Beaverdam elevation = projected Falls elevation if at or above 249 ft.  */
54  Target Bdam_elevation : dstorage1230
55  {   condition : elevation1300 >= 249.0
56   priority  : 1
57      penalty+  : 10000
58      penalty-  : 10000
59      Value     : elev_to_stor {1230, elevation1300}
60  }
61
62  /*Beaverdam drought release policy*/
63
64  Target Beaverdam_release : dflow1230.1300
65
66  {   /* If Falls is between 237 and 240, and Beaverdam is above [Falls_lower_rule], draw down Beaverdam maximum of 1-ft (down to a minimum
67    of [Falls_lower_rule]); next drawdown can occur after 5 days */
68      condition :  elevation1230(-5) - elevation1230 < 5 and elevation1300 < 240
69       and elevation1230 > elevation1300 and elevation1230> [Falls_lower_rule]
70      priority  :  1
71      penalty+  :  1000
72      penalty-  :  1000
73      Value     :  min { elev_to_stor { 1230, elevation1230 } - elev_to_stor { 1230, elevation1230 - 1 },
74         elev_to_stor { 1230, elevation1230 } - elev_to_stor { 1230, [Falls_lower_rule] } }
75
76      /* If Falls is below 249 ft, make sure Beaverdam is not above 249 ft */
77      condition : elevation1230 > 249 and elevation1300 < 249
78      priority  : 1
79      penalty+  : 1000
80      penalty-  : 1000
81      Value     : elev_to_stor { 1230, elevation1230 } - elev_to_stor { 1230, 249 }
82
83     /*  To ensure accurate accounting of water supply and quality pools, when stressed, release some contents from Beaverdam if either
84    yesterday's water supply or water quality account for Falls was less than 5% full; do not draw down more than 1 ft per day
85    THIS IS NOT PART OF TERRY'S SPREADSHEET (sn) */
86      condition :  _FLake_WS_Pct(-1) < 5 or _FLake_WQ_Pct(-1) < 5 and elevation1230 > elevation1300 + 0.9
87       and elevation1230(-5) - elevation1230 < 5
88      priority  : 1
89      penalty+  : 1000
90      penalty-  : 1000
91      Value     : max {0, min {elev_to_stor { 1230, elevation1230 } - elev_to_stor { 1230, elevation1230 - 1 } ,
92        ( _Bdam_WS_Stor(-1) + _Bdam_WQ_Stor(-1) + inflow1230 - evap1230 )} }
93
94      condition : default
```

```
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
    Value     : 0
}


/*  Constrain the delivery for Raleigh from Falls based on amount in the total (Falls+Bdam) water supply storage account.
    Demand will not be fulfilled if the account has gone empty and there is not enough inflow to the water supply account (for the previous day).
    Similarly, constrain the water quality release from Falls (arc 1300.1310) based on amount in the water quality storage account.

    Since we refer to yesterday's storage estimates, for the first day of the run, constrain deliveries and releases to the initialized volumes for
    each account (for simplicity, ignore inflows) so that deliveries and releases are made. */


Constraint   Deliv_Lim_Raleigh :
 {  condition  :  abs_period = 1
    expression :  dflow1300.1305 <= [FLake_WS_Stor] + [Bdam_WS_Stor]
 }

Constraint   Deliv_Lim_Raleigh :
 {  condition  :  abs_period > 1
    expression :  dflow1300.1305 <= _Total_WS_Stor(-1)
 }

Constraint   Release_Limit_Falls :
 {  condition  :  abs_period = 1
    expression :  dflow1300.1304 <= [FLake_WQ_Stor] + [Bdam_WQ_Stor]
 }

Constraint   Release_Limit_Falls :
 {  condition  :  abs_period > 1
    expression :  dflow1300.1304 <= _Total_WQ_Stor(-1)
 }
```

Falls_Bdam_WQ_WS_Accounts.ocl

```
1  /*  Falls_Bdam_WQ_WS_Accounts.ocl */
2
3
4  /*  Beaverdam Accounting */
5
6  Set  :  _Bdam_Inf  {  value :  inflow1230 - evap1230(0) }  /* Base it on net inflow for Beaverdam.
7                Evap (0) since this file is included after the solve statement and we want today's evap, not tomorrow's */
8
9  Set  :  _Bdam_Inf_WS   {  value :  _Pct_Max_WS_Storage / 100 * _Bdam_Inf }
10
11 Set  :  _Bdam_WS_Rel /* Calculate the WS outflow to Falls from Beaverdam.  Assume that the WS amount is simply based on
12     the percent of water supply to total account storage in Beaverdam */
13 {    condition  :  elevation1230 < 249 /* WS Outflow only if Beaverdam is less than 249ft (spillage is accounted for in Falls) */
14     value      :  flow1230.1300 * _Pct_Max_WS_Storage / 100
15
16     condition  :  default
17     value      :  0
18 }
19
20 Set  :  _Bdam_WS_Stor_Init /* Calculate the initial Beaverdam WS storage (before computing spill to WQ and back*/
21 {    condition  :  elevation1230 >= 249 or _Bdam_WS_Stor(-1) + _Bdam_Inf_WS - _Bdam_WS_Rel >= _Bdam_Max_WS_Storage
22     value      :  _Bdam_Max_WS_Storage
23
24 /*   Prevent the water supply account from going negative */
25     condition  :  default
26     value      :  max {  0, _Bdam_WS_Stor(-1) + _Bdam_Inf_WS - _Bdam_WS_Rel }
27 }
28
29 Set  :  _Bdam_WStoWQ_Spill /* Calculate the spillover from WS to WQ*/
30 {    condition  :  _Bdam_WS_Stor(-1) + _Bdam_Inf_WS - _Bdam_WS_Rel > _Bdam_Max_WS_Storage /* Spillover only if projected WS storage
31                    is more than 100% */
32     value      :  _Bdam_WS_Stor(-1) + _Bdam_Inf_WS - _Bdam_WS_Rel - _Bdam_Max_WS_Storage
33
34     condition  :  default
35     value      :  0
36 }
37
38 Set  :  _Bdam_Inf_WQ   {  value  :  _Pct_Max_WQ_Storage / 100 * _Bdam_Inf }
39
40 Set  :  _Bdam_WQ_Rel /* Calculate the WQ outflow to Falls from Beaverdam */
41 {    condition  :  elevation1230 < 249 /* WQ Outflow only if Beaverdam is less than 249ft (spillage is accounted for in Falls) */
42     value      :  flow1230.1300 * _Pct_Max_WQ_Storage / 100
43
44     condition  :  default
45     value      :  0
46 }
47
```

```
Set : _Bdam_WQ_Stor /* Calculate the Beaverdam WQ storage */
{    condition : elevation1230 >= 249 or _Bdam_WQ_Stor(-1) +
    ( _Bdam_WStoWQ_Spill + _Bdam_Inf_WQ - _Bdam_WQ_Rel ) >= _Bdam_Max_WQ_Storage
     value    : _Bdam_Max_WQ_Storage

/*   Prevent the water quality account from going negative */
     condition : default
     value    : max { 0, _Bdam_WQ_Stor(-1) + ( _Bdam_WStoWQ_Spill + _Bdam_Inf_WQ - _Bdam_WQ_Rel ) }
}

Set : _Bdam_WQtoWS_Spill /* Calculate the spillover from WQ to WS */
{    condition : _Bdam_WQ_Stor(-1) +
    ( _Bdam_WStoWQ_Spill + _Bdam_Inf_WQ - _Bdam_WQ_Rel ) > _Bdam_Max_WQ_Storage   /* Spillover only if
                        projected WS storage more than 100% */
     value    : _Bdam_WQ_Stor(-1) + ( _Bdam_WStoWQ_Spill + _Bdam_Inf_WQ - _Bdam_WQ_Rel ) - _Bdam_Max_WQ_Storage

     condition : default
     value    : 0
}

Set : _Bdam_WS_Stor /* Calculate the final Beaverdam WS storage (after computing spillage) */
{    condition : _Bdam_WS_Stor_Init + _Bdam_WQtoWS_Spill >= _Bdam_Max_WS_Storage  /* Set at 100% if at or above full */
     value    : _Bdam_Max_WS_Storage

     condition : default
     value    : _Bdam_WS_Stor_Init + _Bdam_WQtoWS_Spill
}


/*  Falls Accounting  */

/* Falls Lake inflow is Falls gain + upstream flows into Falls*/
Set : _FLake_Inf
{   /* When Beaverdam is full, inflow to Falls account from Beaverdam will simply be the Beaverdam surplus above 249 (= net inflow).
   Note for the general accounting (i.e, not the WS/WQ accounting), storage will accumulate in Beaverdam (and Falls) until the
   upper rule of [Falls_upper_rule] is reached. The point of this is to mirror what historic elevations have been */
   condition :   elevation1230 >= 249 and elevation1230(0) >= 249 // second statement added by Reed
   value    :   inflow1300 + flow1163.1300 + flow1205.1300 + flow1250.1300 + flow1256.1300 +
     flow1270.1300 + flow1705.1300 - delivery1302 - evap1300(0) + _Bdam_Inf

// the next two statements added by Reed to improve performance of reservoir balancing
   condition :  elevation1230 >= 249 and elevation1230(0) < 249 and elevation1300 < 249
   value    : inflow1300 + flow1163.1300 + flow1205.1300 + flow1250.1300 + flow1256.1300 +
     flow1270.1300 + flow1705.1300 - delivery1302 - evap1300(0) + _Bdam_Inf - (storage1230 - storage1230(0))

   condition : elevation1230 >= 249 and elevation1230(0) < 249 and elevation1300 >= 249
   value    : inflow1300 + flow1163.1300 + flow1205.1300 + flow1250.1300 + flow1256.1300 +
```

```
95      flow1270.1300 + flow1705.1300 - delivery1302 - evap1300(0) + _Bdam_Inf - (elev_to_stor{1230,249} - storage1230(0))
96
97  /* Otherwise, inflow to Falls account from Beaverdam is simply the Beaverdam release defined in the main.ocl
98   (associated with drought operations).  This will be today's release since
99     this accounting file is included after the solve statement in the main.ocl file */
100  condition :  default
101  value     :  inflow1300 + flow1163.1300 + flow1205.1300 + flow1250.1300 + flow1256.1300 +
102     flow1270.1300 + flow1705.1300 - delivery1302 - evap1300(0) + flow1230.1300
103 }
104
105 Set : _FLake_Inf_WS { value : _Pct_Max_WS_Storage / 100 * _FLake_Inf } /* Calculate WS portion of Falls inflow */
106
107 /*  The water supply release from Falls = the delivery to Raleigh.  The delivery is constrained in the main.ocl file
108  to the amount in the water supply storage pool plus the inflow to that account.  This way, the delivery will not
109  be made if the account has emptied */
110 Set : _Flake_WS_Rel { value : flow1300.1305 }
111
112 Set : _FLake_WS_Stor_Init /* Calculate the initial Falls WS storage (before computing spill to WQ and back) */
113 {    condition : elevation1300 >= [Falls_upper_rule] or _FLake_WS_Stor(-1)
114     + ( _FLake_Inf_WS -  _Flake_WS_Rel ) >= _FLake_Max_WS_Storage     /* Set at 100% if at or above full */
115      value     : _FLake_Max_WS_Storage
116
117   /*  Sets the water supply storage floor as zero minus the storage in Beaverdam */
118      condition : default
119      value     : max {  0 - _Bdam_WS_Stor, _FLake_WS_Stor(-1) + ( _FLake_Inf_WS -  _Flake_WS_Rel ) }
120 }
121
122 Set : _FLake_WStoWQ_Spill /* Calculate the spillover from WS to WQ */
123 {    condition :  _FLake_WS_Stor(-1) + ( _FLake_Inf_WS - _Flake_WS_Rel ) > _FLake_Max_WS_Storage  /* Spillover only if
124                      projected WS storage is
125                      more than 100%  */
126      value     : _FLake_WS_Stor(-1) + ( _FLake_Inf_WS - _Flake_WS_Rel ) - _FLake_Max_WS_Storage
127
128      condition : default
129      value     : 0
130 }
131
132 Set : _FLake_Inf_WQ { value : _Pct_Max_WQ_Storage / 100 * _FLake_Inf } /* Calculate WQ portion of Falls inflow */
133
134 /*  The water quality release from Falls = outflow from Falls.  The release is constrained in the main.ocl file to the amount in the water
135  quality storage pool plus the inflow to that account.  This way, the release will not be made if the account has emptied. Note the outflow may
136  include releasing surplus water above the rule curve, which technically would be more than the water quality release.  But since the account
137  is reset to full above the rule curve, it makes no difference.  However, to make it more realistic, set the WQ release to the minimum flow from Falls
138  (for simplicity) when the elevation is at [Falls_upper_rule] or above.  */
139 Set : _Flake_WQ_Rel
140 {    condition : elevation1300 >= [Falls_upper_rule]
141    value     : min_flow1300.1304
```

```
142
143    condition  :  default
144    value      :  flow1300.1304
145  }
146
147  Set  :  _FLake_WQ_Stor /* Calculate the Falls WQ storage */
148  {     condition  : elevation1300 >= [Falls_upper_rule] and elevation1230 < [Falls_upper_rule]
149        value      : _FLake_Max_WQ_Storage - ( max { 0, elev_to_stor{ 1230, [Falls_upper_rule] } - storage1230 } ) * _Pct_Max_WQ_Storage/100
150
151        condition  :  elevation1300 >= [Falls_upper_rule] or _FLake_WQ_Stor(-1)
152       + ( _FLake_WStoWQ_Spill + _FLake_Inf_WQ -_Flake_WQ_Rel ) >= _FLake_Max_WQ_Storage
153        value      :  _FLake_Max_WQ_Storage
154
155  /*    Fix WS WQ accounting error on first day of drought. */
156        condition  : elevation1300(0) >= [Falls_upper_rule] and elevation1300 < [Falls_upper_rule]
157        value      : _FLake_Max_WQ_Storage - ( elev_to_stor{ 1300, [Falls_upper_rule] } - storage1300 ) * _Pct_Max_WQ_Storage/100
158
159     /*  Sets the water supply storage floor as zero minus the storage in Beaverdam */
160        condition  :  default
161        value      :  max { 0 - _Bdam_WQ_Stor, _FLake_WQ_Stor(-1)
162         + ( _FLake_WStoWQ_Spill + _FLake_Inf_WQ -_Flake_WQ_Rel ) } /* Appears to be counted twice in
163                        terry's spreadsheet, but we are not here.*/
164  }
165
166  Set  :  _FLake_WQtoWS_Spill /* Calculate the spillover from WQ to WS */
167  {     condition  :   _FLake_WQ_Stor(-1)
168       + ( _FLake_WStoWQ_Spill + _FLake_Inf_WQ - _Flake_WQ_Rel ) > _FLake_Max_WQ_Storage   /* Spillover only if
169                          projected WS storage
170                          more than 100% */
171        value      :   _FLake_WQ_Stor(-1) + ( _FLake_WStoWQ_Spill + _FLake_Inf_WQ - _Flake_WQ_Rel ) - _FLake_Max_WQ_Storage
172
173        condition  :  default
174        value      :  0
175  }
176
177  Set  :  _FLake_WS_Stor /* Calculate the final Falls WS storage (after computing spillage) */
178  {     condition  : elevation1300 >= [Falls_upper_rule] and elevation1230 < [Falls_upper_rule] // modified by R.Palmer
179        value      : _FLake_Max_WS_Storage - ( max { 0, elev_to_stor{ 1230, [Falls_upper_rule] } - storage1230 } ) * _Pct_Max_WS_Storage/100
180
181        // Following two conditions added by R. Palmer to improve accurate accounting under cross-over conditions
182        condition  :  _FLake_WS_Stor_Init + _FLake_WQtoWS_Spill >= _FLake_Max_WS_Storage /* Set to 100% if more than full */
183        value      :  _FLake_Max_WS_Storage
184
185  /*    Fix WS WQ accounting error on first day of drought. */
186        condition  : elevation1300(0) >= [Falls_upper_rule] and elevation1300 < [Falls_upper_rule]
187        value      : _FLake_Max_WS_Storage - ( elev_to_stor{ 1300, [Falls_upper_rule] } - storage1300 ) * _Pct_Max_WS_Storage/100
188
```

```
189
190    condition : default
191       value     : _FLake_WS_Stor_Init + _FLake_WQtoWS_Spill
192  }
193
194  Set : _Total_WS_Stor  {  value : _FLake_WS_Stor + _Bdam_WS_Stor  } /* Sum the total WS storage for Falls + Beaverdam */
195
196
197  Set : _Total_WQ_Stor  {  value : _FLake_WQ_Stor + _Bdam_WQ_Stor  } /* Sum the total WQ storage for Falls + Beaverdam */
198
199
200  /*  Calculate the percent of full for the WS and WQ accounts */
201
202  Set : _Bdam_WS_Pct  {  value : 100 * _Bdam_WS_Stor  / _Bdam_Max_WS_Storage  }
203  Set : _Bdam_WQ_Pct  {  value : 100 * _Bdam_WQ_Stor  / _Bdam_Max_WQ_Storage  }
204  Set : _FLake_WS_Pct {  value : 100 * _FLake_WS_Stor / _FLake_Max_WS_Storage }
205  Set : _FLake_WQ_Pct {  value : 100 * _FLake_WQ_Stor / _FLake_Max_WQ_Storage }
206  Set : _Total_WS_Pct {  value : 100 * _Total_WS_Stor / [Total_Max_WS_Storage]}
207  Set : _Total_WQ_Pct {  value : 100 * _Total_WQ_Stor / [Total_Max_WQ_Storage] }
```

Falls_flood_ops.ocl

```
/*  FALLS_FLOOD_OPS.OCL  */

/* Flood release policy for Falls Lake */

/*  Calculate estimated local inflow to Clayton, which is used in determing Falls flood releases */
Set : _ClaytLocal
{        Value : inflow1290 + inflow1445 + inflow1450 + inflow1630 +
         /*  To increase accuracy, estimate Crabtree outflows by using starting elevation and spillway curve */
         min {convert_units { Lookup{ 1416Outflow, elevation1416 }, cfs, af}, storage1416 - elev_to_stor {1416, 230} } +

         min {convert_units { Lookup{ 1418Outflow, elevation1418 }, cfs, af}, storage1418 - elev_to_stor {1418, 335} } +

         min {convert_units { Lookup{ 1422Outflow, elevation1422 }, cfs, af}, storage1422 - elev_to_stor {1422, 252} }
}


/*  Falls flood operations per recommendations in Terry Brown's email 02/26/2009 */
Target Falls_release  :  dflow1300.1304
{   /*  Release only the minimum release if elevation is less than 255 and est. Clayton inflows >= 7000 cfs */
    condition : elevation1300 >= [Falls_upper_rule] and elevation1300 <= 255 and _ClaytLocal >= convert_units { 7000, cfs, af}
    priority  : 1
    penalty+  : 50
    penalty-  : 50
    Value     : min_flow1300.1304

    /*  If elev. < 255 and est. Clayton inflow < 7000 cfs, release the lesser of 4000 cfs or (7000 - the Clayt inflow).
        Also added provision to only drop Falls to the guide curve, but not less than the minimum release */
    condition : elevation1300 >= [Falls_upper_rule] and elevation1300 <= 255 and _ClaytLocal < convert_units { 7000, cfs, af}
    priority  : 1
    penalty+  : 50
    penalty-  : 0  // Set to 0 for underage to improve release performance - RP
    Value     : max { min_flow1300.1304, min { convert_units { 4000, cfs, af }, convert_units { 7000, cfs, af }
     - _ClaytLocal, storage1300 - elev_to_stor { 1300, [Falls_upper_rule] } } }

    /*  Release only the minimum release if elevation is less than 255 - 258 and est. Clayton inflows >= 7000 cfs */
    condition : elevation1300 > 255 and elevation1300 <= 258 and _ClaytLocal >= convert_units { 7000, cfs, af}
    priority  : 1
    penalty+  : 50
    penalty-  : 50
    Value     : min_flow1300.1304

    /*  If elev. is 255 - 258 and est. Clayton inflow < 7000 cfs, release 7000 - the Clayt inflow. */
    condition : elevation1300 > 255 and elevation1300 <= 258 and _ClaytLocal < convert_units { 7000, cfs, af}
    priority  : 1
    penalty+  : 50
    penalty-  : 50
    Value     : convert_units { 7000, cfs, af } - _ClaytLocal
```

```
48
49     /*  Release only the minimum release if elevation is 258 - 264.8 and est. Clayton inflows >= 8000 cfs */
50     condition : elevation1300 > 258 and elevation1300 <= 264.8 and _ClaytLocal >= convert_units { 8000, cfs, af}
51     priority  : 1
52     penalty+  : 50
53     penalty-  : 50
54     Value     : min_flow1300.1304
55
56     /*   If elev. is 258 - 264.8 and est. Clayton inflow < 8000 cfs, release 8000 - the Clayt inflow. */
57     condition : elevation1300 > 258 and elevation1300 <= 264.8 and _ClaytLocal < convert_units { 8000, cfs, af}
58     priority  : 1
59     penalty+  : 50
60     penalty-  : 50
61     Value     : convert_units { 8000, cfs, af } - _ClaytLocal
62
63     /*  If elev. is 264.8 - 268 and est. Clayton inflow >= 8000 cfs, release only the computed spillway amount */
64     condition : elevation1300 > 264.8 and elevation1300 <= 268 and _ClaytLocal >= convert_units { 8000, cfs, af}
65     priority  : 1
66     penalty+  : 50
67     penalty-  : 50
68     Value     : convert_units { lookup { FallsSpillway, elevation1300 }, cfs, af }
69
70     /*  If elev. is 264.8 - 268 and est. Clayton inflow < 8000 cfs, release [(8000 cfs + the computed spillway amount) - the Clayt inflow]. */
71     condition : elevation1300 > 264.8 and elevation1300 <= 268 and _ClaytLocal < convert_units { 8000, cfs, af}
72     priority  : 1
73     penalty+  : 50
74     penalty-  : 50
75     Value     : convert_units {  8000 + lookup { FallsSpillway, elevation1300 }, cfs, af } - _ClaytLocal
76
77     /*  If elev. is > 268, release the full amounts possible from the service gates and the spillway. */
78     condition : elevation1300 > 268
79     priority  : 1
80     penalty+  : 50
81     penalty-  : 50
82     Value     : convert_units { lookup { FallsSvcGate, elevation1300 } + lookup { FallsSpillway, elevation1300 }, cfs, af }
83  }
84
85  /*  Set targets based on flood stages at downstream gages; note that the above release policy takes priorty over these targets */
86
87  /*  Clayton flood control target */
88  Target Clayton_max  :  dflow1630.1640
89  {   condition : default
90     priority  : 1
91     penalty+  : 10
92     penalty-  : 0
93     Value     : convert_units{ 5332, cfs, af }
94  }
```

```
 95
 96  /*  Goldsboro flood control target  */
 97  Target Goldsboro_max  :  dflow1780.1790
 98  {   condition : default
 99      priority  : 1
100      penalty+  : 10
101      penalty-  : 0
102      Value     : convert_units{ 6003, cfs, af }
103  }
104
105  /*  Kinston flood control target */
106  Target Kinston_max  :  dflow1800.1850
107  {   condition : default
108      priority  : 1
109      penalty+  : 10
110      penalty-  : 0
111      Value     : convert_units{ 7168, cfs, af }
112  }
```

Fayetteville_ops.ocl

```
1  /*  Fayetteville_ops.ocl  */
2  /*  Operational policies for Fayetteville */
3
4
5  // Switch to river intake only when Glenville < 212.2 ft
6  Target Glenville_WD : dflow0760.0731
7  {   condition : storage0760 < lower_rule0760
8      priority  : 1
9      penalty+  : 50
10     penalty-  : 50
11     Value     : 0
12
13 // Otherwise WD 4.5 mgd (per conversation with Chris Smith at Fayetteville). 4.5 mgd is also set as the max flow pattern
14     condition : default
15     priority  : 1
16     penalty+  : 50
17     penalty-  : 50
18     Value     : convert_units { 4.5, mgd, af }
19 }
20
```

filter_inflows.ocl

```
/*  FILTER_INFLOWS.OCL  */

/* Sets the inflows for nodes that need to be filtered. The finalized inflows (through Sept 2011)
   were already filtered; however, the provisional inflows from the update record routine can be
   negative due to time of travel or imperfect impairment estimations, and therefore are filtered
   here to prevent model infeasibility or unrealistic reservoir releases and/or demand shortages.
   All Neuse inflows are filtered except Falls/Bdam, which can have negatives due to the use of
   back-calculated inflows; and Michie/LRR in Durham, which are based on already unimpaired gages
   that will not be negative.  The inflows to the Crabtree Creek system are set and filtered
   separately in Crabtree.ocl. Negative back-calculated inflows for Falls/Bdam are not physically
   possible since we've adjusted for net evap and net withdrawals; however, reservoir storage can
   handle these negatives.  The negatives are not used in developing regressions to fill in other
   gages, so we do not need to adjust the negatives.
*/

// The Cape Fear inflow nodes could be expanded
:For:
{   [node] = { 0020, 0040, 0070, 0090, 0300, 0310, 0324, 0325, 0590, 0760, 0140, 0145, 0170, 0210, 0220, 0260,
    0270, 0280, 0340, 0380, 0400, 0430, 0450, 0470, 0490, 0520, 0527, 0550, 0700, 1010, 1050, 1060,
    1080, 1100, 1110, 1115, 1250, 1270, 1290, 1420, 1440, 1445, 1450, 1500, 1560, 1630, 1740 }
}
    Set : _TempInf[node] { Value : timesers([node]/inflow) }
    Set : inflow[node] { Value : max{0, _TempInf[node] - _InfDeficit[node](-1) } }
    Set : _InfDeficit[node] { Value : max{0, _InfDeficit[node](-1) - _TempInf[node] } }

:Next:

// In addition to filtering, this also sets inflows to points of interest
// that are not contained in the basedata file, and adjusts existing inflows accordingly

// New inflows for CF

// Greensboro Haw intake
Set : _TempInf0044 { Value : timesers(0090/inflow)*(14/174.6) }
Set : inflow0044 { Value : max{0, _TempInf0044 - _InfDeficit0044(-1) } }
Set : _InfDeficit0044 { Value : max{0, _InfDeficit0044(-1) - _TempInf0044 } }

// Adj Haw gage
Set : _TempInf0090 { Value : timesers(0090/inflow)*(160.6/174.6) }
Set : inflow0090 { Value : max{0, _TempInf0090 - _InfDeficit0090(-1) } }
Set : _InfDeficit0090 { Value : max{0, _InfDeficit0090(-1) - _TempInf0090 } }

// Since the timeseries for Oakrdige includes the gain to Brandt, need to separate out that gain
Set : _Gibso_Gain { value : 110.4 *timesers(0140/inflow) / 35 }

// Lake Higgins - 11 sq mi of the gain from Oakridge to Brandt
Set : _TempInf0112 { Value : (11 / 49.4) * _Gibso_Gain * 49.4 / 110.4  } // Higgins is
```

```
48  Set : inflow0112 { Value : max{0, _TempInf0112 - _InfDeficit0112(-1) } }
49  Set : _InfDeficit0112 { Value : max{0, _InfDeficit0112(-1) - _TempInf0112 } }
50
51  // Brandt Reservoir - the remaining 38.4 sq mi of the gain from Oakridge to Brandt
52  Set : _TempInf0120 { Value : (38.4 / 49.4) * _Gibso_Gain * 49.4 / 110.4  }
53  Set : inflow0120 { Value : max{0, _TempInf0120 - _InfDeficit0120(-1) } }
54  Set : _InfDeficit0120 { Value : max{0, _InfDeficit0120(-1) - _TempInf0120 } }
55
56  // Adj Oakridge Inflow - now just the Oakridge gage portion of the 110 inflow timeseries
57  Set : _TempInf0110 { Value : timesers(0110/inflow) - inflow0112 - inflow0120 }
58  Set : inflow0110 { Value : max{0, _TempInf0110 - _InfDeficit0110(-1) } }
59  Set : _InfDeficit0110 { Value : max{0, _InfDeficit0110(-1) - _TempInf0110 } }
60
61  // Rocky River Discharge
62  Set : _TempInf0328 { Value : (timesers(0324/inflow)+timesers(0325/inflow))*(22.8/55) }
63  Set : inflow0328 { Value : max{0, _TempInf0328 - _InfDeficit0328(-1) } }
64  Set : _InfDeficit0328 { Value : max{0, _InfDeficit0328(-1) - _TempInf0328 } }
65
66  // Ramseur Discharge
67  Set : _TempInf0570 { Value : timesers(0300/inflow)*(6/355) }
68  Set : inflow0570 { Value : max{0, _TempInf0570 - _InfDeficit0570(-1) } }
69  Set : _InfDeficit0570 { Value : max{0, _InfDeficit0570(-1) - _TempInf0570 } }
70
71  // Adj 590 for Robbins intake
72  Set : _TempInf0590 { Value : timesers(0590/inflow)*(268/400) }
73  Set : inflow0590 { Value : max{0, _TempInf0590 - _InfDeficit0590(-1) } }
74  Set : _InfDeficit0590 { Value : max{0, _InfDeficit0590(-1) - _TempInf0590 } }
75
76  // Robbins intake
77  Set : _TempInf0580 { Value : timesers(0590/inflow)*(132/400) }
78  Set : inflow0580 { Value : max{0, _TempInf0580 - _InfDeficit0580(-1) } }
79  Set : _InfDeficit0580 { Value : max{0, _InfDeficit0580(-1) - _TempInf0580 } }
80
81  // Pilgrims Pride intake
82  Set : _TempInf0600 { Value : timesers(0640/inflow)*(371/630) }
83  Set : inflow0600 { Value : max{0, _TempInf0600 - _InfDeficit0600(-1) } }
84  Set : _InfDeficit0600 { Value : max{0, _InfDeficit0600(-1) - _TempInf0600 } }
85
86  // Node 610
87  Set : _TempInf0610 { Value : timesers(0640/inflow)*(40/630) }
88  Set : inflow0610 { Value : max{0, _TempInf0610 - _InfDeficit0610(-1) } }
89  Set : _InfDeficit0610 { Value : max{0, _InfDeficit0610(-1) - _TempInf0610 } }
90
91  // Adj Deep Moncure Gage
92  Set : _TempInf0640 { Value : timesers(0640/inflow)*(219/630) - inflow0328 - inflow0570}
93  Set : inflow0640 { Value : max{0, _TempInf0640 - _InfDeficit0640(-1) } }
94  Set : _InfDeficit0640 { Value : max{0, _InfDeficit0640(-1) - _TempInf0640 } }
```

```
95
96  // Node 660
97  Set : _TempInf0660 { Value : timesers(0780/inflow)*(286/919.6) }
98  Set : inflow0660 { Value : max{0, _TempInf0660 - _InfDeficit0660(-1) } }
99  Set : _InfDeficit0660 { Value : max{0, _InfDeficit0660(-1) - _TempInf0660 } }
100
101 // Node 680
102 Set : _TempInf0680 { Value : timesers(0780/inflow)*(20/919.6) }
103 Set : inflow0680 { Value : max{0, _TempInf0680 - _InfDeficit0680(-1) } }
104 Set : _InfDeficit0680 { Value : max{0, _InfDeficit0680(-1) - _TempInf0680 } }
105
106 // Node 700 - Carthage WS WD upstream on Little River.
107 // Note that 700/inflow timeseries is the full Little R. Linden gage flow
108 Set : _TempInf0700 { Value : timesers(0700/inflow)*(200/459) }
109 Set : inflow0700 { Value : max{0, _TempInf0700 - _InfDeficit0700(-1) } }
110 Set : _InfDeficit0700 { Value : max{0, _InfDeficit0700(-1) - _TempInf0700 } }
111
112 // Node 720 - Set as the remainder of the Little River Linden Gage flow
113 Set : _TempInf0720 { Value : timesers(0700/inflow)*(259/459) }
114 Set : inflow0720 { Value : max{0, _TempInf0720 - _InfDeficit0720(-1) } }
115 Set : _InfDeficit0720 { Value : max{0, _InfDeficit0720(-1) - _TempInf0720 } }
116
117 // Fayetteville PWC Intake
118 Set : _TempInf0730 { Value : timesers(0780/inflow)*(131/919.6) }
119 Set : inflow0730 { Value : max{0, _TempInf0730 - _InfDeficit0730(-1) } }
120 Set : _InfDeficit0730 { Value : max{0, _InfDeficit0730(-1) - _TempInf0730 } }
121
122 // Monsanto WS Intake
123 Set : _TempInf0770 { Value : timesers(0780/inflow)*(420.6/919.6) }
124 Set : inflow0770 { Value : max{0, _TempInf0770 - _InfDeficit0770(-1) } }
125 Set : _InfDeficit0770 { Value : max{0, _InfDeficit0770(-1) - _TempInf0770 } }
126
127 // Adj CF Tarheel Gage
128 Set : _TempInf0780 { Value : timesers(0780/inflow)*(62/919.6) }
129 Set : inflow0780 { Value : max{0, _TempInf0780 - _InfDeficit0780(-1) } }
130 Set : _InfDeficit0780 { Value : max{0, _InfDeficit0780(-1) - _TempInf0780 } }
131
132 // L&D #2 / Elizabethtown WWTP
133 Set : _TempInf0790 { Value : timesers(0820/inflow)*(168/403) }
134 Set : inflow0790 { Value : max{0, _TempInf0790 - _InfDeficit0790(-1) } }
135 Set : _InfDeficit0790 { Value : max{0, _InfDeficit0790(-1) - _TempInf0790 } }
136
137 // Adj of CF Kelly Gage
138 Set : _TempInf0820 { Value : timesers(0820/inflow)*(235/403) }
139 Set : inflow0820 { Value : max{0, _TempInf0820 - _InfDeficit0820(-1) } }
140 Set : _InfDeficit0820 { Value : max{0, _InfDeficit0820(-1) - _TempInf0820 } }
141
```

```
142
143 // New inflows for Neuse
144
145 // 205 - Little R @ Eno R
146 Set : _TempInf1205 { Value : timesers(1115/inflow)*(105/75) }
147 Set : inflow1205 { Value : max{0, _TempInf1205 - _InfDeficit1205(-1) } }
148 Set : _InfDeficit1205 { Value : max{0, _InfDeficit1205(-1) - _TempInf1205 } }
149
150 // Adj Falls inflow (not filtered)
151 Set : inflow1300 { Value : timesers(1300/inflow) - inflow1205 }
152
153 // Apex WW Discharge
154 Set : _TempInf1405 { Value : timesers(1480/inflow)*(0.9/83.5) }
155 Set : inflow1405 { Value : max{0, _TempInf1405 - _InfDeficit1405(-1) } }
156 Set : _InfDeficit1405 { Value : max{0, _InfDeficit1405(-1) - _TempInf1405 } }
157
158 // Fuquay-Varina WW Discharge
159 Set : _TempInf1409 { Value : timesers(1480/inflow)*(7.6/83.5) }
160 Set : inflow1409 { Value : max{0, _TempInf1409 - _InfDeficit1409(-1) } }
161 Set : _InfDeficit1409 { Value : max{0, _InfDeficit1409(-1) - _TempInf1409 } }
162
163 // Cary SWRF Discharge
164 Set : _TempInf1471 { Value : timesers(1480/inflow)*(21.5/83.5) }
165 Set : inflow1471 { Value : max{0, _TempInf1471 - _InfDeficit1471(-1) } }
166 Set : _InfDeficit1471 { Value : max{0, _InfDeficit1471(-1) - _TempInf1471 } }
167
168 // Adj Middle Ck Gage
169 Set : _TempInf1480 { Value : timesers(1480/inflow)*(53.5/83.5) }
170 Set : inflow1480 { Value : max{0, _TempInf1480 - _InfDeficit1480(-1) } }
171 Set : _InfDeficit1480 { Value : max{0, _InfDeficit1480(-1) - _TempInf1480 } }
172
173 // Wiggons Mill Lake
174 Set : _TempInf1520 { Value : timesers(1560/inflow)*(77/575) }
175 Set : inflow1520 { Value : max{0, _TempInf1520 - _InfDeficit1520(-1) } }
176 Set : _InfDeficit1520 { Value : max{0, _InfDeficit1520(-1) - _TempInf1520 } }
177
178 // Adj Contentnea Hookerton Gage
179 Set : _TempInf1560 { Value : timesers(1560/inflow)*(498/575) }
180 Set : inflow1560 { Value : max{0, _TempInf1560 - _InfDeficit1560(-1) } }
181 Set : _InfDeficit1560 { Value : max{0, _InfDeficit1560(-1) - _TempInf1560 } }
182
183 // Smith Confluence -
184 Set : _TempInf1320 { Value : timesers(1630/inflow)*(20/271) }
185 Set : inflow1320 { Value : max{0, _TempInf1320 - _InfDeficit1320(-1) } }
186 Set : _InfDeficit1320 { Value : max{0, _InfDeficit1320(-1) - _TempInf1320 } }
187
188 // Crabtree Ck Confluence
```

```
Set : _TempInf1600 { Value : timesers(1630/inflow)*(90/271) }
Set : inflow1600 { Value : max{0, _TempInf1600 - _InfDeficit1600(-1) } }
Set : _InfDeficit1600 { Value : max{0, _InfDeficit1600(-1) - _TempInf1600 } }

// Walnut Ck Confluence -
Set : _TempInf1620 { Value : timesers(1630/inflow)*(41/271) }
Set : inflow1620 { Value : max{0, _TempInf1620 - _InfDeficit1620(-1) } }
Set : _InfDeficit1620 { Value : max{0, _InfDeficit1620(-1) - _TempInf1620 } }

// NRWWTP - Natural inflow between Walnut Creek and Neuse River WWTP - node added in 2014
Set : _TempInf1625 { Value : timesers(1630/inflow)*(62/271) }
Set : inflow1625 { Value : max{0, _TempInf1625 - _InfDeficit1625(-1) } }
Set : _InfDeficit1625 { Value : max{0, _InfDeficit1625(-1) - _TempInf1625 } }

// Adj Neuse Clayton Gage (increased to 58 sq. miles from 11 sq. mi.based on drainage between NRWWTP and Clayton Gage)
Set : _TempInf1630 { Value : timesers(1630/inflow)*(58/271) }
Set : inflow1630 { Value : max{0, _TempInf1630 - _InfDeficit1630(-1) } }
Set : _InfDeficit1630 { Value : max{0, _InfDeficit1630(-1) - _TempInf1630 } }

// Kenly WW
Set : _TempInf1747 { Value : timesers(1750/inflow)*(165.2/181.2) }
Set : inflow1747 { Value : max{0, _TempInf1747 - _InfDeficit1747(-1) } }
Set : _InfDeficit1747 { Value : max{0, _InfDeficit1747(-1) - _TempInf1747 } }

// Adj Little R Princeton Gage
Set : _TempInf1750 { Value : timesers(1750/inflow)*(16/181.2) }
Set : inflow1750 { Value : max{0, _TempInf1750 - _InfDeficit1750(-1) } }
Set : _InfDeficit1750 { Value : max{0, _InfDeficit1750(-1) - _TempInf1750 } }

// Johnston County Intake
Set : _TempInf1650 { Value : timesers(1780/inflow)*(30/867.2) }
Set : inflow1650 { Value : max{0, _TempInf1650 - _InfDeficit1650(-1) } }
Set : _InfDeficit1650 { Value : max{0, _InfDeficit1650(-1) - _TempInf1650 } }

// Neuse Smithfield
Set : _TempInf1660 { Value : timesers(1780/inflow)*(26/867.2) }
Set : inflow1660 { Value : max{0, _TempInf1660 - _InfDeficit1660(-1) } }
Set : _InfDeficit1660 { Value : max{0, _InfDeficit1660(-1) - _TempInf1660 } }

// Swift Ck Confluence - changed from 4 to 144.2 based on total DA at Swift/Middle/Neuse confluence of 1500.0
// sq. mi (per USGS streamstats) - 1206 @ Smithfield  - 83.5@ Middle Creek - 66.3 @ L. Benson  = 144.2
Set : _TempInf1700 { Value : timesers(1780/inflow)*(144.2/867.2) }
Set : inflow1700 { Value : max{0, _TempInf1700 - _InfDeficit1700(-1) } }
Set : _InfDeficit1700 { Value : max{0, _InfDeficit1700(-1) - _TempInf1700 } }

// Richardson Bridge Rd crossing of Neuse - potential JC Intake #2 site. Total DA is 1677 sq mi. per CH2M Hill 2013 SY Addendum
Set : _TempInf1730 { Value : timesers(1780/inflow)*(177/867.2) }
```

```
Set : inflow1730 { Value : max{0, _TempInf1730 - _InfDeficit1730(-1) } }
Set : _InfDeficit1730 { Value : max{0, _InfDeficit1730(-1) - _TempInf1730 } }

// Alternative site for Johnston County lower Neuse Intake below the confluence with Mill Creek - total DA is 1889 sq. mi
// per CH2M Hill 2013 SY Addendum
Set : _TempInf1735 { Value : timesers(1780/inflow)*(212/867.2) }
Set : inflow1735 { Value : max{0, _TempInf1735 - _InfDeficit1735(-1) } }
Set : _InfDeficit1735 { Value : max{0, _InfDeficit1735(-1) - _TempInf1735 } }

// Princeton WWTP
Set : _TempInf1755 { Value : timesers(1780/inflow)*(32/867.2) }
Set : inflow1755 { Value : max{0, _TempInf1755 - _InfDeficit1755(-1) } }
Set : _InfDeficit1755 { Value : max{0, _InfDeficit1755(-1) - _TempInf1755 } }

// Progress Energy Intake - reduced to 161 based on multiple adjustments above Swift Ck confluence adjustment above
Set : _TempInf1760 { Value : timesers(1780/inflow)*(161/867.2) }
Set : inflow1760 { Value : max{0, _TempInf1760 - _InfDeficit1760(-1) } }
Set : _InfDeficit1760 { Value : max{0, _InfDeficit1760(-1) - _TempInf1760 } }

// Little R Confluence
Set : _TempInf1775 { Value : timesers(1780/inflow)*(62/867.2) }
Set : inflow1775 { Value : max{0, _TempInf1775 - _InfDeficit1775(-1) } }
Set : _InfDeficit1775 { Value : max{0, _InfDeficit1775(-1) - _TempInf1775 } }

// Adj Neuse Goldsboro Gage
Set : _TempInf1780 { Value : timesers(1780/inflow)*(23/867.2) }
Set : inflow1780 { Value : max{0, _TempInf1780 - _InfDeficit1780(-1) } }
Set : _InfDeficit1780 { Value : max{0, _InfDeficit1780(-1) - _TempInf1780 } }

// NRWASA Intake
Set : _TempInf1795 { Value : timesers(1800/inflow)*(211/293) }
Set : inflow1795 { Value : max{0, _TempInf1795 - _InfDeficit1795(-1) } }
Set : _InfDeficit1795 { Value : max{0, _InfDeficit1795(-1) - _TempInf1795 } }

// Adj Neuse Kinston Gage
Set : _TempInf1800 { Value : timesers(1800/inflow)*(82/293) }
Set : inflow1800 { Value : max{0, _TempInf1800 - _InfDeficit1800(-1) } }
Set : _InfDeficit1800 { Value : max{0, _InfDeficit1800(-1) - _TempInf1800 } }

// Little Contentnea Confluence
Set : _TempInf1570 { Value : timesers(1900/inflow)*(62/625) }
Set : inflow1570 { Value : max{0, _TempInf1570 - _InfDeficit1570(-1) } }
Set : _InfDeficit1570 { Value : max{0, _InfDeficit1570(-1) - _TempInf1570 } }

// Contentnea Confluence
Set : _TempInf1850 { Value : timesers(1900/inflow)*(208/625) }
Set : inflow1850 { Value : max{0, _TempInf1850 - _InfDeficit1850(-1) } }
```

```
283  Set : _InfDeficit1850 { Value : max{0, _InfDeficit1850(-1) - _TempInf1850 } }
284
285  // Adj Weyerhauser Gain
286  Set : _TempInf1900 { Value : timesers(1900/inflow)*(355/625) }
287  Set : inflow1900 { Value : max{0, _TempInf1900 - _InfDeficit1900(-1) } }
288  Set : _InfDeficit1900 { Value : max{0, _InfDeficit1900(-1) - _TempInf1900 } }
289
290  // New Bern
291  Set : _TempInf1999 { Value : timesers(1900/inflow)*(10/625) }
292  Set : inflow1999 { Value : max{0, _TempInf1999 - _InfDeficit1999(-1) } }
293  Set : _InfDeficit1999 { Value : max{0, _InfDeficit1999(-1) - _TempInf1999 } }
```

Forecast_Horizon_Days.ocl

```
1  /* This file converts the forecast horizon in weeks to days (less one, for the accumulate function)
2    for use in the projections in the user_def_ops.ocl file  */
3
4
5
6  /* Start with the forecast horizon 1 */
7  :if: {[Forecast_1_Horizon] = 24 }
8    :Substitute: [Forecast_1_Horizon_Days] = 167
9  :endif:
10
11 :if: {[Forecast_1_Horizon] = 23 }
12   :Substitute: [Forecast_1_Horizon_Days] = 160
13 :endif:
14
15 :if: {[Forecast_1_Horizon] = 22 }
16   :Substitute: [Forecast_1_Horizon_Days] = 153
17 :endif:
18
19 :if: {[Forecast_1_Horizon] = 21 }
20   :Substitute: [Forecast_1_Horizon_Days] = 146
21 :endif:
22
23 :if: {[Forecast_1_Horizon] = 20 }
24   :Substitute: [Forecast_1_Horizon_Days] = 139
25 :endif:
26
27 :if: {[Forecast_1_Horizon] = 19 }
28   :Substitute: [Forecast_1_Horizon_Days] = 132
29 :endif:
30
31 :if: {[Forecast_1_Horizon] = 18 }
32   :Substitute: [Forecast_1_Horizon_Days] = 125
33 :endif:
34
35 :if: {[Forecast_1_Horizon] = 17 }
36   :Substitute: [Forecast_1_Horizon_Days] = 118
37 :endif:
38
39 :if: {[Forecast_1_Horizon] = 16 }
40   :Substitute: [Forecast_1_Horizon_Days] = 111
41 :endif:
42
43 :if: {[Forecast_1_Horizon] = 15 }
44   :Substitute: [Forecast_1_Horizon_Days] = 104
45 :endif:
46
47 :if: {[Forecast_1_Horizon] = 14 }
```

```
  :Substitute: [Forecast_1_Horizon_Days] = 97
:endif:

:if: {[Forecast_1_Horizon] = 13 }
  :Substitute: [Forecast_1_Horizon_Days] = 90
:endif:

:if: {[Forecast_1_Horizon] = 12 }
  :Substitute: [Forecast_1_Horizon_Days] = 83
:endif:

:if: {[Forecast_1_Horizon] = 11 }
  :Substitute: [Forecast_1_Horizon_Days] = 76
:endif:

:if: {[Forecast_1_Horizon] = 10 }
  :Substitute: [Forecast_1_Horizon_Days] = 69
:endif:

:if: {[Forecast_1_Horizon] = 9 }
  :Substitute: [Forecast_1_Horizon_Days] = 62
:endif:

:if: {[Forecast_1_Horizon] = 8}
  :Substitute: [Forecast_1_Horizon_Days] = 55
:endif:

:if: {[Forecast_1_Horizon] = 7 }
  :Substitute: [Forecast_1_Horizon_Days] = 48
:endif:

:if: {[Forecast_1_Horizon] = 6 }
  :Substitute: [Forecast_1_Horizon_Days] = 41
:endif:

:if: {[Forecast_1_Horizon] = 5 }
  :Substitute: [Forecast_1_Horizon_Days] = 34
:endif:

:if: {[Forecast_1_Horizon] = 4 }
  :Substitute: [Forecast_1_Horizon_Days] = 27
:endif:

:if: {[Forecast_1_Horizon] = 3 }
  :Substitute: [Forecast_1_Horizon_Days] = 20
:endif:

```

```
:if: {[Forecast_1_Horizon] = 2 }
  :Substitute: [Forecast_1_Horizon_Days] = 13
:endif:

:if: {[Forecast_1_Horizon] = 1 }
  :Substitute: [Forecast_1_Horizon_Days] = 6
:endif:


/* Repeat for forecast horizon 2 */

:if: {[Forecast_2_Horizon] = 24 }
  :Substitute: [Forecast_2_Horizon_Days] = 167
:endif:

:if: {[Forecast_2_Horizon] = 23 }
  :Substitute: [Forecast_2_Horizon_Days] = 160
:endif:

:if: {[Forecast_2_Horizon] = 22 }
  :Substitute: [Forecast_2_Horizon_Days] = 153
:endif:

:if: {[Forecast_2_Horizon] = 21 }
  :Substitute: [Forecast_2_Horizon_Days] = 146
:endif:

:if: {[Forecast_2_Horizon] = 20 }
  :Substitute: [Forecast_2_Horizon_Days] = 139
:endif:

:if: {[Forecast_2_Horizon] = 19 }
  :Substitute: [Forecast_2_Horizon_Days] = 132
:endif:

:if: {[Forecast_2_Horizon] = 18 }
  :Substitute: [Forecast_2_Horizon_Days] = 125
:endif:

:if: {[Forecast_2_Horizon] = 17 }
  :Substitute: [Forecast_2_Horizon_Days] = 118
:endif:

:if: {[Forecast_2_Horizon] = 16 }
  :Substitute: [Forecast_2_Horizon_Days] = 111
:endif:

```

```
:if: {[Forecast_2_Horizon] = 15 }
  :Substitute: [Forecast_2_Horizon_Days] = 104
:endif:

:if: {[Forecast_2_Horizon] = 14 }
  :Substitute: [Forecast_2_Horizon_Days] = 97
:endif:

:if: {[Forecast_2_Horizon] = 13 }
  :Substitute: [Forecast_2_Horizon_Days] = 90
:endif:

:if: {[Forecast_2_Horizon] = 12 }
  :Substitute: [Forecast_2_Horizon_Days] = 83
:endif:

:if: {[Forecast_2_Horizon] = 11 }
  :Substitute: [Forecast_2_Horizon_Days] = 76
:endif:

:if: {[Forecast_2_Horizon] = 10 }
  :Substitute: [Forecast_2_Horizon_Days] = 69
:endif:

:if: {[Forecast_2_Horizon] = 9 }
  :Substitute: [Forecast_2_Horizon_Days] = 62
:endif:

:if: {[Forecast_2_Horizon] = 8}
  :Substitute: [Forecast_2_Horizon_Days] = 55
:endif:

:if: {[Forecast_2_Horizon] = 7 }
  :Substitute: [Forecast_2_Horizon_Days] = 48
:endif:

:if: {[Forecast_2_Horizon] = 6 }
  :Substitute: [Forecast_2_Horizon_Days] = 41
:endif:

:if: {[Forecast_2_Horizon] = 5 }
  :Substitute: [Forecast_2_Horizon_Days] = 34
:endif:

:if: {[Forecast_2_Horizon] = 4 }
  :Substitute: [Forecast_2_Horizon_Days] = 27
:endif:
```

```
189
190  :if: {[Forecast_2_Horizon] = 3 }
191    :Substitute: [Forecast_2_Horizon_Days] = 20
192  :endif:
193
194  :if: {[Forecast_2_Horizon] = 2 }
195    :Substitute: [Forecast_2_Horizon_Days] = 13
196  :endif:
197
198  :if: {[Forecast_2_Horizon] = 1 }
199    :Substitute: [Forecast_2_Horizon_Days] = 6
200  :endif:
201
202
203  /* Repeat for forecast horizon 3 */
204
205  :if: {[Forecast_3_Horizon] = 24 }
206    :Substitute: [Forecast_3_Horizon_Days] = 167
207  :endif:
208
209  :if: {[Forecast_3_Horizon] = 23 }
210    :Substitute: [Forecast_3_Horizon_Days] = 160
211  :endif:
212
213  :if: {[Forecast_3_Horizon] = 22 }
214    :Substitute: [Forecast_3_Horizon_Days] = 153
215  :endif:
216
217  :if: {[Forecast_3_Horizon] = 21 }
218    :Substitute: [Forecast_3_Horizon_Days] = 146
219  :endif:
220
221  :if: {[Forecast_3_Horizon] = 20 }
222    :Substitute: [Forecast_3_Horizon_Days] = 139
223  :endif:
224
225  :if: {[Forecast_3_Horizon] = 19 }
226    :Substitute: [Forecast_3_Horizon_Days] = 132
227  :endif:
228
229  :if: {[Forecast_3_Horizon] = 18 }
230    :Substitute: [Forecast_3_Horizon_Days] = 125
231  :endif:
232
233  :if: {[Forecast_3_Horizon] = 17 }
234    :Substitute: [Forecast_3_Horizon_Days] = 118
235  :endif:
```

```
236
237  :if: {[Forecast_3_Horizon] = 16 }
238    :Substitute: [Forecast_3_Horizon_Days] = 111
239  :endif:
240
241  :if: {[Forecast_3_Horizon] = 15 }
242    :Substitute: [Forecast_3_Horizon_Days] = 104
243  :endif:
244
245  :if: {[Forecast_3_Horizon] = 14 }
246    :Substitute: [Forecast_3_Horizon_Days] = 97
247  :endif:
248
249  :if: {[Forecast_3_Horizon] = 13 }
250    :Substitute: [Forecast_3_Horizon_Days] = 90
251  :endif:
252
253  :if: {[Forecast_3_Horizon] = 12 }
254    :Substitute: [Forecast_3_Horizon_Days] = 83
255  :endif:
256
257  :if: {[Forecast_3_Horizon] = 11 }
258    :Substitute: [Forecast_3_Horizon_Days] = 76
259  :endif:
260
261  :if: {[Forecast_3_Horizon] = 10 }
262    :Substitute: [Forecast_3_Horizon_Days] = 69
263  :endif:
264
265  :if: {[Forecast_3_Horizon] = 9 }
266    :Substitute: [Forecast_3_Horizon_Days] = 62
267  :endif:
268
269  :if: {[Forecast_3_Horizon] = 8}
270    :Substitute: [Forecast_3_Horizon_Days] = 55
271  :endif:
272
273  :if: {[Forecast_3_Horizon] = 7 }
274    :Substitute: [Forecast_3_Horizon_Days] = 48
275  :endif:
276
277  :if: {[Forecast_3_Horizon] = 6 }
278    :Substitute: [Forecast_3_Horizon_Days] = 41
279  :endif:
280
281  :if: {[Forecast_3_Horizon] = 5 }
282    :Substitute: [Forecast_3_Horizon_Days] = 34
```

```
283  :endif:
284
285  :if: {[Forecast_3_Horizon] = 4 }
286    :Substitute: [Forecast_3_Horizon_Days] = 27
287  :endif:
288
289  :if: {[Forecast_3_Horizon] = 3 }
290    :Substitute: [Forecast_3_Horizon_Days] = 20
291  :endif:
292
293  :if: {[Forecast_3_Horizon] = 2 }
294    :Substitute: [Forecast_3_Horizon_Days] = 13
295  :endif:
296
297  :if: {[Forecast_3_Horizon] = 1 }
298    :Substitute: [Forecast_3_Horizon_Days] = 6
299  :endif:
300
301
302  /* Repeat for forecast horizon 4 */
303
304  :if: {[Forecast_4_Horizon] = 24 }
305    :Substitute: [Forecast_4_Horizon_Days] = 167
306  :endif:
307
308  :if: {[Forecast_4_Horizon] = 23 }
309    :Substitute: [Forecast_4_Horizon_Days] = 160
310  :endif:
311
312  :if: {[Forecast_4_Horizon] = 22 }
313    :Substitute: [Forecast_4_Horizon_Days] = 153
314  :endif:
315
316  :if: {[Forecast_4_Horizon] = 21 }
317    :Substitute: [Forecast_4_Horizon_Days] = 146
318  :endif:
319
320  :if: {[Forecast_4_Horizon] = 20 }
321    :Substitute: [Forecast_4_Horizon_Days] = 139
322  :endif:
323
324  :if: {[Forecast_4_Horizon] = 19 }
325    :Substitute: [Forecast_4_Horizon_Days] = 132
326  :endif:
327
328  :if: {[Forecast_4_Horizon] = 18 }
329    :Substitute: [Forecast_4_Horizon_Days] = 125
```

```
:endif:

:if: {[Forecast_4_Horizon] = 17 }
  :Substitute: [Forecast_4_Horizon_Days] = 118
:endif:

:if: {[Forecast_4_Horizon] = 16 }
  :Substitute: [Forecast_4_Horizon_Days] = 111
:endif:

:if: {[Forecast_4_Horizon] = 15 }
  :Substitute: [Forecast_4_Horizon_Days] = 104
:endif:

:if: {[Forecast_4_Horizon] = 14 }
  :Substitute: [Forecast_4_Horizon_Days] = 97
:endif:

:if: {[Forecast_4_Horizon] = 13 }
  :Substitute: [Forecast_4_Horizon_Days] = 90
:endif:

:if: {[Forecast_4_Horizon] = 12 }
  :Substitute: [Forecast_4_Horizon_Days] = 83
:endif:

:if: {[Forecast_4_Horizon] = 11 }
  :Substitute: [Forecast_4_Horizon_Days] = 76
:endif:

:if: {[Forecast_4_Horizon] = 10 }
  :Substitute: [Forecast_4_Horizon_Days] = 69
:endif:

:if: {[Forecast_4_Horizon] = 9 }
  :Substitute: [Forecast_4_Horizon_Days] = 62
:endif:

:if: {[Forecast_4_Horizon] = 8}
  :Substitute: [Forecast_4_Horizon_Days] = 55
:endif:

:if: {[Forecast_4_Horizon] = 7 }
  :Substitute: [Forecast_4_Horizon_Days] = 48
:endif:

:if: {[Forecast_4_Horizon] = 6 }
```

```
377   :Substitute: [Forecast_4_Horizon_Days] = 41
378  :endif:
379
380  :if: {[Forecast_4_Horizon] = 5 }
381   :Substitute: [Forecast_4_Horizon_Days] = 34
382  :endif:
383
384  :if: {[Forecast_4_Horizon] = 4 }
385   :Substitute: [Forecast_4_Horizon_Days] = 27
386  :endif:
387
388  :if: {[Forecast_4_Horizon] = 3 }
389   :Substitute: [Forecast_4_Horizon_Days] = 20
390  :endif:
391
392  :if: {[Forecast_4_Horizon] = 2 }
393   :Substitute: [Forecast_4_Horizon_Days] = 13
394  :endif:
395
396  :if: {[Forecast_4_Horizon] = 1 }
397   :Substitute: [Forecast_4_Horizon_Days] = 6
398  :endif:
399
400
401  /* Repeat for forecast horizon 5 */
402
403  :if: {[Forecast_5_Horizon] = 24 }
404   :Substitute: [Forecast_5_Horizon_Days] = 167
405  :endif:
406
407  :if: {[Forecast_5_Horizon] = 23 }
408   :Substitute: [Forecast_5_Horizon_Days] = 160
409  :endif:
410
411  :if: {[Forecast_5_Horizon] = 22 }
412   :Substitute: [Forecast_5_Horizon_Days] = 153
413  :endif:
414
415  :if: {[Forecast_5_Horizon] = 21 }
416   :Substitute: [Forecast_5_Horizon_Days] = 146
417  :endif:
418
419  :if: {[Forecast_5_Horizon] = 20 }
420   :Substitute: [Forecast_5_Horizon_Days] = 139
421  :endif:
422
423  :if: {[Forecast_5_Horizon] = 19 }
```

```
424    :Substitute: [Forecast_5_Horizon_Days] = 132
425   :endif:
426
427   :if: {[Forecast_5_Horizon] = 18 }
428    :Substitute: [Forecast_5_Horizon_Days] = 125
429   :endif:
430
431   :if: {[Forecast_5_Horizon] = 17 }
432    :Substitute: [Forecast_5_Horizon_Days] = 118
433   :endif:
434
435   :if: {[Forecast_5_Horizon] = 16 }
436    :Substitute: [Forecast_5_Horizon_Days] = 111
437   :endif:
438
439   :if: {[Forecast_5_Horizon] = 15 }
440    :Substitute: [Forecast_5_Horizon_Days] = 104
441   :endif:
442
443   :if: {[Forecast_5_Horizon] = 14 }
444    :Substitute: [Forecast_5_Horizon_Days] = 97
445   :endif:
446
447   :if: {[Forecast_5_Horizon] = 13 }
448    :Substitute: [Forecast_5_Horizon_Days] = 90
449   :endif:
450
451   :if: {[Forecast_5_Horizon] = 12 }
452    :Substitute: [Forecast_5_Horizon_Days] = 83
453   :endif:
454
455   :if: {[Forecast_5_Horizon] = 11 }
456    :Substitute: [Forecast_5_Horizon_Days] = 76
457   :endif:
458
459   :if: {[Forecast_5_Horizon] = 10 }
460    :Substitute: [Forecast_5_Horizon_Days] = 69
461   :endif:
462
463   :if: {[Forecast_5_Horizon] = 9 }
464    :Substitute: [Forecast_5_Horizon_Days] = 62
465   :endif:
466
467   :if: {[Forecast_5_Horizon] = 8}
468    :Substitute: [Forecast_5_Horizon_Days] = 55
469   :endif:
470
```

```
471  :if: {[Forecast_5_Horizon] = 7 }
472    :Substitute: [Forecast_5_Horizon_Days] = 48
473  :endif:
474
475  :if: {[Forecast_5_Horizon] = 6 }
476    :Substitute: [Forecast_5_Horizon_Days] = 41
477  :endif:
478
479  :if: {[Forecast_5_Horizon] = 5 }
480    :Substitute: [Forecast_5_Horizon_Days] = 34
481  :endif:
482
483  :if: {[Forecast_5_Horizon] = 4 }
484    :Substitute: [Forecast_5_Horizon_Days] = 27
485  :endif:
486
487  :if: {[Forecast_5_Horizon] = 3 }
488    :Substitute: [Forecast_5_Horizon_Days] = 20
489  :endif:
490
491  :if: {[Forecast_5_Horizon] = 2 }
492    :Substitute: [Forecast_5_Horizon_Days] = 13
493  :endif:
494
495  :if: {[Forecast_5_Horizon] = 1 }
496    :Substitute: [Forecast_5_Horizon_Days] = 6
497  :endif:
498
499
500
501
502
503  /* Repeat for forecast horizon 6 */
504
505  :if: {[Forecast_6_Horizon] = 24 }
506    :Substitute: [Forecast_6_Horizon_Days] = 167
507  :endif:
508
509  :if: {[Forecast_6_Horizon] = 23 }
510    :Substitute: [Forecast_6_Horizon_Days] = 160
511  :endif:
512
513  :if: {[Forecast_6_Horizon] = 22 }
514    :Substitute: [Forecast_6_Horizon_Days] = 153
515  :endif:
516
517  :if: {[Forecast_6_Horizon] = 21 }
```

```
518   :Substitute: [Forecast_6_Horizon_Days] = 146
519  :endif:
520
521  :if: {[Forecast_6_Horizon] = 20 }
522   :Substitute: [Forecast_6_Horizon_Days] = 139
523  :endif:
524
525  :if: {[Forecast_6_Horizon] = 19 }
526   :Substitute: [Forecast_6_Horizon_Days] = 132
527  :endif:
528
529  :if: {[Forecast_6_Horizon] = 18 }
530   :Substitute: [Forecast_6_Horizon_Days] = 125
531  :endif:
532
533  :if: {[Forecast_6_Horizon] = 17 }
534   :Substitute: [Forecast_6_Horizon_Days] = 118
535  :endif:
536
537  :if: {[Forecast_6_Horizon] = 16 }
538   :Substitute: [Forecast_6_Horizon_Days] = 111
539  :endif:
540
541  :if: {[Forecast_6_Horizon] = 15 }
542   :Substitute: [Forecast_6_Horizon_Days] = 104
543  :endif:
544
545  :if: {[Forecast_6_Horizon] = 14 }
546   :Substitute: [Forecast_6_Horizon_Days] = 97
547  :endif:
548
549  :if: {[Forecast_6_Horizon] = 13 }
550   :Substitute: [Forecast_6_Horizon_Days] = 90
551  :endif:
552
553  :if: {[Forecast_6_Horizon] = 12 }
554   :Substitute: [Forecast_6_Horizon_Days] = 83
555  :endif:
556
557  :if: {[Forecast_6_Horizon] = 11 }
558   :Substitute: [Forecast_6_Horizon_Days] = 76
559  :endif:
560
561  :if: {[Forecast_6_Horizon] = 10 }
562   :Substitute: [Forecast_6_Horizon_Days] = 69
563  :endif:
564
```

```
565  :if: {[Forecast_6_Horizon] = 9 }
566    :Substitute: [Forecast_6_Horizon_Days] = 62
567  :endif:
568
569  :if: {[Forecast_6_Horizon] = 8}
570    :Substitute: [Forecast_6_Horizon_Days] = 55
571  :endif:
572
573  :if: {[Forecast_6_Horizon] = 7 }
574    :Substitute: [Forecast_6_Horizon_Days] = 48
575  :endif:
576
577  :if: {[Forecast_6_Horizon] = 6 }
578    :Substitute: [Forecast_6_Horizon_Days] = 41
579  :endif:
580
581  :if: {[Forecast_6_Horizon] = 5 }
582    :Substitute: [Forecast_6_Horizon_Days] = 34
583  :endif:
584
585  :if: {[Forecast_6_Horizon] = 4 }
586    :Substitute: [Forecast_6_Horizon_Days] = 27
587  :endif:
588
589  :if: {[Forecast_6_Horizon] = 3 }
590    :Substitute: [Forecast_6_Horizon_Days] = 20
591  :endif:
592
593  :if: {[Forecast_6_Horizon] = 2 }
594    :Substitute: [Forecast_6_Horizon_Days] = 13
595  :endif:
596
597  :if: {[Forecast_6_Horizon] = 1 }
598    :Substitute: [Forecast_6_Horizon_Days] = 6
599  :endif:
600
601
602
603
604  /* Repeat for forecast horizon 7 */
605
606  :if: {[Forecast_7_Horizon] = 24 }
607    :Substitute: [Forecast_7_Horizon_Days] = 167
608  :endif:
609
610  :if: {[Forecast_7_Horizon] = 23 }
611    :Substitute: [Forecast_7_Horizon_Days] = 160
```

```
612  :endif:
613
614  :if: {[Forecast_7_Horizon] = 22 }
615    :Substitute: [Forecast_7_Horizon_Days] = 153
616  :endif:
617
618  :if: {[Forecast_7_Horizon] = 21 }
619    :Substitute: [Forecast_7_Horizon_Days] = 146
620  :endif:
621
622  :if: {[Forecast_7_Horizon] = 20 }
623    :Substitute: [Forecast_7_Horizon_Days] = 139
624  :endif:
625
626  :if: {[Forecast_7_Horizon] = 19 }
627    :Substitute: [Forecast_7_Horizon_Days] = 132
628  :endif:
629
630  :if: {[Forecast_7_Horizon] = 18 }
631    :Substitute: [Forecast_7_Horizon_Days] = 125
632  :endif:
633
634  :if: {[Forecast_7_Horizon] = 17 }
635    :Substitute: [Forecast_7_Horizon_Days] = 118
636  :endif:
637
638  :if: {[Forecast_7_Horizon] = 16 }
639    :Substitute: [Forecast_7_Horizon_Days] = 111
640  :endif:
641
642  :if: {[Forecast_7_Horizon] = 15 }
643    :Substitute: [Forecast_7_Horizon_Days] = 104
644  :endif:
645
646  :if: {[Forecast_7_Horizon] = 14 }
647    :Substitute: [Forecast_7_Horizon_Days] = 97
648  :endif:
649
650  :if: {[Forecast_7_Horizon] = 13 }
651    :Substitute: [Forecast_7_Horizon_Days] = 90
652  :endif:
653
654  :if: {[Forecast_7_Horizon] = 12 }
655    :Substitute: [Forecast_7_Horizon_Days] = 83
656  :endif:
657
658  :if: {[Forecast_7_Horizon] = 11 }
```

```
659   :Substitute: [Forecast_7_Horizon_Days] = 76
660  :endif:
661
662  :if: {[Forecast_7_Horizon] = 10 }
663   :Substitute: [Forecast_7_Horizon_Days] = 69
664  :endif:
665
666  :if: {[Forecast_7_Horizon] = 9 }
667   :Substitute: [Forecast_7_Horizon_Days] = 62
668  :endif:
669
670  :if: {[Forecast_7_Horizon] = 8}
671   :Substitute: [Forecast_7_Horizon_Days] = 55
672  :endif:
673
674  :if: {[Forecast_7_Horizon] = 7 }
675   :Substitute: [Forecast_7_Horizon_Days] = 48
676  :endif:
677
678  :if: {[Forecast_7_Horizon] = 6 }
679   :Substitute: [Forecast_7_Horizon_Days] = 41
680  :endif:
681
682  :if: {[Forecast_7_Horizon] = 5 }
683   :Substitute: [Forecast_7_Horizon_Days] = 34
684  :endif:
685
686  :if: {[Forecast_7_Horizon] = 4 }
687   :Substitute: [Forecast_7_Horizon_Days] = 27
688  :endif:
689
690  :if: {[Forecast_7_Horizon] = 3 }
691   :Substitute: [Forecast_7_Horizon_Days] = 20
692  :endif:
693
694  :if: {[Forecast_7_Horizon] = 2 }
695   :Substitute: [Forecast_7_Horizon_Days] = 13
696  :endif:
697
698  :if: {[Forecast_7_Horizon] = 1 }
699   :Substitute: [Forecast_7_Horizon_Days] = 6
700  :endif:
```

Forecast-Trigger_Parms.ocl

```
1  // This file is automatically generated by the OASIS GUI
2  // Any changes you make in this file may be automatically overwritten
3
4  // This file contains parameter values that define the forecasting-and-trigger scenario
5
6  :SUBSTITUTE: [UseForecast] = 1
7  :SUBSTITUTE: [ForecastData] = cond
8
9
10 // The values below vary by trigger level
11
12 :SUBSTITUTE: [ForcCode_1] = R30W12
13 :SUBSTITUTE: [ForcCode_2] = R20W10
14 :SUBSTITUTE: [ForcCode_3] = R10W08
15 :SUBSTITUTE: [ForcCode_4] = R05W04
16 :SUBSTITUTE: [ForcCode_5] = R05W10
17
18 :SUBSTITUTE: [Risk_1_Factor_0] = 30
19 :SUBSTITUTE: [Risk_2_Factor_0] = 20
20 :SUBSTITUTE: [Risk_3_Factor_0] = 10
21 :SUBSTITUTE: [Risk_4_Factor_0] = 05
22 :SUBSTITUTE: [Risk_5_Factor_0] = 05
23
24 :SUBSTITUTE: [Forecast_1_Horizon_0] = 12
25 :SUBSTITUTE: [Forecast_2_Horizon_0] = 10
26 :SUBSTITUTE: [Forecast_3_Horizon_0] = 08
27 :SUBSTITUTE: [Forecast_4_Horizon_0] = 04
28 :SUBSTITUTE: [Forecast_5_Horizon_0] = 10
29
30 :SUBSTITUTE: [Risk_1_Factor] = 30
31 :SUBSTITUTE: [Risk_2_Factor] = 20
32 :SUBSTITUTE: [Risk_3_Factor] = 10
33 :SUBSTITUTE: [Risk_4_Factor] = 5
34 :SUBSTITUTE: [Risk_5_Factor] = 5
35
36 :SUBSTITUTE: [Forecast_1_Horizon] = 12
37 :SUBSTITUTE: [Forecast_2_Horizon] = 10
38 :SUBSTITUTE: [Forecast_3_Horizon] = 8
39 :SUBSTITUTE: [Forecast_4_Horizon] = 4
40 :SUBSTITUTE: [Forecast_5_Horizon] = 10
41
42 :SUBSTITUTE: [Trigger_1_Stor] = 45
43 :SUBSTITUTE: [Trigger_2_Stor] = 35
44 :SUBSTITUTE: [Trigger_3_Stor] = 25
45 :SUBSTITUTE: [Trigger_4_Stor] = 15
46 :SUBSTITUTE: [Trigger_5_Stor] = 90
47
```

```
:SUBSTITUTE: [Dem_1_Red_Factor] = 0
:SUBSTITUTE: [Dem_2_Red_Factor] = 0
:SUBSTITUTE: [Dem_3_Red_Factor] = 0
:SUBSTITUTE: [Dem_4_Red_Factor] = 0
:SUBSTITUTE: [Dem_5_Red_Factor] = 0

:SUBSTITUTE: [MinFlow_1_Red_Factor] = 0
:SUBSTITUTE: [MinFlow_2_Red_Factor] = 0
:SUBSTITUTE: [MinFlow_3_Red_Factor] = 0
:SUBSTITUTE: [MinFlow_4_Red_Factor] = 0
:SUBSTITUTE: [MinFlow_5_Red_Factor] = 0

```

FtBragg_ops.ocl

```
1  /*FTBRAGG_OPS.OCL  */
2
3  /*  Operational policy for Ft. Bragg */
4
5  // Set targets to dictate WDs between
6  Constraint : {dFlow0662.0721 = 0}  // none from Dunn
7
8
9  // Set the fraction coming from Harnett w/ a substitute
10
11 :Substitute: [FtBraggWS_Harnett] = 0.5
12
13 Target Harnett_WD : dflow0549.0721
14 {   condition : default
15    priority  : 1
16    penalty+  : 90
17    penalty-  : 90
18    Value     : [FtBraggWS_Harnett] * demand0721 // The rest will be from Fayettville
19 }
```

Fuquay_ops.ocl

```
/* FUQUAY_OPS.OCL  */

/*  Operational policy for Fuquay-Varina's system.  Set as maximum flows to limit deliveries to supply contracts, with OASIS reducing deliveries
 if needed so that the nominal F-V demand is not exceeded.  Weighting on delivery arcs reflects priority of delivery using supply contracts with
 local entities. First, for the Neuse portion of the F-V demand (= demand 1706 x [Demand_FV_Neuse], meet first from Raleigh, then Johnston
 County, so no IBT since they are both in the Neuse. Assume any additional supply needed to meet the Neuse portion of demand would be part
 of the alternative that is being evaluated assuming it is in the Neuse (thus minimizing the IBT).

 Any unmet portion of this demand then comes from Sanford, then Harnett County. IBT would be from Cape Fear (since Sanford and HC are in the
 Cape Fear) to the Neuse to meet the Neuse portion of the demand. Should that not be enough, if the alternative supply is in the Cape Fear, this
 is assumed to provide the remaining amount to meet the Neuse portion of the demand.

 For the remaining portion of the F-V demand, in the Cape Fear, first meet from Sanford, then Harnett County, then Johnston County, ensuring the
 contracts are maxed out.  [Although for alternative supplies that rely on new WTP for F-V, F-V would probably prioritize the alternative supply
 since it would be cheaper].  This approach provides consistency across all alternatives.

 IBT would be from Neuse to Cape Fear (since Johnston County is in the Neuse) to meet the Cape Fear portion of the demand.  Raleigh supply since
 it is relatively small would only be used on the Neuse portion of the F-V demand. Assume any additional supply needed to meet the Cape Fear
 portion of the demand would be part of the alternative that is being evaluated.   */

// First pull from Raleigh to meet the Neuse portion of the F-V demand.
Set FV_Ral_Max : max_flow1305.1706  { value  : min { demand1706 * [Demand_FV_Neuse], convert_units{[FV_Ral_Supply], mgd, af} } }

// Pull from JC for the remaining Neuse portion of this demand.
Set FV_Johnston_Prelim :  _Prelim_Max_JC_Neuse
{  value  : min { demand1706 * [Demand_FV_Neuse] - max_flow1305.1706, convert_units{[FV_Johnston_Supply], mgd, af } } }

// ***
// Pull from the alternative being evaluated (if in the Neuse) for the remaining Neuse portion of this demand.  Set to 0 if not evaluating an alternative,
// or evaluating an alternative that pulls only from the Cape Fear.
Set FV_Alt_Prelim :  _Prelim_Max_Alt_Neuse
{  value  : 0 }  // demand1706 * [Demand_FV_Neuse] - max_flow1305.1706 -  _Prelim_Max_JC_Neuse }

// Pull from Sanford for the remaining Neuse portion of this demand.
Set FV_Sanford_Prelim :  _Prelim_Max_Sanford_Neuse
{  value  : min { demand1706 * [Demand_FV_Neuse] - max_flow1305.1706 - _Prelim_Max_JC_Neuse
    -_Prelim_Max_Alt_Neuse, convert_units{[FV_Sanford_Supply], mgd, af } } }

// Pull from Harnett County for the remaining Neuse portion of this demand.
Set FV_HC_Prelim :  _Prelim_Max_HC_Neuse
{  value  : min { demand1706 * [Demand_FV_Neuse] - max_flow1305.1706 -  _Prelim_Max_JC_Neuse
    - _Prelim_Max_Alt_Neuse - _Prelim_Max_Sanford_Neuse, convert_units{[FV_Harnett_Supply], mgd, af } } }

// ***
// Pull from the alternative being evaluated (if in the Cape Fear) for the remaining Neuse portion of this demand.  Set to 0 if not evaluating an
// alternative, or if the alternative pulls only from the Neuse.
Set FV_Alt_Prelim :  _Prelim_Max_Alt_CF_to_Neuse
```

```
{  value  : 0  }
// demand1706 * [Demand_FV_Neuse] - max_flow1305.1706 -  _Prelim_Max_JC_Neuse - _Prelim_Max_Sanford_Neuse - _Prelim_Max_HC_Neuse }

// Set the IBTs based on this.  For the Cape Fear to Neuse, it would be Sanford and HC and alternative supply (if any) deliveries to the Neuse portion
// of the F-V demand since they are in the Cape Fear.
Set :  _IBT_CF_to_Neuse {  value  :  _Prelim_Max_Sanford_Neuse + _Prelim_Max_HC_Neuse + _Prelim_Max_Alt_CF_to_Neuse }

// The above assumes the Neuse portion of the demand is fully met (check output to confirm this). Reset production for Sanford, HC, and JC
// based on the total system demand less the contributions above toward the Neuse portion of the demand.

// Now for the Cape Fear portion of the demand.  To be met first from Sanford, then Harnett County (so no IBT), then Johnston County (so an IBT),
// then the alternative being evaluated (Whether in the Neuse or Cape Fear).
Set FV_Sanford_Max : max_flow0489.1706
{  value  : min { demand1706 - max_flow1305.1706 - _Prelim_Max_JC_Neuse - _Prelim_Max_Alt_Neuse
    - _IBT_CF_to_Neuse, convert_units{[FV_Sanford_Supply], mgd, af } } }
Set FV_Harnett_Max : max_flow0549.1706
{  value  : min { demand1706 - max_flow1305.1706 - _Prelim_Max_JC_Neuse - _Prelim_Max_Alt_Neuse
    - _IBT_CF_to_Neuse - max_flow0489.1706, convert_units{[FV_Harnett_Supply], mgd, af } } }

// Reset Johnston County delivery depending on whether there is still a demand deficit for F-V Cape Fear portion to be met.  Do not include
// the alternative supply that comes only from the Cape Fear since that comes later..
Set  Johnston_County_Final :  max_flow1656.1706
{  value :  min {demand1706 - max_flow1305.1706 - _Prelim_Max_Alt_Neuse -  max_flow0489.1706 - max_flow0549.1706,
    convert_units{[FV_Johnston_Supply], mgd, af } } }

// ***
// Set alternative to 0 if not being evaluated.  Otherwise, it is the amount to meet the remaining system demand.
Set :  _Final_Max_Flow_Alt  { value  :  0  }// demand1706 - max_flow1305.1706 - max_flow0489.1706 - max_flow0549.1706 - max_flow1656.1706}

// Comment out if not evaluating an alternative.  Otherwise, the max flow is on the alternative supply arc.
// Set :  max_flow0490.1706   {  value :  _Final_Max_Flow_Alt }


// Set the IBT from the Neuse to the Cape Fear to meet the Cape Fear portion of F-V demand.  Again, assume Raleigh supply is only
// enough to help meet the Neuse portion of demand.
Set :  _IBT_Neuse_to_CF
/* This will be zero if either Sanford or HC supplies water to the Neuse portion of the demand (since the alternative supply if from the Neuse
   would be used first).  If Raleigh and JC supply were high enough to meet the Neuse portion of the demand, this condition may not be met,
   but this scenario would not occur based on expected contract amounts. */
{   condition  :  _Prelim_Max_Sanford_Neuse > 0 or _Prelim_Max_HC_Neuse > 0
 value     :  0

/* This will be the amount from JC in excess of what it supplies to the Neuse portion of the demand, plus the amount of the
 alternative supply in excess of what is supplied to the Neuse portion of the demand.  */
    condition  :  default
 value    :   ( max_flow1656.1706 - _Prelim_Max_JC_Neuse )  + ( _Final_Max_Flow_Alt - _Prelim_Max_Alt_Neuse )
}
```

Gravity_Refill.ocl

```
/* This file contains the commands for estimating one day's spill from a reservoir.
  The file is included once for each reservoir where detailed spill estimates are
  required.  A set of substitutes must be properly set before the :include:
  statement of this file.  The substitutes are:

  //updated from Spill_Curve.ocl

    [sp_us_node]     = The reservoir node to which the spillway flows //1120
    [sp_spill_node]  = The junction node at which we compute spill //1115
    [sp_ds_node]     = The downstream node that represents gatehouse flow from the reservoir, or 'NONE'
    [sp_spill_node2] = The node to which the second spillway flows, or 'NONE'.
                       If there are two spillways, then this must be the lower of the two.
    [sp_lookup2]     = The name of the OCL lookup function for the second spillway, or 'NONE'


  The calculations are performed at a small time step for better accuracy.  The
  small time step is now 1 hour, but the file is easily modified for another
  small-time-step size.  The assumed 'total inflow' and 'total outflow' for the
  reservoir node are assumed steady over the day.  Within each small time step,
  the spillway flow is assumed steady based on the WSE at the beginning of the
  small time step.
*/


// The number of steps must correspond with the number of iterations
// in the :FOR: loop below

:substitute: [sp_num_steps] = 24

// Repeat the calculations once for every small time step for calculating
// spillway flow.  The number of iterations in the :FOR: loop must match
// [sp_num_steps] above.  The first [sp_step_num] must be 01, and the last
// must be the same as [sp_num_steps].

:FOR:
{ [sp_step_num] =
   { 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14,15, 16, 17, 18, 19, 20, 21, 22, 23, 24 }
}

  :if: { [sp_step_num]=01 }
     // In the first small time step, use zero spillway flow for the day
     :substitute: [i_sp_flow]  = 0
  :else:
     // In the subsequent small time step, accumulate spillway flow in this variable
     :substitute: [i_sp_flow]  = sp_flow
  :endif:

```

```
48     // Compute storage in Teer that results from flow (from Eno) of the current small time step
49     SET sp_stor_[sp_us_node].[sp_spill_node]_[sp_step_num]: sp_stor
50     {
51         value:   storage[sp_us_node]+ [i_sp_flow]
52
53     }
54
55   //Calculates head differential between Eno River and Teer Quarry to determine flow through pumping station,
56   //calc doesn't consider quarry elevation below 254
57
58
59    Set : Head_Differential_Teer_Hourly
60   {
61    condition 1 : stor_to_elev{[sp_us_node],sp_stor} >= 254
62    value     : Eno_River_Stage-stor_to_elev{[sp_us_node],sp_stor}
63
64    condition 2 : default
65    value       : Eno_River_Stage - 254
66   }
67
68
69
70    SET : Max_Gravity_Refill_Eno_Hourly
71    {
72     value  : min{Lookup{48inConduit, Head_Differential_Teer_Hourly}, Max_Weir_Flow} //will be in cfs
73
74    }
75
76     // Compute Flow from Eno that results from the storage level at the beginning
77     // of the current small time step.
78     SET sp_flow_[sp_us_node].[sp_spill_node]_[sp_step_num]: sp_flow
79     {
80         value:   [i_sp_flow]
81               + convert_units { Max_Gravity_Refill_Eno_Hourly , cfs , af }
82                     / [sp_num_steps]
83
84     }
85
86
87
88   :NEXT:
89
90
91   // Apply the spill to the model using the min_flow variable.  The weights in
92   // the weights table apply a very large penalty to exceeding this min flow.
93   // A negative weight on the D zone of the reservoir forces the water out
94   // of the reservoir.
```

```
95
96  SET: Max_Gravity_Refill_Eno_Hourly_1
97  {
98      value: sp_flow
99  }
100
101
102
```

Greensboro_ops.ocl

```
1  /*GREENSBORO_OPS.OCL  */
2
3  /*  Operational policy for Greensboro's system */
4
5  /*  Set interconnects unused in basecase to zero */
6  Constraint : {dFlow0044.0140 = 0 } // Emer Intake
7
8  //Constraint : {dFlow0271.0121 = 0 } // PTRA - currently in use, not 0
9  //Constraint : {dFlow0122.0224 = 0 } // High Pt WW
10 //Constraint : {dFlow0121.0903 = 0 } // Jamestown
11
12
13
14 //  Current Townsend Min. Release
15 //Set TownsendRelease : min_flow0140.0145 { value :  convert_units { 3.0, cfs, af } }
16
17 //  Future scenario Townsend minimum release - based on stage
18 Set TownsendRelease : min_flow0140.0145
19 {   condition : elevation0140 < 709.7
20     value     : convert_units { 2.0, cfs, af }
21
22     condition : elevation0140 < 714.5
23     value     : convert_units { 3.5, cfs, af }
24
25     condition : default
26     value     : convert_units { 7.0, cfs, af }
27 }
28
29 // Set the transfer (1 MGD constant) from Reidsville
30 Target Reids_GB_Transfer : dflow0029.0121
31 {   condition : default
32     priority  : 1
33     penalty+  : 10000
34     penalty-  :  275
35     Value     : convert_units { 5, mgd, af } // new contract value
36 }
37
38 // Set the transfer (2 MGD constant) from Burlington
39 Target Burl_GB_Transfer : dflow0071.0121
40 {   condition : default
41     priority  : 1
42     penalty+  : 10000
43     penalty-  : 275
44     Value     : convert_units { 5, mgd, af } //new contract value
45 }
46
47 //Set the transfer from PTRA
```

```
Target PTRA_GB_Transfer: dflow0271.0121
{ condition : default
 priority  : 1
 penalty+  : 100
 penalty-  : 1000
 Value     : convert_units{15.31, mgd,af} // must purchase 53.1% of increase in allocation
}

Set PTRA_GB_Max: max_flow0271.0121
{ condition: default
 Value: convert_units{24.03,mgd,af} // max contract in 2055
}

// Set targets to dictate WDs between reservoirs
Target Townsend_WD : dflow0140.0121
{   condition : default
    priority  : 1
    penalty+  : 100
    penalty-  : 100
    Value     : 0.67 * (demand0123 - flow0071.0121 - flow0029.0121 - flow0271.0121) // 67% (previously 50%, changed by KES based off of
                    // LWSP) (less the Burlington/Reidsville/PTRA
                    // transfers) from Townsend, the rest will be from Brandt
}
```

Harris_ops.ocl

```
1  /*  Harris_Ops.ocl  */
2  /*  Operational policies for Harris Lake */
3
4  // Spill rating curve for Harris.
5
6  // The D zone weight is -25, so if in the spill zone, the computed spill will occur because 25 points will otherwise be lost.
7  // However, spill will not exceed the computed amount because 100 points will be lost, or a net loss of 100 -25, or 75 points.
8  // We don't want spill to occur above the computed amount in order to meet shortages downstream on the main stem. Also, we don't
9  // want the spill to be curtailed for a Fayetteville max flow downstream of 20,000 cfs, which is the Corps operating target.  Jordan
10 // will curtail releases (but not below the minimum release), but Harris will not, so the D zone penalty is higher than the weight
11 // at Fayetteville.
12
13 // If reservoir elevation is below the spill zone starting at 220 feet, only the min release (if any is set) will be met since that arc gets a weight
14 // of gets a weight of 10.  The spill arc gets a weight of -10.    Note releases will not exceed the minimum when below the spill zone since
15 // a weight of -100 is placed on the B zone of the arc.  Normally this is not needed but with the interplay with Jordan Lake, the weights in the
16 // reservoir zones are such that we need additional confirmation that Harris won't release more than the minimum in this arc.
17
18 // Set a udef for the projected end of day elevation will be used to determine spill from the rating curve.
19 Set :  _Proj_Harris_Storage  {  value :  min {max_stor0520, storage0520 + inflow0520 - ( timesers(0520/evap)
20            / 12 * stor_to_area{0520,storage0520} )
21            - delivery0531 - delivery0521 - flow0521.0520 - flow0520.0528 - flow0520.0525 } }
22 Set :  _Proj_Harris_Elev     {  value :  stor_to_elev {0520, _Proj_Harris_Storage}  }
23
24
25 Target Harris_spill: dflow0520.0526
26 {   Condition : default
27    priority  : 1
28    penalty+  : 100
29    penalty-  : 0
30    Value     : convert_units { Lookup{ Harris_Spill, _Proj_Harris_Elev }, cfs, af}
31 }
32
```

HawR_Or_Almnc.ocl

```
1  /*  Northeast Har River Basin Ops  */
2  // Orange- Alamance
3  // Haw River 02-01-020
4  // Graham-Mebane - to be used later
5
6
7  // Set the transfer from Haw River to Orange-Alamance
8
9  Set : inflow1041 { Value : convert_units { 0.05, mgd, af } } // Looking at sum of well usage from LWSP and days of use
10
11 Target Burl_HR_OA : dflow0074.1046
12 {   condition : default
13     priority  : 1
14     penalty+  : 500
15     penalty-  : 20
16     Value     : min {convert_units { 0.8, mgd, af }, demand1046 - _Max_OrAl_WD } // contract value is 0.8 mgd max
17 }
18
19
```

Johnston_ops.ocl

```
1  /*  Johnston_OPS.OCL  */
2
3  /*  Operational policy for Johnston County's facilities */
4
5  :substitute: [Tim_Broome_Permit] = 17 //mgd, DWR permitted withdrawal includes return (assumed 10% in the WW_returns.ocl file) -- sn comment
6
7  // Existing intake
8  Set: max_flow1650.1654   {  value : Convert_Units {[Tim_Broome_Permit], mgd, af } }
9
10
11 //Purchases //Setting these first to be used in flow by calcs for lower intake -KS
12
13 Set: max_flow1660.1656 //Smithfield sales
14 {  condition : default
15  value  : convert_units{3.0, mgd, af}
16 }
17
18 Set: max_flow1505.1656 //Wilson sales, set at less than 2 mgd IBT trigger amount
19 {  condition : default
20  value  : convert_units{1.99, mgd, af}
21 }
22
23 Set: max_flow0549.1656 //Harnett sales, set at less than 2 mgd IBT-trigger amount
24 {  condition : default
25  value  : convert_units{1.99, mgd, af}
26 }
27
28
29
30
31
32
33 // This is for intake 2 operations with the quarries.  Use simplified estimate of flow upstream of intake 2 using yesterday's flow + local inflow.
34 // Set to min flow for day 1 x d.a. adjustment to get a reasonable estimate for day 1.
35
36 Set: Exp_RBrdgeRd_Upstream
37 {   condition  :  abs_period = 1
38  value      :  min_flow1630.1640 * 1677 / 1150
39
40  condition  : default
41  value      : flow1700.1730 + inflow1730
42 }
43
44
45 /* This assumes JC Intake#2 on Neuse is at Richardson Bridge Rd, not below the confluence with Mill Creek (node 1735).
46  WD amounts per the revised guidance from Reed (no longer using the 2009 EA/FONSI).
47
```

```
48  So pumped flows are as follows:  none below 198 cfs (as estimated upstream).  Up to 29.2 mgd (20% of the updated 7Q10)
49  for flows below 903 cfs (which is the median annual flow). with pumping limited to ensure flow does not drop below 198 cfs.
50  Above 903 cfs, pump 20% of the estimated flow (or the amount above 903 cfs, whichever is less) or the maximum amount set
51  for the alternative (in lookup table). There may be a quick bump in pumping from 29.2 to the maximum pumping level above
52  903 cfs depending on what the maximum pumping level is used. Here it is 30 mgd.   */
53
54 Set: max_flow1730.1652
55 {   condition  :  convert_units{Exp_RBrdgeRd_Upstream, af, cfs} > 903
56  value      :  min {
57       max { convert_units {lookup {JohnstonCFlow, 903}, mgd, af},
58         min {0.2 * Exp_RBrdgeRd_Upstream, Exp_RBrdgeRd_Upstream - convert_units {903, cfs, af} } }  ,
59       convert_Units {lookup {JohnstonCFlow, convert_units{Exp_RBrdgeRd_Upstream, af, cfs}}, mgd, af}
60        }
61
62  condition  :  default
63  value      :  min {convert_Units {lookup {JohnstonCFlow, convert_units{Exp_RBrdgeRd_Upstream, af, cfs}}, mgd, af},
64         max {Exp_RBrdgeRd_Upstream - convert_units {198, cfs, af}, 0} }
65 }
66
67 /* Assume abandoned quarry is being used. Water is assumed here to go directly to the demand, even though it would go technically
68  through the WTP node of 1652.  Can do this here since it is assumed there would be no WTP process loss with the new plant.
69  Water only pumped to quarry if below full (could do with weighting of course).  Put a negative weight on delivery arc to
70  prioritize water from intake node/WTP.   */
71 Set : max_flow1653.1648
72 {   condition  :  storage1648 < max_stor1648
73  value      :  1000   // Set high limit as not to be constraining
74
75  condition  :  default
76  value      :  0
77 }
78
79 // Do not consider any use of the active quarry, so set supply to the quarry to 0.
80 Set : max_flow1653.1647   {  value  :  0  }
```

Jordan_ops.ocl

```
1  /*  Jordan_Ops.ocl  */
2  /*  Operational policies for Jordan Lake */
3
4  // Limit the increase in flood releases from previous day (per Terry Brown's suggestion) when Jordan is above normal pool
5  Target JordanFloodRelease : dflow0470.0480
6  {  // Above 240 ft just release uncontrolled spill
7     condition : elevation0470 >= 240
8     priority  : 1
9     penalty+  : 10
10    penalty-  : 0
11    Value     : convert_units { lookup { JordanSpillway, elevation0470 }, cfs, af }
12
13    // When Jordan is on the way back down (defined by decreasing inflows) limit the decrease in releases for a 'soft landing',
14   // making sure not to drop it below the normal pool.
15    condition : elevation0470 >= 216 and inflow0470 < inflow0470(-1) and inflow0470(-1) < inflow0470(-2) and inflow0470(-2) < inflow0470(-3)
16    priority  : 1
17    penalty+  : 10
18    penalty-  : 0
19    Value     : min  {flow0470.0480(-1) - convert_units {4000, cfs, af }, storage0470 - elev_to_stor { 0470, 216 } }
20
21    // Above 220 ft release no more than the previous days' release + 5500 cfs
22    condition : elevation0470 >= 220
23    priority  : 1
24    penalty+  : 10
25    penalty-  : 0
26    Value     : flow0470.0480(-1) + convert_units {5500, cfs, af }
27
28    // Above 216 ft release no more than the previous days' release + 4000 cfs, making sure not to drop it below the normal pool.
29    condition : elevation0470 >= 216
30    priority  : 1
31    penalty+  : 10
32    penalty-  : 0
33    Value     : min { flow0470.0480(-1) + convert_units {4000, cfs, af }, storage0470 - elev_to_stor { 0470, 216 } }
34 }
35
36 // Set a flood target of 18,000 cfs at Lillington
37 Target LillingtonMaxFlow : dflow0550.0555
38 {   condition :  default
39    priority  : 1
40    penalty+  : 12
41    penalty-  : 0
42    Value     : convert_units {18000, cfs, af }
43 }
44
45 // Set a flood control target at Fayetteville of 20,000 cfs, meaning Jordan will store water to minimize chance of having flow downstream
46 // exceed this target.  Local inflows between Jordan and Fayetteville could cause flows to exceed this target.  However, Jordan will not curtail
47 // the minimum release, nor the release to meet local demands.  So the penalty for going above the 20000 cfs flow is less than the minimum release
```

```
48 // weight from Jordan (but is more than the D zone weight for Jordan).
49 Target FayettevilleMaxFlow : dflow0740.0749
50 {   condition :  default
51     priority  : 1
52     penalty+  : 12
53     penalty-  : 0
54     Value     : convert_units {20000, cfs, af }
55 }
56
57
58 /*  The Jordan water quality and supply accounting file is evaluated after the solve statement, mainly to establish the water quality
59  release based on computation of the decision variable for outflow from Jordan.  This determination is made based on weights and min
60  flow targets from Jordan andat Lillington (and points in between).  The min flow from Jordan depends on the drought protocol.
61  When the Lillington target applies, the model will release enough water to exactly meet the target after accounting for today's
62  inflows (namely on the Deep River) and demands between Jordan and Lillington (the intent of which is to mimic how the Corps would
63  operate).  Extra water will not be released above the target based on how the weighting is done.
64
65  Set delivery for the water supply users based on amount in the their accounts.  Demand will not be fulfilled if the account has gone
66  empty and there is not enough inflow to the water supply account (for simplicity, use yesterday's inflow as factored into yesterday's
67  storage).The water supply account is not allowed to go negative (see the Jordan_WQ_WS_Accounts.ocl file). Similarly, set the water
68  quality release from Jordan (arc 470.480) based on amount in the water quality storage account, again forbidding the account to go negative.
69
70  Since we refer to yesterday's storage estimates, for the first day of the run, constrain deliveries and releases to the initialized
71  volumes for each account so that deliveries and releases are made */
72
73
74 //  Water supply releases
75 Constraint   Deliv_Lim_CaryAp :
76  {  condition  :  abs_period = 1
77     expression :  ddelivery0471 <= [WS_CaryAp_Fraction]  * [Max_WS_Storage]
78  }
79
80 Constraint   Deliv_Lim_CaryAp :
81  {  condition  :  abs_period > 1
82     expression :  ddelivery0471 <= _Stor_Final_CaryAp(-1)
83  }
84
85 Constraint   Deliv_Lim_Chatham :
86  {  condition  :  abs_period = 1
87     expression :  ddelivery0473 <= [WS_Chatham_Fraction] * [Max_WS_Storage]
88  }
89
90 Constraint   Deliv_Lim_Chatham :
91  {  condition  :  abs_period > 1
92     expression :  ddelivery0473 <= _Stor_Final_Chatham(-1)
93  }
94
```

```
95  Constraint   Deliv_Lim_Pittsboro :
96   {  condition  :  abs_period = 1
97      expression :  dflow0468.0401 <= [WS_Pitt_Fraction] * [Max_WS_Storage]
98   }
99
100 Constraint   Deliv_Lim_Pittsboro :
101  {  condition  :  abs_period > 1
102     expression :  dflow0468.0401 <= _Stor_Final_Pitt(-1) // + 0.7 * _Stor_Final_Chatham(-1)  // RNP SWAG that Chatham and
103                   // Pittsboro work something out
104                   // on their JL allocations
105  }
106
107 Constraint   Deliv_Lim_RTP :
108  {  condition  :  abs_period = 1
109     expression :  ddelivery0474 <= [WS_RTP_Fraction]  * [Max_WS_Storage]
110  }
111
112 Constraint   Deliv_Lim_RTP :
113  {  condition  :  abs_period > 1
114     expression :  ddelivery0474 <= _Stor_Final_RTP(-1)
115  }
116
117 Constraint   Deliv_Lim_Other :
118  {  condition  :  abs_period = 1
119     expression :  ddelivery0475 <= [WS_Other_Fraction]   * [Max_WS_Storage]
120  }
121
122 Constraint   Deliv_Lim_Other :
123  {  condition  :  abs_period > 1
124     expression :  ddelivery0475 <= _Stor_Final_Other(-1)
125  }
126
127 Constraint   Deliv_Lim_Durham&OWASA :
128  {  condition  :  abs_period = 1
129     expression :  dflow0468.1151 <= [WS_Durham_Fraction]  * [Max_WS_Storage] + [WS_OWASA_Fraction]  * [Max_WS_Storage]
130  }
131
132 Constraint   Deliv_Lim_Durham&OWASA :
133  {  condition  :  abs_period > 1
134     expression :  dflow0468.1151 <= _Stor_Final_Durham(-1) + _Stor_Final_OWASA(-1)
135  }
136
137 Constraint   Deliv_Lim_Durham&OWASA_alt :
138  {  condition  :  abs_period = 1
139     expression :  dflow0479.1151 <= [WS_Durham_Fraction]  * [Max_WS_Storage] + [WS_OWASA_Fraction]  * [Max_WS_Storage]
140  }
141
```

```
142  Constraint   Deliv_Lim_Durham&OWASA_alt :
143   {  condition  :  abs_period > 1
144      expression :  dflow0479.1151 <= _Stor_Final_Durham(-1) + _Stor_Final_OWASA(-1)
145   }
146
147  Constraint   Deliv_Lim_Morris :
148   {  condition  :  abs_period = 1
149      expression :  ddelivery0477 <= [WS_Morris_Fraction]  * [Max_WS_Storage]
150   }
151
152  Constraint   Deliv_Lim_Morris :
153   {  condition  :  abs_period > 1
154      expression :  ddelivery0477 <= _Stor_Final_Morris(-1)
155   }
156
157  Constraint   Deliv_Lim_Orange :
158   {  condition  :  abs_period = 1
159      expression :  ddelivery0921 <= [WS_Orange_Fraction]  * [Max_WS_Storage]
160   }
161
162  Constraint   Deliv_Lim_Orange:
163   {  condition  :  abs_period > 1
164      expression :  ddelivery0921 <= _Stor_Final_Orange(-1)
165   }
166
167  Constraint   Deliv_Lim_Holly :
168   {  condition  :  abs_period = 1
169      expression :  dflow0479.0923 <= [WS_Holly_Fraction]  * [Max_WS_Storage]
170   }
171
172  Constraint   Deliv_Lim_Holly :
173   {  condition  :  abs_period > 1
174      expression :  dflow0479.0923 <= _Stor_Final_Holly(-1)
175   }
176
177  Constraint Deliv_Lim_Hillsb :
178   {   condition  : abs_period = 1
179    expression : dflow1151.1106 <= [WS_Hillsb_Fraction] * [Max_WS_Storage]
180   }
181
182  Constraint Deliv_Lim_Hillsb :
183   {   condition  : abs_period > 1
184    expression : dflow1151.1106 <= _Stor_Final_Hillsb(-1)
185   }
186
187
188  // Water quality release
```

```
189
190
191 Constraint   Release_Limit_Jordan :
192  {  condition  :  abs_period = 1
193     expression :  dflow0470.0480 <= [Max_WQ_Storage]
194  }
195
196 Constraint   Release_Limit_Jordan :
197  {  condition  :  abs_period > 1
198     expression :  dflow0470.0480 <= _WQ_Storage(-1)
199  }
200
201
202 // Compute Jordan hydro production (total kW)
203 Set : _Jordan_Hydropower { Value : lookup { JordanHydro, convert_units { flow0470.0480, af, cfs } } }
204
```

Jordan_WQ_WS_Accounts.ocl

```
/*  Jordan_WQ_WS_Accounts.ocl */

// Note this file is included after the solve statement in the main.ocl file, so references to decision variables like flow and delivery
// have already been solved.


/* The conservation storage between elevation 202 and 216 feet consists of the water supply storage for up to six users and the
 water quality storage.

Fraction of conservation storage and inflow :
WQ = 67.38% allocated (94,600 acft.)
WS = 32.62% allocated (45,800 acft.), which is broken down by user:

The accounts are numbered as follows:

   Cary-Apex (node 471)
   Chatham County (node 473)
 Wake (RTP South) (node 474)
  Durham (arc1151)
 Morrisville  (node 477)
   Orange County (node 921)
 OWASA (arc 1151.431, via 479.1151)  - now via arc 0468.1151
 Holly Springs (arc 479.923)
 Pittsboro (no path to access yet defined) - now 0468.0401
 Hillsborough (arc 1151.1106, via arc 0471.1151)

 To this we add an allocation to a "dummy" account to track the unallocated water or to increase
 demands on the water supply storage without changing other allocations

 Other (node 475)

The allocations for each account are defined below (formerly in constants table for DWR model) */


/*  INFLOW DISTRIBUTION BY WATER SUPPLY ACCOUNT */

/* Start with Leila's spreadsheet calculating the water supply inflow distribution */

// Evap (0) since this file is included after the solve statement and we want today's evap, not tomorrow's */

Set  :  _JLakeInf     {  value :  flow0410.0470 + inflow0470 - evap0470(0) }  /* Base it on net inflow */
Set  :  _JLake_WQ_Inf {  value :  _JLakeInf * [Max_WQ_Storage] /  [Max_WQ_WS_Storage] }
Set  :  _JLake_WS_Inf {  value :  _JLakeInf * [Max_WS_Storage]/  [Max_WQ_WS_Storage]  }
/*  Calculate total inflow available to pool to include any spillover from the water quality account. */
Set  :  _Inf_avail_to_WS_pool   {  value  :  _WQ_Pool_Excess(-1) + _JLake_WS_Inf  }

/*  Calculate the total water supply demand and delivery for all accounts */
```

```
Set : _WS_Total_Demand  { value : demand0471 + demand0473 + demand0474 + demand0475
      + flow0470.0468 + demand0477 + demand0921 + 0 + 0 }  // Since OWASA & Durham, and HIllsborough
                  // are arcs and not demand nodes, sub in
                  // zero, can be changed if a Jordan transfer
                  // is used. No Holly Springs either.
Set : _WS_Total_Deliv  { value : delivery0471 + delivery0473 + delivery0474 + delivery0475
        + flow0479.1151  + delivery0477 + delivery0921 + flow0479.0923 + flow0470.0468 }

// Reset water supply account to 100% if elevation reaches 216 or projected water supply is full.
// For the first day of simulation, use the starting storage based on the individual accounts
// as defined in the constants table.
Set : _Total_WS_Storage
{  condition : abs_period = 1
 value    : [Starting_Storage_CaryAp]  + [Starting_Storage_Chatham] + [Starting_Storage_RTP]     + [Starting_Storage_Other]
   + [Starting_Storage_Durham] + [Starting_Storage_Morris]  + [Starting_Storage_Orange]  + [Starting_Storage_OWASA]
   + [Starting_Storage_Holly] + [Starting_Storage_Pitt] + [Starting_Storage_Hillsb]

 condition : elevation0470 >= 216.0 or (_Total_WS_Storage(-1) + _Inf_avail_to_WS_pool - _WS_Total_Deliv ) >= [Max_WS_Storage]
   value    : [Max_WS_Storage]

   condition : default
   value    : _Total_WS_Storage(-1) + _Inf_avail_to_WS_pool - _WS_Total_Deliv
}

Set :  _Total_WS_Storage_Pct {  value : 100 * _Total_WS_Storage / [Max_WS_Storage] }

Set : _Req_Refill_WS_Pool  { value : [Max_WS_Storage] - _Total_WS_Storage + _WS_Total_Deliv }
Set : _WS_Pool_Excess      { value : max { 0, _JLake_WS_Inf - _Req_Refill_WS_Pool  } }
Set : _Inf_used_for_WS_pool {  value : min { _Inf_avail_to_WS_pool,  _Req_Refill_WS_Pool } }


/*  ---------- */

// Determine required refill for each account.

Set : _Req_Refill_CaryAp
{ condition : abs_period = 1
 value    : delivery0471

 condition : default
 value    : [WS_CaryAp_Fraction] * [Max_WS_Storage] - _Stor_Final_CaryAp(-1) +  delivery0471
}

Set : _Req_Refill_Chatham
{ condition : abs_period = 1
 value    : delivery0473

```

```
 condition : default
 value     : [WS_Chatham_Fraction]  * [Max_WS_Storage] - _Stor_Final_Chatham(-1) +  delivery0473
}

Set : _Req_Refill_RTP
{ condition : abs_period = 1
 value     : delivery0474

 condition : default
 value     : [WS_RTP_Fraction] * [Max_WS_Storage] - _Stor_Final_RTP(-1) +  delivery0474
}

Set : _Req_Refill_Other
{ condition : abs_period = 1
 value     : delivery0475

 condition : default
 value     : [WS_Other_Fraction] * [Max_WS_Storage] - _Stor_Final_Other(-1) +  delivery0475
}

Set : _Req_Refill_Durham
{ condition : abs_period = 1
 value     : flow0468.1151 - flow1151.0431

 condition : default
 value     : [WS_Durham_Fraction] * [Max_WS_Storage] - _Stor_Final_Durham(-1) +  flow0468.1151 - flow1151.0431
}

Set : _Req_Refill_Morris
{ condition : abs_period = 1
 value     : delivery0477

 condition : default
 value     : [WS_Morris_Fraction] * [Max_WS_Storage] - _Stor_Final_Morris(-1) +  delivery0477
}

Set : _Req_Refill_Orange
{ condition : abs_period = 1
 value     : delivery0921

 condition : default
 value     : [WS_Orange_Fraction] * [Max_WS_Storage] - _Stor_Final_Orange(-1) +  delivery0921
}

Set : _Req_Refill_OWASA
{ condition : abs_period = 1
 value     : flow1151.0431
```

```
142
143   condition  :  default
144   value      :  [WS_OWASA_Fraction] * [Max_WS_Storage] - _Stor_Final_OWASA(-1) +  flow1151.0431
145  }
146
147  Set  : _Req_Refill_Holly
148  { condition  :  abs_period = 1
149   value      :  flow0479.0923
150
151   condition  :  default
152   value      :  [WS_Holly_Fraction] * [Max_WS_Storage] - _Stor_Final_Holly(-1) +  flow0479.0923
153  }
154
155  Set  : _Req_Refill_Pitt
156  { condition  :  abs_period = 1
157   value      :  0
158
159   condition  :  default
160   value      :  [WS_Pitt_Fraction] * [Max_WS_Storage] - _Stor_Final_Pitt(-1) + flow0468.0401 // Pittsboro 6% Rnd 4 JLA
161  }
162
163  Set  : _Req_Refill_Hillsb
164  { condition  :  abs_period = 1
165   value      :  flow1151.1106
166
167   condition  :  default
168   value      :  [WS_Hillsb_Fraction] * [Max_WS_Storage] - _Stor_Final_Hillsb(-1) +  flow1151.1106 // Hillsborough 1% Rnd 4 JLA
169  }
170
171
172  /*  Establish initial inflow to the accounts */
173
174  // Determine initial inflow to each account
175  Set  :  _Inf_CaryAp  {  value  :  min { [WS_CaryAp_Fraction]  * _Inf_avail_to_WS_pool, _Req_Refill_CaryAp  } }
176  Set  :  _Inf_Chatham {  value  :  min { [WS_Chatham_Fraction] * _Inf_avail_to_WS_pool, _Req_Refill_Chatham } }
177  Set  :  _Inf_RTP     {  value  :  min { [WS_RTP_Fraction]     * _Inf_avail_to_WS_pool, _Req_Refill_RTP     } }
178  Set  :  _Inf_Other   {  value  :  min { [WS_Other_Fraction]   * _Inf_avail_to_WS_pool, _Req_Refill_Other   } }
179  Set  :  _Inf_Durham  {  value  :  min { [WS_Durham_Fraction]  * _Inf_avail_to_WS_pool, _Req_Refill_Durham  } }
180  Set  :  _Inf_Morris  {  value  :  min { [WS_Morris_Fraction]  * _Inf_avail_to_WS_pool, _Req_Refill_Morris  } }
181  Set  :  _Inf_Orange  {  value  :  min { [WS_Orange_Fraction]  * _Inf_avail_to_WS_pool, _Req_Refill_Orange  } }
182  Set  :  _Inf_OWASA   {  value  :  min { [WS_OWASA_Fraction]   * _Inf_avail_to_WS_pool, _Req_Refill_OWASA   } }
183  Set  :  _Inf_Holly   {  value  :  min { [WS_Holly_Fraction]   * _Inf_avail_to_WS_pool, _Req_Refill_Holly   } }
184  Set  :  _Inf_Pitt    {  value  :  min { [WS_Pitt_Fraction]    * _Inf_avail_to_WS_pool, _Req_Refill_Pitt    } } // new for JLA Round 4 6%
185  Set  :  _Inf_Hillsb  {  value  :  min { [WS_Hillsb_Fraction]  * _Inf_avail_to_WS_pool, _Req_Refill_Hillsb  } } //new for JLA Round 4 1%
186
187  /*  Determine remaining inflow to be distributed */
188  Set  :  _Inf_Rem_WS   { value :  _Inf_used_for_WS_pool - (_Inf_CaryAp +  _Inf_Chatham + _Inf_Durham + _Inf_Other + _Inf_RTP
```

```
189             + _Inf_Morris +_Inf_Orange + _Inf_OWASA + _Inf_Holly + _Inf_Pitt
190             + _Inf_Hillsb ) }
191
192 /*  Determine remaining deficit by account */
193
194 :FOR:
195 {  [Account] = { CaryAp, Chatham, RTP, Other, Durham, Morris, Orange, OWASA, Holly, Pitt, Hillsb }  }
196
197  Set  :  _Rem_def_[Account]   {  value  :  _Req_Refill_[Account] - _Inf_[Account]  }
198
199 :NEXT:
200
201 Set  :  _Rem_def_Total    {  value  :  _Rem_def_CaryAp +  _Rem_def_Chatham + _Rem_def_Durham  + _Rem_def_Other + _Rem_def_RTP
202         +  _Rem_def_Morris+ _Rem_def_Orange + _Rem_def_OWASA + _Rem_Def_Holly + _Rem_Def_Pitt
203         + _Rem_Def_Hillsb }
204
205 :FOR:
206 {  [Account] = { CaryAp, Chatham, RTP, Other, Durham, Morris, Orange, OWASA, Holly, Pitt, Hillsb }  }
207
208  //  Distribute remaining inflow proportional to remaining deficit
209  Set  :  _Rem_Inf_[Account]
210   {   condition  :  _Rem_def_total > 0
211       value     :  min { _Rem_def_[Account], _Inf_Rem_WS * _Rem_def_[Account] / _Rem_def_total }
212
213       condition  :  default
214       value     :  0
215   }
216
217  //  Compute total inflow to each pool
218  Set :  _Inf_Total_[Account]  {  value  :  _Inf_[Account] + _Rem_Inf_[Account] }
219
220 :NEXT:
221
222
223 // Determine water supply storage in each account.  For initialization in the udef list, set equal to the starting storage defined in the constants table.
224 // Set the storage to account for starting storage less the delivery plus the total inflow. If that exceeds the max storage for that account, reset
225 // the account to full.  The accounts are not allowed to go negative.
226
227 Set  : _Storage_CaryAp  {  value :  max { 0, min { [WS_CaryAp_Fraction]  * [Max_WS_Storage] ,
228           _Stor_Final_CaryAp(-1)  + _Inf_Total_CaryAp  - delivery0471 } } }
229 Set  : _Storage_Chatham {  value :  max { 0, min { [WS_Chatham_Fraction] * [Max_WS_Storage] ,
230           _Stor_Final_Chatham(-1) + _Inf_Total_Chatham - delivery0473 } } }
231 Set  : _Storage_RTP  {  value :  max { 0, min { [WS_RTP_Fraction]    * [Max_WS_Storage] ,
232           _Stor_Final_RTP(-1)    + _Inf_Total_RTP    - delivery0474 } } }
233 Set  : _Storage_Other  {  value :  max { 0, min { [WS_Other_Fraction]   * [Max_WS_Storage] ,
234           _Stor_Final_Other(-1)   + _Inf_Total_Other   - delivery0475 } } }
235 Set  : _Storage_Durham  {  value :  max { 0, min { [WS_Durham_Fraction]  * [Max_WS_Storage] ,
```

```
            _Stor_Final_Durham(-1)  + _Inf_Total_Durham  - flow0468.1151 - flow1151.0431 } } }
Set  : _Storage_Morris  {  value :  max { 0, min { [WS_Morris_Fraction]  * [Max_WS_Storage] ,
            _Stor_Final_Morris(-1)  + _Inf_Total_Morris  - delivery0477 } } }
Set  : _Storage_Orange  {  value :  max { 0, min { [WS_Orange_Fraction]  * [Max_WS_Storage] ,
            _Stor_Final_Orange(-1)  + _Inf_Total_Orange  - delivery0921 } } }
Set  : _Storage_OWASA  {  value :  max { 0, min { [WS_OWASA_Fraction]   * [Max_WS_Storage] ,
            _Stor_Final_OWASA(-1)   + _Inf_Total_OWASA   - flow1151.0431 } } }
Set  : _Storage_Holly  {  value :  max { 0, min { [WS_Holly_Fraction]   * [Max_WS_Storage] ,
            _Stor_Final_Holly(-1)   + _Inf_Total_Holly   - flow0479.0923 } } }
Set  : _Storage_Pitt  {  value :  max { 0, min { [WS_Pitt_Fraction]    * [Max_WS_Storage] , _Stor_Final_Pitt(-1)
          + _Inf_Total_Pitt    - flow0468.0401 } } }//new for JLA Round 4 JLA
Set  : _Storage_Hillsb {  value :  max { 0, min { [WS_Hillsb_Fraction]  * [Max_WS_Storage] ,
         _Stor_Final_Hillsb(-1)  + _Inf_Total_Hillsb  - flow1151.1106 } } }//new for JLA Round 4 JLA
// Assume pools are automatically reset to full if the total water supply storage account has refilled (do this by overwriting initial calculation).
// Account is refilled automatically when Jordan elevation reaches 216 feet.

:FOR:
{  [Account] = { CaryAp, Chatham, RTP, Other, Durham, Morris, Orange, OWASA, Holly, Pitt, Hillsb }  }

 Set :  _Stor_Final_[Account]
  {  condition  :  _Total_WS_Storage >= [Max_WS_Storage] //
    value      :  [WS_[Account]_Fraction]  * [Max_WS_Storage] //

    condition  :  default
    value      :  _Storage_[Account]
      }

:NEXT:

// Calculate pool volume as percent of max storage

:FOR:
{  [Account] = { CaryAp, Chatham, RTP, Other, Durham, Morris, Orange, OWASA, Holly, Pitt, Hillsb }  }

 Set :  _Stor_Final_Pct_[Account]
  {
  condition : [WS_[Account]_Fraction] = 0
   value  : 0

  condition : default
   value  : _Stor_Final_[Account] / ( [WS_[Account]_Fraction]  * [Max_WS_Storage] )  * 100  } //
:NEXT:


/*  WQ ACCOUNTING */

/*  The _WQ_Release is the amount of water required to be released from Jordan Lake to meet the Lillington flow target for days
```

```
283  when the lake is not full.  This variable's value should be the same as the model's computed Jordan release when the lake
284  is not full. It is done by setting the WQ Release to the model's computed Jordan releases at the dam.  When the lake is full,
285  we set the WQ Release to the value that would have been required to meet the Lillington target were the lake not full.
286  So it is the Lillington target minus the Moncure flow minus the Harris Lake release plus demands between the
287     dam at Jordan Lake and Lillington minus the discharges between the dam and Lillington. */
288
289
290  /*  The water quality release from Jordan = outflow from Jordan.  The release is constrained in the main.ocl file to the amount
291  in the water quality storage pool plus the inflow to that account.  This way, the release will not be made if the account
292  has emptied. Note the outflow may include releasing surplus water above the rule curve, which technically would be more than
293  the water quality release.  But since the account is reset to full above the rule curve, it makes no difference.  However,
294  to make it more realistic, set the WQ release to the minimum flow from Jordan when the elevation is at 216 or above.  */
295  Set  :  _WQ_Release
296  {     condition  :  elevation0470 >= 216
297     value      :  min_flow0470.0480
298
299     condition  :  default
300     value      :  flow0470.0480
301  }
302
303
304  // Initial value set in the udef list based on starting WQ storage reported in the constants table
305  Set  :  _WQ_Storage
306   {  condition  : elevation0470 >= 216.0
307         value      : [Max_WQ_Storage]
308
309    // the WQ storage is not allowed to go negative
310    condition  :  default
311         value      :  max { 0, min { [Max_WQ_Storage], _WQ_Storage(-1) + _JLake_WQ_Inf + _WS_Pool_Excess - _WQ_Release } }
312   }
313
314  Set  :  _WQ_Storage_Pct  {  value  :  _WQ_Storage /  [Max_WQ_Storage] * 100     }
315  Set  :  _Req_Refill_WQ   {  value  :  [Max_WQ_Storage] - _WQ_Storage + _WQ_Release }
316
317  Set  :  _WQ_Pool_Excess
318  {      condition  :  _Req_Refill_WS_Pool > _JLake_WS_Inf
319        value      :  max { 0, _JLake_WQ_Inf -  _Req_Refill_WQ  }
320
321        condition  :  default
322        value      :  0
323  }
324
325
326
```

main.ocl

```
1  /*  MAIN.OCL  */
2
3  :INCLUDE: OCL\constants.ocl
4  :INCLUDE: OCL\constants_removed.ocl
5  :INCLUDE: OCL\Forecast-Trigger_Parms.ocl
6  :INCLUDE: OCL\Forecast_Horizon_Days.ocl
7  :Static: statdata.mdb
8  :Time:   [HomeDir]\basedata\basedata.dss
9
10 :if: {[UseForecast]=1}
11   :if: {[ForecastData]=cond}
12     :Time:   [HomeDir]\basedata\forecasts_sim_cond_durham.dss
13   :Time:   [HomeDir]\basedata\forecasts_cond.dss
14   :else:
15     :Time:   [HomeDir]\basedata\forecasts_sim_noncond_durham.dss
16   :Time:   [HomeDir]\basedata\forecasts_non_cond.dss
17   :endif:
18 :endif:
19
20 :if: {[Drought_Plans_On] = 1}
21   :Time:   [HomeDir]\basedata\forecasts_non_cond.dss
22 :endif:
23
24 :MODULE: DLL  AgricDem = modules\AgricDem.DLL
25
26 :Include: ocl\udef_list.ocl
27
28 :Commands:
29
30 // For both basins
31
32 :Include: ocl\Agric_Calculation.ocl
33 :Include: ocl\Agric_Allocation.ocl
34 :Include: ocl\filter_inflows.ocl
35
36 // For the Cape Fear
37
38 /* :Include: ocl\user_def_ops.ocl */
39
40 :Include: ocl\routing_cf.ocl
41 :Include: ocl\Harris_ops.ocl
42 :Include: ocl\drought_protocol_jordan.ocl
43 :Include: ocl\Greensboro_ops.ocl
44 :Include: ocl\owasa_ops.ocl
45 :Include: ocl\Jordan_ops.ocl
46 :Include: ocl\Pitt_Chatham_ops.ocl
47 :Include: ocl\Randleman_ops.ocl
```

```
:Include: ocl\SilerCity_ops.ocl
:Include: ocl\Fayetteville_ops.ocl
:Include: ocl\FtBragg_ops.ocl
:Include: ocl\SpringLake_ops.ocl
:Include: ocl\drought_plans_cf.ocl
:Include: ocl\WW_Returns.ocl

// For the Neuse

:Include: ocl\routing_neuse.ocl
:Include: ocl\crabtree_ops.ocl
:Include: ocl\upper_eno_ops.ocl
:Include: ocl\HawR_Or_Almnc.ocl
:Include: ocl\durham_ops.ocl
:Include: ocl\falls_bdam_ops.ocl
:Include: ocl\falls_flood_ops.ocl
:Include: ocl\raleigh_ops.ocl
:Include: ocl\Fuquay_ops.ocl
:Include: ocl\Johnston_ops.ocl
:Include: ocl\buckhorn_Wilson_ops.ocl
:Include: ocl\Raleigh_Quarry_ops.ocl
:Include: ocl\NRWWTP_intake.ocl
:Include: ocl\drought_plans_neuse.ocl
:Include: ocl\drought_plan_durham.ocl
:Include: ocl\Benson_ops.ocl


// For both basins, this captures miscellaneous operations
:Include: ocl\misc_ops.ocl


// Solve model

Solve : {Priority : 1}

//Compute actual shortages based on drought plans
:Include: ocl\Shortages.ocl //added during Fuquay IBT study to calculate shortages based on cosnvn demands

//  Compute the Falls/Beaverdam and Jordan water quality and supply accounting after the SOLVE statement

:Include:   ocl\Falls_Bdam_WQ_WS_accounts.ocl
:Include:   ocl\Jordan_WQ_WS_Accounts.ocl


:End:

```

Misc_Ops.ocl

```
1  /*  Misc_Ops  */
2
3
4
5  // Misc. Cape Fear Ops.
6
7  // Set Cape Fear Arcs/Interconnects not used in basecase to zero
8  Constraint : {dFlow0319.0077 = 0}  // Green Level Gr-Meb WS
9  Constraint : {dFlow0479.0923 = 0}  // JL Holly Springs
10 Constraint : {dFlow0920.0319 = 0}  // Orange Co. Gr-Meb
11 Constraint : {dFlow0920.1106 = 0}  // Orange Co. Hills
12 Constraint : {dFlow0920.1162 = 0}  // Orange Co. Durham
13
14 // Add arc from Sanford to Pittsboro. Limit the current supply to Pittsboro
15 // from the Haw River to 2 mgd; the rest will come from Sanford.
16 Constraint : {dFlow0400.0401 = convert_units {2, mgd, af} }  // Haw River supply to Pittsboro
17
18 // Add arc from Sanford to Holly Springs with baseload supply of 4 mgd.  Use a constraint.
19 // Rest of Holly Springs demand will be met from the supply from Harnett County.
20 Constraint : {dFlow0489.0923 = convert_units {4, mgd, af} }  // Sanford to Holly Springs
21
22
23 // Let's add the corrected min release for Graham-Mebane Lake.  Since drought triggers are tied
24 // to usable storage (days of supply remaining), base min release adjustment on usable storage.
25 // The WTP process return (about 5% of the demand, applied to arc 319.100) can be used to help meet the min release
26
27 Set :  min_flow0320.0100
28 {   condition  :  (storage0320 - lower_rule0320) / (upper_rule0320 - lower_rule0320) <  0.4
29  value      :  convert_units {3, cfs, af} - flow0319.0100
30
31  condition  :  default
32  value      :  convert_units {5, cfs, af} - flow0319.0100
33 }
34
35
36 // Misc. Neuse Ops.
37
38 /*  Set demands not used in basecase run to zero */
39 Set :  demand1318  {  value :  0 } /* Old Burlington Industries */
40
41 /*  Set interconnects not used in basecase run to zero */
42 Constraint : {dFlow1300.0471 = 0}  /* Raleigh-Cary Interconnect */
43 Constraint : {dFlow1300.0923 = 0}  /* Raleigh-Holly Springs Interconnect */
44
45 /*  Set inflows not used in basecase run to zero*/
46 Set : inflow1252  {  value :  0 } /* Kerr Lake indirect transfer*/
47 Set : inflow1403  {  value :  0 } /* Quarry dewatering */
```

```
48  Set : inflow1528  {  value :  0 } /* Tar River transfer - Wilson */
49
50
51
```

NRWWTP_intake.ocl

```
/* NRWWTP_Intake.OCL */

/* This subroutine dictates the operation of the NRWWTP intake alternative G2. */

Set Neuse_intake : max_flow1620.1305 {value: convert_units {[NR_DS_intake], mgd, af}}

Target Deliv_NRintake_to_Raleigh : dflow1620.1305
{   condition : abs_period<=1
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
    Value     : 0

 // This code is being written so that the sum of withdrawals from Lake Benson and NR Intake
 // equals whatever we set the Benton WTP capacity.  This would only serve for Operational
 // yield tests as reality would dictate running at lower than max plant capacity
    condition : abs_period > 1
    priority  : 1
    penalty+  : 500
    penalty-  : 500
    Value     : convert_units {[DE_Benton_WTP_Capacity], mgd, af}-max_flow1440.1305

    condition : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 0
    value     : 0
}

Set Total_Intake_Pumping: _tot_intake_pump
{   condition : flow1620.1305 > 0
    value     : _tot_intake_pump(-1) + flow1620.1305

    condition : default
    value     : 0
}
```

OWASA_ops.ocl

```
// Operations policy for OWASA's system

// Set the Stone Quarry inflow - area adjustment of the Univ. Lake inflow
// Quarry = 1.2 sq. mi., Univ. Lake = 28.7 sq. mi.

Set : inflow0395 { value : 1.2 * inflow0430 / 28.7 }


//Set to refill Stone Quarry w/ spill from Cane Ck Res.
Target CaneCk_SQ_Trans : dflow0390.0395
{   condition : storage0390 >= upper_rule0390
    priority  : 1
    penalty+  : 350
    penalty-  : 300
    Value     : max { 0, min { upper_rule0395 - storage0390 - inflow0395 + evap0395 * stor_to_area { 0395, storage0395 } / 12 ,
                inflow0390 - evap0390 * stor_to_area { 0390, storage0390 } / 12 - min_flow0390.0370 - upper_rule0390 } }

    condition : default
    priority  : 1
    penalty+  : 350
    penalty-  : 350
    Value     : 0
}


// Anticipated OPERATING POLICY
//This is only necessary becuase dFlow can't be used in RHS of equation below in the
//next two targets - particularly the second one
Set  : _OWASA_JL_Use_Targ
{ // Use JL when in WSRP stages 1-3
 condition : (_OWASA_Trigger_3_On(-1) + _OWASA_Trigger_2_On(-1) + _OWASA_Trigger_1_On(-1) ) >=1
     and _Storage_OWASA(-1) > convert_units { 4, mg , af } //if any trigger is on, and there is
                  // water intheir JL Account, then buy
                  // water from WIP WTP
    Value     : convert_units { 4, mg , af }

    // No regular JL use if not in WSRP
    condition : default
    Value     : 0
}

Target JL_Access : dFlow1151.0431  // Access JL supply if WSRP stage >=1
{
    condition : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
```

```
48     Value     : _OWASA_JL_Use_Targ
49  }
50
51  // EXISTING OPERATING POLICY
52  // Set the WD from Cane Creek Reservoir, depending on reservoir levels
53  // Stone Quarry will be utilized last.
54
55  Target CaneCkWD : dflow0390.0431
56  {   // If Univ. Lake full and CCR is below full, make all WDs from Univ. Lake
57     condition : storage0430 >= upper_rule0430 - 0.1 and storage0390 < upper_rule0390
58     priority  : 1
59     penalty+  : 310
60     penalty-  : 310
61     Value     : 0
62
63     // If both reservoirs are full split the WD
64     condition : storage0430 >= upper_rule0430 and storage0390 >= upper_rule0390
65     priority  : 1
66     penalty+  : 310
67     penalty-  : 310
68     Value     : min { 0.5 * demand0431, max_flow0390.0431 }
69
70
71     // Split WDs for the first 100 MG of drawdown (50 MG from Univ Lake)
72     condition :  upper_rule0430 - storage0430 <= convert_units { 50, mg, af}
73     priority  : 1
74     penalty+  : 310
75     penalty-  : 310
76     Value     : min { 0.5 * demand0431, max_flow0390.0431 }
77
78     // After that withdraw the majority, less 1 mgd, from Cane Creek
79     condition : upper_rule0430 - storage0430 > convert_units { 50, mg, af}
80     priority  : 1
81     penalty+  : 310
82     penalty-  : 310
83     Value     : min { demand0431 - convert_units { 1, mgd, af } - _OWASA_JL_Use_Targ, max_flow0390.0431 }
84
85     // Then draw down Cane Creek completely if Univ Lake is depleted
86     condition : default
87     priority  : 1
88     penalty+  : 310
89     penalty-  : 310
90     Value     : min { demand0431 - _OWASA_JL_Use_Targ, max_flow0390.0431 }
91  }
92
```

OWASA_wsrp.ocl

```
/* OWASA's Drought Plan - based on the risk that usable storage will drop below 20% over the next year */

Set : _OWASA_Max_Usable_Stor { Value: (upper_rule0390 - lower_rule0390) + (upper_rule0395 - lower_rule0395)
        + (upper_rule0430 - lower_rule0430) }
Set : _OWASA_Usable_Stor { Value : min { _OWASA_Max_Usable_Stor,
                                (storage0390 - lower_rule0390) + (storage0395 - lower_rule0395)
        + (storage0430 - lower_rule0430) } }
Set : _OWASA_Usable_Stor_Pct { Value : 100 * _OWASA_Usable_Stor / _OWASA_Max_Usable_Stor }

// Compute the projected total inflows, demand, min. flow and evap at various forecast horizons over the next 52 weeks
:For:
{   [hrz] = {08, 12, 16, 20, 24, 52}
     [lag] = {56, 84, 112, 140, 168, 364}
}

// Trigger 1 horizon.
Set : _OWASA_ProjInflow1_[hrz]
{    condition : weekday{year, month, day} <= 1
     value     : 7 * ( timesers(0380/R02W[hrz]) + (1.2 / 28.7) * timesers(0430/R02W[hrz]) + timesers(0430/R02W[hrz]) )

     condition :  default
     value     :  _OWASA_ProjInflow1_[hrz](-1)
}


Set : _OWASA_ProjDemand1_[hrz]
{    condition : weekday{year, month, day} <= 1
     value     : accumulate { demand0431 , 0 , +[lag] }

     condition :  default
     value     :  _OWASA_ProjDemand1_[hrz](-1)
}


Set : _OWASA_ProjMinFlow1_[hrz]
{    condition : weekday{year, month, day} <= 1
     value     : accumulate { min_flow0390.0370 , 0 , +[lag]}

     condition :  default
     value     :  _OWASA_ProjMinFlow1_[hrz](-1)
}


Set : _OWASA_ProjEvap1_[hrz]
{    condition : weekday{year, month, day} <= 1
     value     : (stor_to_area { 0390 , storage0390 } * 7 * timesers(0390/EVAP_R02W[hrz]) / 12) +
                 (stor_to_area { 0395 , storage0395 } * 7 * timesers(0395/EVAP_R02W[hrz]) / 12) +
```

```
48              (stor_to_area { 0430 , storage0390 } * 7 * timesers(0430/EVAP_R02W[hrz]) / 12)
49      condition :  default
50      value     :  _OWASA_ProjEvap1_[hrz](-1)
51  }
52
53  // Trigger 2 horizon.
54  Set : _OWASA_ProjInflow2_[hrz]
55  {    condition : weekday{year, month, day} <= 1
56      value     : 7 * ( timesers(0380/R10W[hrz]) + (1.2 / 28.7) * timesers(0430/R10W[hrz]) + timesers(0430/R10W[hrz]) )
57
58      condition :  default
59      value     :  _OWASA_ProjInflow1_[hrz](-1)
60  }
61
62
63  Set : _OWASA_ProjDemand2_[hrz]
64  {    condition : weekday{year, month, day} <= 1
65      value     : accumulate { demand0431 , 0 , +[lag] }  * 0.9
66
67      condition :  default
68      value     :  _OWASA_ProjDemand1_[hrz](-1)
69  }
70
71
72  Set : _OWASA_ProjMinFlow2_[hrz]
73  {    condition : weekday{year, month, day} <= 1
74      value     : accumulate { min_flow0390.0370 , 0 , +[lag]}
75
76      condition :  default
77      value     :  _OWASA_ProjMinFlow1_[hrz](-1)
78  }
79
80
81  Set : _OWASA_ProjEvap2_[hrz]
82  {    condition : weekday{year, month, day} <= 1
83      value     : (stor_to_area { 0390 , storage0390 } * 7 * timesers(0390/EVAP_R10W[hrz]) / 12) +
84              (stor_to_area { 0395 , storage0395 } * 7 * timesers(0395/EVAP_R10W[hrz]) / 12) +
85              (stor_to_area { 0430 , storage0390 } * 7 * timesers(0430/EVAP_R10W[hrz]) / 12)
86      condition :  default
87      value     :  _OWASA_ProjEvap1_[hrz](-1)
88  }
89
90  // Trigger 3 horizon.
91  Set : _OWASA_ProjInflow3_[hrz]
92  {    condition : weekday{year, month, day} <= 1
93      value     : 7 * ( timesers(0380/R20W[hrz]) + (1.2 / 28.7) * timesers(0430/R20W[hrz]) + timesers(0430/R20W[hrz]) )
94
```

```
    condition :  default
    value     :  _OWASA_ProjInflow1_[hrz](-1)
}


Set : _OWASA_ProjDemand3_[hrz]
{    condition : weekday{year, month, day} <= 1
     value     : accumulate { demand0431 , 0 , +[lag] }  * 0.85

     condition :  default
     value     :  _OWASA_ProjDemand1_[hrz](-1)
}


Set : _OWASA_ProjMinFlow3_[hrz]
{    condition : weekday{year, month, day} <= 1
     value     : accumulate { min_flow0390.0370 , 0 , +[lag]}

     condition :  default
     value     :  _OWASA_ProjMinFlow1_[hrz](-1)
}


Set : _OWASA_ProjEvap3_[hrz]
{    condition : weekday{year, month, day} <= 1
     value     : (stor_to_area { 0390 , storage0390 } * 7 * timesers(0390/EVAP_R20W[hrz]) / 12) +
                 (stor_to_area { 0395 , storage0395 } * 7 * timesers(0395/EVAP_R20W[hrz]) / 12) +
                 (stor_to_area { 0430 , storage0390 } * 7 * timesers(0430/EVAP_R20W[hrz]) / 12)
     condition :  default
     value     :  _OWASA_ProjEvap1_[hrz](-1)
}


 // Compute projected storage for the entire system for each trigger.  Projected storage will not exceed the max usable storage

 :For:
 {   [trig] = {1, 2, 3}
 }

 Set : _OWASA_ProjStorage[trig]_[hrz]
 {   Condition : weekday{year, month, day} <= 1
  Value     : min{_OWASA_Usable_Stor + _OWASA_ProjInflow[trig]_[hrz] - _OWASA_ProjDemand[trig]_[hrz]
        - _OWASA_ProjEvap[trig]_[hrz] - _OWASA_ProjMinFlow[trig]_[hrz] ,
     _OWASA_Max_Usable_Stor}

  Condition : default
  Value     : _OWASA_ProjStorage[trig]_[hrz](-1)
```

```
142   }
143
144   Set : _OWASA_ProjStorage_Pct[trig]_[hrz]
145   {   Condition : weekday{year, month, day} <= 1
146    Value     : 100 * _OWASA_ProjStorage[trig]_[hrz] / _OWASA_Max_Usable_Stor
147
148    Condition : default
149    Value     : _OWASA_ProjStorage_Pct[trig]_[hrz](-1)
150   }
151
152   :Next:
153  :Next:
154
155  /*  This section evaluates whether any of the three triggers were on during the
156     last time step.  If so, it checks to see whether the reservoir has re-filled
157     to the release storage, in which case the triggers are released.
158     If the trigger was not on in the last timestep, it compares the projected stage with
159     the threshold to determine whether it should be turned on.
160
161     Note the projected storage is calculated only at beginning of week, so determination of triggers
162     is kept to the beginning of the week.  That provides some delay in enactment of triggers and duplicates
163     to some extent the waiting period requirement below.
164  */
165
166  // Enact only if trigger storage is met and put in some waiting period as shown below.
167  // Triggers 2 and 3 can only turn on in sequence after trigger 1 has turned on.
168
169  Set : _OWASA_Trigger_3_On
170  {   Condition : _OWASA_Trigger_3_On(-1) = 1
171     {   Condition : _OWASA_Usable_Stor >= _OWASA_Max_Usable_Stor
172        Value     : 0
173
174        Condition : default
175        Value     : _OWASA_Trigger_3_On(-1)
176     }
177
178     Condition : _OWASA_Stage_2_Counter(-1) >= 7   // Require a 7 day waiting period before going into phase 3
179     {   Condition : weekday{year, month, day} <= 1
180        {     Condition : _OWASA_ProjStorage_Pct3_08 <= 20 or _OWASA_ProjStorage_Pct3_12 <= 20
181       or _OWASA_ProjStorage_Pct3_16 <= 20 or _OWASA_ProjStorage_Pct3_20 <= 20
182       or _OWASA_ProjStorage_Pct3_24 <= 20 or _OWASA_ProjStorage_Pct3_52 <= 20
183            Value     : 1
184        }
185        Condition : default
186        Value     : _OWASA_Trigger_3_On(-1)
187     }
188     Condition : default
```

```
    Value    : _OWASA_Trigger_3_On(-1)
}


Set : _OWASA_Trigger_2_On
{   Condition : _OWASA_Trigger_2_On(-1) = 1
    {   Condition : _OWASA_Usable_Stor >= _OWASA_Max_Usable_Stor
        Value    : 0

        Condition : default
        Value    : _OWASA_Trigger_2_On(-1)
    }

    Condition : _OWASA_Stage_1_Counter(-1) >= 7   // Require a 7 day waiting period before going into phase 2
    {   Condition : weekday{year, month, day} <= 1
        {   Condition : _OWASA_ProjStorage_Pct2_08 <= 20 or _OWASA_ProjStorage_Pct2_12 <= 20
      or _OWASA_ProjStorage_Pct2_16 <= 20 or _OWASA_ProjStorage_Pct2_20 <= 20
      or _OWASA_ProjStorage_Pct2_24 <= 20 or _OWASA_ProjStorage_Pct2_52 <= 20
            Value    : 1
        }
        Condition : default
        Value    : _OWASA_Trigger_2_On(-1)
    }
    Condition : default
    Value    : _OWASA_Trigger_2_On(-1)
}


Set : _OWASA_Trigger_1_On
{   Condition : _OWASA_Trigger_1_On(-1) = 1
    {   Condition : _OWASA_Usable_Stor >= _OWASA_Max_Usable_Stor
        Value    : 0

        Condition : default
        Value    : _OWASA_Trigger_1_On(-1)
    }

    Condition : weekday{year, month, day} <= 1
    {   Condition : _OWASA_ProjStorage_Pct1_08 <= 20 or _OWASA_ProjStorage_Pct1_12 <= 20
     or _OWASA_ProjStorage_Pct1_16 <= 20 or _OWASA_ProjStorage_Pct1_20 <= 20
     or _OWASA_ProjStorage_Pct1_24 <= 20 or _OWASA_ProjStorage_Pct1_52 <= 20
        Value    : 1

        Condition : default
        Value    : _OWASA_Trigger_1_On(-1)
    }
    Condition : default
```

```
236     Value     : _OWASA_Trigger_1_On(-1)
237  }
238
239  :For:
240  {   [trig] = {1, 2, 3}
241  }
242
243  Set : _OWASA_Stage_[trig]_Counter
244  {   Condition : _OWASA_Stage_[trig]_Counter(-1) > 0 and _OWASA_Trigger_[trig]_On = 0
245     Value     : 0
246
247     Condition : _OWASA_Trigger_[trig]_On = 1
248     Value     : _OWASA_Stage_[trig]_Counter(-1) + 1
249
250     Condition : default
251     Value     : _OWASA_Stage_[trig]_Counter(-1)
252  }
253
254  /*  Count all trigger events lasting at least 7 days */
255
256  Set : _OWASA_Ph_[trig]_event_counter
257  {   Condition : _OWASA_Stage_[trig]_Counter = 7 and _OWASA_Stage_[trig]_Counter(-1) = 6
258     Value     : _OWASA_Ph_[trig]_event_counter(-1) + 1
259
260     Condition : default
261     Value      : _OWASA_Ph_[trig]_event_counter(-1)
262  }
263
264  :Next:
265
266  /*  This section determines the demand depending upon which level of conservation
267     is in place. */
268
269  Set : _OWASA_Consvn_1_Demand
270  {
271     Condition : _OWASA_Trigger_1_On = 1
272     Value     : Demand0431 * ( 1 - ( 10/ 100 ))
273
274     Condition : default
275     Value     : Demand0431
276  }
277
278  Set : _OWASA_Consvn_2_Demand
279  {
280   Condition : _OWASA_Trigger_2_On = 1
281     Value     : Demand0431 * ( 1 - ( 15 / 100 ))
282
```

```
283     Condition : default
284     Value     : Demand0431
285  }
286
287  Set : _OWASA_Consvn_3_Demand
288  {
289   Condition : _OWASA_Trigger_3_On = 1
290     Value     : Demand0431 * ( 1 - ( 20 / 100 ))
291
292     Condition : default
293     Value     : Demand0431
294  }
295
296  :For:
297  {   [trig] = {1, 2, 3}
298  }
299
300  Constraint   OWASA_Demand_Limit_Consvn_[trig] :
301             {   Condition  :  _OWASA_Trigger_[trig]_On = 1
302                 Expression :  ddelivery0431<= _OWASA_Consvn_[trig]_Demand }
303
304  :Next:
305
```

Pitt_Chatham_ops.ocl

```
1  /*  Pittsboro_Ops.ocl  */
2  /*  Operational policies for Town of Pittsboro */
3
4  // Since supply from Jordan Lake WIP to Pittsboro may not occcur, set the flow to 0 in this arc.  Ignore the rest below.
5  Constraint : {dFlow0468.0401 = convert_units {0, mgd, af} }  // JLake supply to Pittsboro
6
7  /*
8
9  // Balance use of the two water sources for Pittsboro in accordance with rough guidance from J. Hennessy in fall of 2021
10 Target Pittsboro_WIP_usage : dflow0468.0401
11 {
12    condition : _Storage_Pitt(-1) > demand0401  //Sufficient storage in JL is available
13    priority  : 1
14    penalty+  : 20
15    penalty-  : 20
16    Value     : 0.75 * demand0401
17
18    condition : default
19    priority  : 1
20    penalty+  : 5
21    penalty-  : 5
22    Value     : min {_Storage_Pitt(-1), 0.5 * demand0401}
23
24 }
25
26 */
27
28 Constraint : {dFlow0468.0473 = 0}   // WIP to Chatham - for calculation simplicity, not what will actually happen.
29          // This way Chatham gets all it water directly from the 0470.0473 arc
30
31 // Ignore the rest below.
32
33 // Balance use of the two water sources for Chatham Co. in accordance with rough guidance from J. Hennessy
34 // in fall of 2021 that Chatham will supply it's North zone/region from the WIP facility
35 // Data on usage from WIP demands.xlsx
36
37 /*Target Chatham_WIP_usage : dflow0468.0473
38 {
39    condition : default
40    priority  : 1
41    penalty+  : 10
42    penalty-  : 10
43    Value     : 0.64 * demand0473
44
45 }*/
46
47
```

Raleigh_ops.ocl

```
/*  RALEIGH_OPS.OCL  */

/*  Set flow from Falls Lake to Raleigh demand to zero when performing anaysis on the Swift Creek system in isolation. */
//Constraint : {dFlow1300.1305 = 0 }

/* This code block was moved from Falls_Bdam_WQ_WS_Accounts.ocl in order that the variable _Raleigh_Sys_Stor_Pct
 (see end of file) can be appropriately calculated here. These variables will mostly be used in
 Falls_Bdam_WQ_WS_Accounts.ocl*/

/* The Falls conservation storage zone is divided into water quality and water storage accounts
Fraction of conservation storage and inflow :
WQ = 57.7% allocated (61,322 acft.)
WS = 42.3% allocated (45,000 acft.)

Beaverdam is also included in the WQ/WS accounting, the proportion to each is the same as Falls. */
/*  WQ and WS accounts by lake */

set :  _FLake_Max_WQ_WS_Storage
{    condition  :   Default
     value      :   101705 // removed algorithm that allows adjustment to Falls Conservation Pool - RNP
}

set :  _FLake_Max_WS_Storage
{    condition  :   Default
     value      :   _FLake_Max_WQ_WS_Storage - [FLake_WQ_Stor] // This latter number should be the volume of the reallocated
                  // WQ Poolin Falls only (w/o Beaver Dam portion)

}

set :  _FLake_Max_WQ_Storage
{    condition  :   Default
     value      :   _FLake_Max_WQ_WS_Storage - _FLake_Max_WS_Storage

}


Set :  _Pct_Max_WS_Storage
{  value  :  ( _FLake_Max_WS_Storage  /  _FLake_Max_WQ_WS_Storage  ) * 100  } // removed algortihm allowing
                    //easy adjusment to pool percentage - RNP 1/25/21
Set :  _Pct_Max_WQ_Storage  {  value  :   100 - _Pct_Max_WS_Storage }

set :   _Total_Max_WQ_WS_Storage {value: _FLake_Max_WQ_WS_Storage + [Bdam_WQ_WS_Stor]  }
set :   _Total_Max_WS_Storage  { value : _FLake_Max_WS_Storage + [Bdam_WQ_WS_Stor]  * _Pct_Max_WS_Storage / 100  }
set :   _Total_Max_WQ_Storage { value : _Total_Max_WQ_WS_Storage  -  _Total_Max_WS_Storage}

Set :  _Bdam_Max_WQ_Storage  {  value  : [Bdam_WQ_WS_Stor]  * _Pct_Max_WQ_Storage / 100 }
Set :  _Bdam_Max_WS_Storage  {  value  : [Bdam_WQ_WS_Stor]  * _Pct_Max_WS_Storage / 100 } //  add this when Beaver Dam Sediment
```

```
48                      // Storage is to be included in Alt
49                      // A3:  + (elev_to_stor{230, [Falls_lower_rule]} - lower_rule230)
50
51
52  /* Set inflow and evaporation on farm ponds in Little River Sub-basin */
53  Set : evap1739 { value :0.40 * evap1740}
54  :Substitute: [farm_inflow_fraction] = 0.46 // I believe this was a GIS estimate of the fraction of the LRR watershed
55            // that passes through an upstream pond before reaching the LRR
56  Set : inflow1739 { value : [farm_inflow_fraction] * inflow1740}
57  Set : inflow1740 { value : inflow1740 - inflow1739}
58
59  // Set operational policy for Swift Creek system
60
61  Set : Swift_Sys_WS_Stor_Pct
62  { value: ((storage1420 - dead_stor1420 + storage1440 -  dead_stor1440)
63    / (max_stor1420 - dead_stor1420 + max_stor1440 - dead_stor1440)) *100 }
64
65  /*  Set the minimum release for Benson/Wheeler - based on useable storage */
66  Set :  min_flow1440.1700
67  {   condition : Swift_Sys_WS_Stor_Pct < 30
68     Value     : convert_units { 1 , cfs , af }
69
70     condition : Swift_Sys_WS_Stor_Pct < 60
71     Value     : convert_units { 2 , cfs , af }
72
73     condition : default
74     Value     : convert_units { 3 , cfs , af }
75  }
76
77
78
79  /*  Operational policy for withdrawals from Benson/Wheeler */
80
81
82  /* Set the maximum delivery from Raleigh WTP's (change the capacities using the substitutes below) */
83
84  :Substitute: [EMJ_WTP_capacity] = 120 //MGD - Reed changed from 86 to 120 since this run is used for long-term planning out beyond 2040
85
86  Set :  max_flow1440.1305 //Set max WTP flows based on Final EA for D.E. Benton WTP
87  {
88
89   condition : (Swift_Sys_WS_Stor_Pct + 10) < _Total_WS_Pct(-1) // adjusted margin to +10% and low Benton production to 6 mgd
90     Value     : convert_units {6, mgd, af}
91
92     condition : Swift_Sys_WS_Stor_Pct < 30
93     Value     : convert_units { 11.2, mgd, af }
94
```

```
    condition : Swift_Sys_WS_Stor_Pct < 60
    Value     : convert_units { 12.6, mgd, af }

    condition : default
    Value     : convert_units { 14 , mgd , af }
}


Set :  max_flow1300.1305
{   condition  :  default
 Value      :  convert_units { [EMJ_WTP_capacity], mgd , af }

}

// Don't allow Falls/EMJ WD to drop below 36 MGD
Target Falls_WTP_Min_production  :  dflow1300.1305
{   condition : default
    priority  : 1
    penalty+  : 0
    penalty-  : 200
    Value     : convert_units{ 36, mgd, af }
}

/* Set delivery target for DE Benton WTP  */
Target Benton_WTP_Min_production  :  dflow1440.1305
{   condition : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 10
    Value     : max_flow1440.1305
}


/*  RESERVOIR BALANCING -- Raleigh - Attempt to draw down the Falls/Bdam WS account and the usable storage
    in Benson/Wheeler proportionally. */

Constraint Balance1300 : { d_StorRatio2 > (( Dstorage1300 + Dstorage1230 - elev_to_stor { 1300 , [Falls_lower_rule] }
        - elev_to_stor { 1230, [Falls_lower_rule] } - _Total_WQ_Stor(-1))
                                / ( (elev_to_stor { 1300 , [Falls_upper_rule] } - elev_to_stor { 1300 , [Falls_lower_rule] }) +
                                  (elev_to_stor { 1230 , [Falls_upper_rule] } - elev_to_stor { 1230 , [Falls_lower_rule] })
        - _Total_Max_WQ_Storage )) }

Constraint Balance1440 : { d_StorRatio2 > (( Dstorage1440 + Dstorage1420 - dead_stor1440 - dead_stor1420 )
        / (max_stor1440 + max_stor1420 - dead_stor1440 - dead_stor1420)) }
```

```
142
143  // Assume Little River Reservoir is not operational in the 2055 scenario since its projected demand can
144  // be met from the existing supply sources.
145
146  /*
147  Target LRR_WTP_Min_production  :  dflow1740.1305
148  {   condition : abs_period > 1 and ((storage1740 - dead_stor1740)/(max_stor1740 - dead_stor1740) + 0.07) < _Total_WS_Pct(-1)/100
149      priority  : 1
150      penalty+  : 30
151      penalty-  : 30
152      Value     : convert_units{ 6, mgd, af }
153
154      condition : abs_period > 1 and ((storage1740 - dead_stor1740)/(max_stor1740 - dead_stor1740)) - 0.07 > _Total_WS_Pct(-1)/100
155      priority  : 1
156      penalty+  : 50
157      penalty-  : 30
158      Value     : convert_units{ 20, mgd, af }
159
160      condition : default
161      priority  : 1
162      penalty+  : 0
163      penalty-  : 30
164      Value     : convert_units{ 7.5, mgd, af }
165  }
166  */
167
168  // Set delivery to Raleigh to 0.
169  Set :  max_flow1740.1305
170  {   condition  :  default
171   Value      :  convert_units { 0, mgd , af }
172  }
173
174
175  // Set the minimum release.  Set to 0 since reservoir is not active for the 2055 scenario.
176
177  Set :  min_flow1740.1747
178  {   /*condition : (storage1740 - dead_stor1740) / (max_stor1740 - dead_stor1740) < 0.5
179      Value     : convert_units { 0.48 , cfs , af }
180
181      condition : (storage1740 - dead_stor1740) / (max_stor1740 - dead_stor1740) < 0.7
182      Value     : convert_units { 2.31 , cfs , af }
183   */
184
185      condition : default
186      Value     : convert_units { 0 , cfs , af }
187  }
188
```

```
189
190 // More reservoir balancing -- include Little River.  Shut off for the 2055 scenario since it is not active.
191
192 /*
193 Constraint Balance1740 : { d_StorRatio2 > (( Dstorage1740 - dead_stor1740) / (max_stor1740 - dead_stor1740)) }
194
195 Minimax : d_StorRatio2
196
197 {  priority  : 1
198    penalty   : 50
199    tolerance : .02
200 }
201
202 */
203
204
205 /* System Storage for Raleigh - including Little River Reservoir should it be evaluated.
206 Little River set to 0 storage since not used for this scenario.   */
207
208 Set : _Raleigh_Sys_Stor_Pct
209 {  value      :   (_Total_WS_Stor(-1) + storage1420 - dead_stor1420 + storage1440 -  dead_stor1440 + storage1740 - dead_stor1740 ) /
210                  ( _Total_Max_WS_Storage + max_stor1420 - dead_stor1420 + max_stor1440 - dead_stor1440 + max_stor1740 - dead_stor1740)
211
212 }
```

Raleigh_Quarry_ops.ocl

```
/*  Raleigh_Quarry_ops.OCL  */

/* This subroutine dictates the operation of the Raleigh Quarry WS concept. */



// Ensure that the minimum release obligation from Falls is also met below the Quarry and Lag node
Constraint FallsDownstreamFlow1 :
{   condition : month > 3 and month < 11
    expression: dflow1310.1320 >= convert_units { 100, cfs, af } * ( 1 + [FLakeMin_SafeFact] / 100 )
}

Constraint FallsDownstreamFlow2 :
{   condition : month<=3 or month>=11
    expression: dflow1310.1320 >= convert_units { lookup { PiggybackGate, elevation1300 }, cfs, af }
}


Set :  Expected_Durham_Spill
{
    value : max {0, inflow1140 + inflow1200 + storage1140 + storage1200 - evap1140 - evap1200 - demand1162 - max_stor1140 - max_stor1200}
}

Set : Expected_Falls_Spill
{               // Spill is expected
    condition : (inflow1300 + flow1163.1300(-1) + inflow1080 + inflow1100 + inflow1110 + inflow1115 + flow1256.1300(-1)
     + inflow1270 + inflow1230  + Expected_Durham_Spill - delivery1302 - evap1300 - evap1230 - demand1306
     - min_flow1300.1304 + storage1300 + storage1230 - elev_to_stor{1300, [Falls_upper_rule]}
     - elev_to_stor{1230, elevation1300}) > 0

    value     :  inflow1300 + flow1163.1300(-1) + inflow1080 + inflow1100 + inflow1110 + inflow1115 + flow1256.1300(-1)
     + inflow1270 + inflow1230  + Expected_Durham_Spill - delivery1302 - evap1300 - evap1230 - demand1306
     - min_flow1300.1304 + storage1300 + storage1230 - elev_to_stor{1300,[Falls_upper_rule]}
     - elev_to_stor{1230, elevation1300}
               // No spill expected
    condition : default
    value     : 0
}



Set Raleigh_Quarry_Refill : max_flow1304.1340 // Fill conditions
{
    condition : Expected_Falls_Spill > 0 and storage1340 < max_stor1340
    value     : max {0, min{ convert_units { [Max_Quarry_refill_rate] , mgd , af }, max_stor1340
       - storage1340, Expected_Falls_Spill}}

```

```
    condition : default
    value     : 0
}



//Quarry release rule
Target Raleigh_Quarry_Outflow  :  dflow1340.1305
{   condition : elevation1300 < [Falls_upper_rule] - 0.5
    priority  : 1
    penalty+  : 1000
    penalty-  : 50
    Value     : convert_units { [Max_Quarry_refill_rate]  , mgd , af }


    condition : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 0
    Value     : 0
}

//Quarry refill target
Target Raleigh_Quarry_Refill  :  dflow1304.1340
{   condition : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 50
    Value     : max_flow1304.1340



}
```

Randleman_ops.ocl

```
1  /*  Randleman_Ops.ocl  */
2  /*  Operational policies for Randleman Lake */
3
4
5  Set MinReleaseRandleman :  min_flow0270.0280
6  {    condition  :  storage0270 / max_stor0270 <= 0.30
7       value      :  convert_units {10, cfs, af }
8
9       condition  :  storage0270 / max_stor0270 <= 0.60
10      value      :  convert_units {20, cfs, af }
11
12      condition  :  default
13      value      :  convert_units {30, cfs, af }
14 }
15
```

routing_cf.ocl

```
1  /*  File is ROUTING_CF.OCL, which has the coding to handle the Jordan - Lillington,
2     and Lillington to Fayetteville routing, daily time step only. */
3
4  /*  Jordan-to-Lillington.
5        Jordan Release seen at Lill.
6        = .5 * yesterday's release + .5 * today's release.
7
8     Lillington-to-Fayetteville.
9        Lillington flow seen at Fayetteville
10       = Average flow of previous day
11
12    Nodes 555 and 749 are reservoirs used for channel storage.
13    The flow into these three nodes is unrouted; the release from them is routed.
14    The storage in the nodes makes up the difference.
15
16    Note that for the first day of the simulation the routed flows need to be
17    estimated; the current values set the routed flows equal to the flow
18    for that day when the simulation is started on 01/01/1930; they may need to be
19    adjusted if the run is started on a different date. */
20
21 Target JordanRout : dflow0555.0650 - 0.5 * dflow0550.0555
22 {   Condition : abs_period <= 1
23    priority  : 1
24    penalty+  : 10000
25    penalty-  : 10000
26    value     : convert_units { 3711, cfs, af }
27
28    Condition : default
29    priority  : 1
30    penalty+  : 10000
31    penalty-  : 10000
32
33    value     : 0.5 * flow0550.0555(-1)
34 }
35
36 Target LillRout : dflow0749.0770
37 {   Condition : abs_period <= 1
38    priority  : 1
39    penalty+  : 10000
40    penalty-  : 10000
41    value     : convert_units { 4381, cfs, af }
42
43
44    Condition : default
45    priority  : 1
46    penalty+  : 10000
47    penalty-  : 10000
```

```
48      value     : flow0740.0749(-1)
49  }
```

routing_neuse.ocl

```
1  /*  File is ROUTING_NEUSE.OCL, which has the coding to handle the Falls - Clayton,
2     Clayton - Goldsboro and Goldsboro - Kinston routing, daily time step only. */
3
4  /*  Falls-to-Clayton.
5        Falls Release seen at Clayton
6        = .5 * yesterday's release + .5 * today's release.
7
8     Clayton-to-Goldsboro.
9        Clayton flow seen at Goldsboro
10       = Average flow of previous four days
11
12    Goldsboro-to-Kinston.
13       Goldsboro flow seen at Kinston
14       = Average flow of previous two days
15
16    Nodes 310, 640 and 790 are reservoirs used for channel storage.
17    The flow into these three nodes is unrouted; the release from them is routed.
18    The storage in the nodes makes up the difference.
19
20    Note that for the first day of the simulation the routed flows need to be
21    estimated; the current values set the routed flows equal to the upstream flow
22    for that day when the simulation is started on 01/01/1929; they may need to be
23    adjusted if the run is started on a different date. */
24
25 Target FallsRout : dflow1310.1320 - .5 * dflow1300.1304
26 {   Condition : abs_period <= 1
27    priority  : 1
28    penalty+  : 10000
29    penalty-  : 10000
30    value     : convert_units { 49.25, cfs, af }
31
32    Condition : default
33    priority  : 1
34    penalty+  : 10000
35    penalty-  : 10000
36    value     : .5 * flow1304.1310(-1)
37 }
38 Target ClaytRout : dflow1640.1650
39 {   Condition : abs_period <= 1
40    priority  : 1
41    penalty+  : 10000
42    penalty-  : 10000
43    value     : convert_units { 353.6, cfs, af }
44
45    Condition : abs_period = 2
46    priority  : 1
47    penalty+  : 10000
```

```
48      penalty-  : 10000
49      value     : flow1630.1640(-1)
50
51      Condition : abs_period = 3
52      priority  : 1
53      penalty+  : 10000
54      penalty-  : 10000
55      value     : ( flow1630.1640(-2) + flow1630.1640(-1) ) / 2
56
57      Condition : abs_period = 4
58      priority  : 1
59      penalty+  : 10000
60      penalty-  : 10000
61      value     : ( flow1630.1640(-3) + flow1630.1640(-2) + flow1630.1640(-1) ) / 3
62
63      Condition : default
64      priority  : 1
65      penalty+  : 10000
66      penalty-  : 10000
67      value     : ( flow1630.1640(-4) + flow1630.1640(-3) + flow1630.1640(-2) + flow1630.1640(-1) ) / 4
68  }
69  Target GoldsRout : dflow1790.1795
70  {   Condition : abs_period <= 1
71      priority  : 1
72      penalty+  : 10000
73      penalty-  : 10000
74      value     : convert_units { 1047.6, cfs, af }
75
76      Condition : abs_period = 2
77      priority  : 1
78      penalty+  : 10000
79      penalty-  : 10000
80      value     : flow1780.1790(-1)
81
82      Condition : default
83      priority  : 1
84      penalty+  : 10000
85      penalty-  : 10000
86      value     : ( flow1780.1790(-2) + flow1780.1790(-1) ) / 2
87  }
```

Shortages.ocl

```
1  //Shortages.ocl
2  //Calculates shortages using conservation demands from drought plans to determine actual shortages
3
4  //Neuse drought demands
5
6
7  set:_Durham_Shortage_Calc
8  { condition  : default
9   value   : demand1162 - delivery1162
10 }
11
12 :For:
13 {   [trig] = {1,2,3,4}
14 }
15 set:_Durham_Shortage_Calc
16 { condition  : _Durham_Trigger_[trig]_On = 1
17  value   : _Durham_Consvn_[trig]_Demand-delivery1162
18 }
19 :Next:
20
21
22 set:_Ral_Shortage_Calc
23 { condition  : default
24  value   : demand1306 - delivery1306
25 }
26
27 :For:
28 {   [trig] = {1,2,3}
29 }
30 set:_Ral_Shortage_Calc
31 { condition  : _Ral_Trigger_[trig]_On = 1
32  value   : _Ral_Consvn_[trig]_Demand-delivery1306
33 }
34 :Next:
35
36 set:_SGWASA_Shortage_Calc
37 { condition  : default
38  value   : demand1256 - delivery1256
39 }
40
41 :For:
42 {   [trig] = {1,2,3,4,5}
43 }
44 set:_SGWASA_Shortage_Calc
45 { condition  : _SGWASA_Trigger_[trig]_On = 1
46  value   : _SGWASA_Consvn_[trig]_Demand-delivery1256
47 }
```

```
:Next:

set:_Wilson_Shortage_Calc
{ condition  : default
 value   : demand1506 - delivery1506
}

:For:
{   [trig] = {1,2,3,4,5}
}
set:_Wilson_Shortage_Calc
{ condition  : _Wilson_Trigger_[trig]_On = 1
 value   : _Wilson_Consvn_[trig]_Demand-delivery1506
}
:Next:


set:_Benson_Shortage_Calc
{ condition  : default
 value   : demand1756 - delivery1756
}

:For:
{   [trig] = {1,2,3,4,5,6}
}
set:_Benson_Shortage_Calc
{ condition  : _Benson_Trigger_[trig]_On = 1
 value   : _Benson_Consvn_[trig]_Demand-delivery1756
}
:Next:


////Cape Fear drought demands
//

set:_OWASA_Shortage_Calc
{ condition  : default
 value   : demand0431 - delivery0431
}

:For:
{   [trig] = {1,2,3}
}
set:_OWASA_Shortage_Calc
{ condition  : _OWASA_Trigger_[trig]_On = 1
 value   : _OWASA_Consvn_[trig]_Demand-delivery0431
}
```

```
:Next:

set:_Burl_Shortage_Calc
{ condition  : default
 value   : demand0341 - delivery0341
}

:For:
{   [trig] = {1,2,3,4,5}
}
set:_Burl_Shortage_Calc
{ condition  : _Burl_Trigger_[trig]_On = 1
 value   : _Burl2_Consvn_[trig]_Demand-delivery0341
}
:Next:

set:_Gree_Shortage_Calc
{ condition  : default
 value   : demand0123 - delivery0123
}

:For:
{   [trig] = {1,2,3,4,5}
}
set:_Gree_Shortage_Calc
{ condition  : _Gree_Trigger_[trig]_On = 1
 value   : _Gree2_Consvn_[trig]_Demand-delivery0123
}
:Next:

set:_High_Shortage_Calc
{ condition  : default
 value   : demand0223 - delivery0223
}

:For:
{   [trig] = {1,2,3,4}
}
set:_High_Shortage_Calc
{ condition  : _High_Trigger_[trig]_On = 1
 value   : _High_Consvn_[trig]_Demand-delivery0223
}
:Next:

set:_Reid_Shortage_Calc
{ condition  : default
 value   : demand0031 - delivery0031
```

```
142  }
143
144  :For:
145  {   [trig] = {1,2,3,4,5}
146  }
147  set:_Reid_Shortage_Calc
148  { condition  : _Reid_Trigger_[trig]_On = 1
149   value   : _Reid_Consvn_[trig]_Demand-delivery0031
150  }
151  :Next:
152
153  set:_Rams_Shortage_Calc
154  { condition  : default
155   value   : demand0301 - delivery0301
156  }
157
158  :For:
159  {   [trig] = {1,2,3,4,5}
160  }
161  set:_Rams_Shortage_Calc
162  { condition  : _Rams_Trigger_[trig]_On = 1
163   value   : _Rams_Consvn_[trig]_Demand-delivery0301
164  }
165  :Next:
166
167  set:_GramMeb_Shortage_Calc
168  { condition  : default
169   value   : demand0321 - delivery0321
170  }
171
172  :For:
173  {   [trig] = {1,2,3,4,5}
174  }
175  set:_GramMeb_Shortage_Calc
176  { condition  : _GramMeb_Trigger_[trig]_On = 1
177   value   : _GramMeb_Consvn_[trig]_Demand-delivery0321
178  }
179  :Next:
180
181
182  set:_Cary_Shortage_Calc
183  { condition  : default
184   value   : demand0471 - delivery0471
185  }
186
187  :For:
188  {   [trig] = {1,2,3,4}
```

```
189  }
190  set:_Cary_Shortage_Calc
191  { condition  : _Cary_Trigger_[trig]_On = 1
192   value   : _Cary_Consvn_[trig]_Demand-delivery0471
193  }
194  :Next:
195
196
197  set:_Dunn_Shortage_Calc
198  { condition  : default
199   value   : demand0663 - delivery0663
200  }
201
202  :For:
203  {   [trig] = {1,2,3,4,5,6}
204  }
205  set:_Dunn_Shortage_Calc
206  { condition  : _Dunn_Trigger_[trig]_On = 1
207   value   : _Dunn_Consvn_[trig]_Demand-delivery0663
208  }
209  :Next:
210
211
```

SilerCity_ops.ocl

```
1  /*  SilerCity_Ops.OCL  */
2
3  /*  Minimum release policy for Siler City's Charles Turner Reservoir on the Rocky River - based on combined usable
4     storage remaining in the reservoirs. */
5
6  Set : _SilerCity_UsableStor     { Value : max { 0,
7              min { (max_stor0324 - dead_stor0324 + max_stor0325 - dead_stor0325),
8                (storage0324 - dead_stor0324 + storage0325 - dead_stor0325)  } } }
9  Set : _SilerCity_UsableStorPct { Value : 100 * _SilerCity_UsableStor
10           / (max_stor0324 - dead_stor0324 + max_stor0325 - dead_stor0325) }
11
12
13 // Trigger when reaching tier 2
14 Set :  _SilerCityTrig2
15 {   condition :  _SilerCity_UsableStorPct < 70
16    value     :  1
17
18    condition :  default
19    value     :  0
20 }
21
22
23 // Trigger when reaching tier 3
24 Set :  _SilerCityTrig3
25 {   condition :  _SilerCity_UsableStorPct < 40
26    value     :  1
27
28    condition :  default
29    value     :  0
30 }
31
32
33 Set :  _Tier_MinRelease
34 {   // Tier 3
35    condition : _SilerCityTrig3 = 1
36    Value     : convert_units {pattern(Tier3_RockyRiver),cfs,af}
37
38    // Tier 2
39    condition : _SilerCityTrig2 = 1
40    Value     : convert_units {pattern(Tier2_RockyRiver),cfs,af}
41
42    // Tier 1
43    condition : default
44    Value     : convert_units {pattern(Tier1_RockyRiver),cfs,af}
45 }
46
47 // Also provide pulsing to simulate storm events (if those do not occur) of 20 cfs for 12 hours, or 20 acre feet per day, once per month,
```

```
// whenever combined usable storage exceeds 40%.  401 Water Quality Certificate says pulses only required when no natural events of similar
// magnitude are observed.  Assume we will provide this at the beginning of each month regardless of natural flows.

// Set min flow
Set :  min_flow0325.0328
{   condition  :  day = 1 and _SilerCity_UsableStorPct > 0.4
    value      :  max{_Tier_MinRelease, 20}

    condition  :  default
    value      :  _Tier_MinRelease
}
```

SpringLake_ops.ocl

```
1  /*SPRINGLAKE_OPS.OCL  */
2
3  /*  Operational policy for Spring Lake */
4
5  // Set the fraction coming from Harnett w/ a substitute
6
7  :Substitute: [SpringLakeWS_Harnett] = .28//0.21 old value
8
9
10 // Set targets to dictate WDs between sources
11 Target Harnett_WD : dflow0549.0719
12 {   condition : default
13     priority  : 1
14     penalty+  : 100
15     penalty-  : 100
16     Value     : [SpringLakeWS_Harnett] * demand0719 // 72% from Fayettville from 2019 LWSP  rest will be from Harnett
17 }
```

udef_list.ocl

```
/* File is udefs_list.ocl */

:Udef:

// ---------------------------


/* Udefs for inflow filtering */
:For:
{   [node] = { 0020, 0040, 0070, 0090, 0300, 0310, 0324, 0325, 0590, 0760, 0110, 0140, 0145, 0170, 0210, 0220, 0260, 0270, 0280, 0340,
    0380, 0400, 0430, 0450, 0470, 0490, 0520, 0527, 0550, 0640, 0700, 0780, 0820, 1010, 1050, 1060, 1080, 1100, 1110, 1115,
    1250, 1270, 1290, 1420, 1440, 1445, 1450, 1480, 1500, 1560, 1630, 1740, 1780, 1800, 1900, 0044, 0112, 0120, 0328, 0570,
    0580, 0600, 0610, 0660, 0680, 0720, 0730, 0770, 0790, 1205, 1320, 1405, 1409, 1471, 1520, 1600, 1620, 1625, 1650, 1660,
    1700, 1730, 1735, 1747, 1750, 1755, 1760, 1775, 1795, 1570, 1850, 1999 }
}
    Udef : _TempInf[node]
    Udef : _InfDeficit[node]  init{0}
:Next:

/* Udefs for Crabtree inflow filtering */
Udef : _TempInfCrabtree
Udef : _TotInfCrabtree
Udef : _InfDeficitCrabtree  init{0}

// Gibson gain - required for allocating inflows to Higgins & Brandt
Udef : _Gibso_Gain

// For Harris Ops
Udef :  _Proj_Harris_Storage
Udef :  _Proj_Harris_Elev

// For Siler City operations
Udef : _SilerCity_UsableStor init {5348.79}
Udef : _SilerCity_UsableStorPct init {1}
Udef : _SilerCityTrig2
Udef : _SilerCityTrig3
Udef : _Tier_MinRelease

// Use for the Jordan Lake drought protocol

Udef :  _JLake_Inflow    init {0}
Udef :  _Avg_JLake_Inflow
Udef :  _WQZone
Udef :  _Drought_Stage
Udef :  _Level_Drawdown

// FOR:NEXT loop to declare udefs
```

```
:FOR: { [level_num] = { 1, 2, 3, 4 } }

 Udef :  _Trigger_[level_num]_On         init {0}
 Udef :  _Count_Trigger_[level_num]     init {0}
 Udef :  _Total_Count_Trigger_[level_num] init {0}
 Udef :  _CumDayWithinInt_[level_num]   init {0}
 Udef :  _Lill_Target_[level_num]   init {0}
 Udef :  _Ph_[level_num]_event_count   init {0}

:NEXT:

// Jordan hydropower generation
Udef : _Jordan_hydropower

// ------------------

/*  For the agricultural demand computations */

// FOR:NEXT loop to declare udefs
:FOR: { [county] = { 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21,
          22, 23, 24, 25, 26, 27, 28, 29, 30, 31  } }

 Udef : dem[county]

:NEXT:

// -----------------------

/*  Udefs for the Jordan Lake pool allocation */

Udef :  _JLakeInf
Udef :  _JLake_WQ_Inf
Udef :  _JLake_WS_Inf
Udef :  _Inf_avail_to_WS_pool
Udef :  _Inf_used_for_WS_pool
Udef :  _WS_Total_Demand
Udef :  _WS_Total_Deliv


// FOR:NEXT loop to declare udefs

:substitute:       [Starting_Storage_CaryAp] = 17953.6        /* Initial condition for the CaryApex account (in acre feet) */
:substitute:      [Starting_Storage_Chatham] = 5954          /* Initial condition for the Chatham account (in acre feet) */
:substitute:       [Starting_Storage_Durham] = 7557          /* Initial condition for the Durham account (in acre feet) */
:substitute:        [Starting_Storage_Holly] = 916          /* Initial condition for the Holly Springs account (in acre feet) */
:substitute:       [Starting_Storage_Morris] = 1603          /* Initial condition for the Morrisville account (in acre feet) */
:substitute:       [Starting_Storage_Orange] = 687          /* Initial condition for the Orange Co. account (in acre feet) */
```

```
 95 :substitute:        [Starting_Storage_Other] = 4030.4        /* Initial condition for the unallocated account (in acre feet) */
 96 :substitute:        [Starting_Storage_OWASA] = 2290          /* Initial condition for the OWASA account (in acre feet) */
 97 :substitute:         [Starting_Storage_RTP] = 1603           /* Initial condition for the RTP account (in acre feet) */
 98 :substitute:         [Starting_Storage_Pitt] =  2748         /* Initial condition for the Pittsboro account (in acre feet) */
 99 :substitute:         [Starting_Storage_Hillsb] =  458        /* Initial condition for the Hillsborough account (in acre feet) */
100 :substitute:         [Starting_WQ_Storage] = 94600           /* Initial Jordan Lake WQ storage (in acre feet) */
101
102
103
104  :FOR: {  [accounts] = {CaryAp, Chatham, RTP, Other, Durham, Morris, Orange, OWASA, Holly, Pitt, Hillsb }  }
105
106   Udef :  _Req_Refill_[Accounts]
107   Udef :  _Inf_[Accounts]
108   Udef :  _Rem_def_[Accounts]
109   Udef :  _Rem_Inf_[Accounts]
110   Udef :  _Inf_Total_[Accounts]
111   Udef :  _Storage_[Accounts]     init{ [Starting_Storage_[Accounts]] }
112   Udef :  _Stor_Final_[Accounts]
113   Udef :  _Stor_Final_Pct_[Accounts]
114
115  :NEXT:
116
117 Udef :  _Inf_Rem_WS
118 Udef :  _Rem_def_Total
119
120 Udef :  _Total_WS_Storage
121 Udef :  _Total_WS_Storage_Pct
122 Udef :  _Req_Refill_WS_Pool
123 Udef :  _WS_Pool_Excess
124 Udef :  _WQ_Release
125 Udef :  _WQ_Storage   init {[Starting_WQ_Storage]}
126 Udef :  _WQ_Storage_Pct
127 Udef :  _Req_Refill_WQ
128 Udef :  _WQ_Pool_Excess
129
130
131 // FOR THE NEUSE
132 //
133 //
134
135 /*  Udefs for cumulative tracking variables */
136 Udef :  _CumWSupplyDemand   init {0}
137 Udef :  _CumWSupplyDelivery init {0}
138 Udef :  _CumWWReturn        init {0}
139 Udef :  _CumWSupplyWWReturn init {0}
140
141 /*  Udefs for Eno operations */
```

```
Udef :  _Orange_streamflow  init {3.376} /* Initially set to 1.1 mgd*/
Udef :  _Eno_Channel_Loss   init {0}
Udef :  _Max_Hills_WD       init {4.634} /* Initially set to 1.51 mgd */
Udef :  _Max_OrAl_WD        init {2.157} /* Initially set to 0.82 mgd */
Udef :  _Max_Pied_WD        init {1.320} /* Initially set to 0.43 mgd */
Udef :  _WFER_Tier          init {1}

/*  For proportional drawdown for Durham*/
Udef : _StorRatio   Decision { 0 , unbounded }
Udef : _StorRatio2  Decision { 0 , unbounded }

/*  Udef for Local Clayton Inflow for Falls Flood control */
Udef : _ClaytLocal init {0}

/*  Udefs for Falls/Clayton minimum flow */
Udef : ClaytonTarget_Override
Udef : ClaytonTarget_SafeFact
Udef : FLake_WQ_Threshold
Udef : FLakeMin_SafeFact

/* Udefs for Raleigh Quarry and Neuse River Intake operations*/
Udef : _tot_intake_pump      init{0}
Udef :  Expected_Falls_Spill
Udef :  Expected_Durham_Spill

/*  Udefs for Raleigh system storage pct. - only used when Swift
    Creek WD being used. */
UDef : _Raleigh_Sys_Stor_Pct
Udef : Swift_Sys_WS_Stor_Pct


/* Udefs for operating Johnston County's water supply system*/
Udef : Clayton_gage_expected
Udef : Expected_JC_WTP_flowby
Udef : Middle&Swift_Expected_Discharge
Udef : Exp_RBrdgeRd_Upstream

/*  Udefs for the Falls and Beaverdam pool allocation */
Udef :  _Pct_Max_WQ_Storage
Udef :  _Pct_Max_WS_Storage
Udef :  _FLake_Max_WQ_Storage
Udef :  _FLake_Max_WS_Storage
Udef :  _Bdam_Max_WQ_Storage
Udef :  _Bdam_Max_WS_Storage
Udef :  _Total_Max_WQ_Storage
Udef :  _Total_Max_WS_Storage
Udef :  _Total_Max_WQ_WS_Storage
```

```
Udef :  _FLake_Max_WQ_WS_Storage
Udef :  _WQ_Stor_fraction
Udef :  _WS_Stor_fraction
Udef :  _Bdam_Inf
Udef :  _Bdam_Inf_WS
Udef :  _Bdam_WS_Rel
Udef :  _Bdam_WS_Stor_Init
Udef :  _Bdam_WStoWQ_Spill
Udef :  _Bdam_Inf_WQ
Udef :  _Bdam_WQ_Rel
Udef :  _Bdam_WQ_Stor       init {[Bdam_WQ_Stor]}
Udef :  _Bdam_WQtoWS_Spill
Udef :  _Bdam_WS_Stor       init {[Bdam_WS_Stor]}
Udef :  _FLake_Inf
Udef :  _FLake_Inf_WS
Udef :  _Flake_WS_Rel
Udef :  _FLake_WS_Stor_Init
Udef :  _FLake_WStoWQ_Spill
Udef :  _FLake_Inf_WQ
Udef :  _Flake_WQ_Rel
Udef :  _FLake_WQ_Stor      init {[FLake_WQ_Stor]}
Udef :  _Total_WQ_Stor
Udef :  _FLake_WQtoWS_Spill
Udef :  _FLake_WS_Stor      init {[FLake_WS_Stor]}
Udef :  _Total_WS_Stor
Udef :  _Bdam_WS_Pct
Udef :  _Bdam_WQ_Pct
Udef :  _FLake_WS_Pct
Udef :  _FLake_WQ_Pct
Udef :  _Total_WS_Pct
Udef :  _Total_WQ_Pct


Udef :  _WtAvgRunoff

// Set usable storage & DSR udefs for drought plans
Udef : _OWASA_Max_Usable_Stor
Udef : _OWASA_Usable_Stor
Udef : _OWASA_Usable_Stor_Pct init {100}
Udef : _OWASA_JL_Use_Targ


Udef : _Burl_Max_Usable_Stor
Udef : _Burl_Usable_Stor
Udef : _Burl_Usable_Stor_Pct init {100}

Udef : _Gree_Max_Usable_Stor
```

```
236 Udef : _Gree_Usable_Stor
237 Udef : _Gree_Usable_Stor_Pct init {100}
238 Udef : _Gree_DSR
239
240 Udef : _High_Max_Usable_Stor
241 Udef : _High_Usable_Stor
242 Udef : _High_Usable_Stor_Pct init {100}
243
244 Udef : _Reid_Max_Usable_Stor
245 Udef : _Reid_Usable_Stor
246 Udef : _Reid_Usable_Stor_Pct init {100}
247 Udef : _Reid_DSR
248
249 Udef : _Rams_Max_Usable_Stor
250 Udef : _Rams_Usable_Stor
251 Udef : _Rams_Usable_Stor_Pct init {100}
252
253 Udef : _GramMeb_Max_Usable_Stor
254 Udef : _GramMeb_Usable_Stor
255 Udef : _GramMeb_Usable_Stor_Pct init {100}
256 Udef : _GramMeb_DSR
257
258 Udef : _Siler_Max_Usable_Stor
259 Udef : _Siler_Usable_Stor
260 Udef : _Siler_Usable_Stor_Pct init {100}
261
262 Udef : _Cary_DSR
263
264 Udef : _ChatNo_Usable_Stor_Pct init {100}
265
266 Udef : _Durham_add_sources init {0}
267 Udef : _Durham_usable_stor
268 Udef : _Max_Durham_usable_stor
269 Udef : _Durham_usable_pct
270 // Udefs below straight from Neuse mode run name "Scenario_2" from 2012 Durham modeling per Reed
271 Udef : _Durham_Tot_Use_Stor
272 Udef : _Durham_Stor
273 Udef : _Durham_Use_Stor
274 Udef : _Durham_Pct_Use_Stor
275 Udef : _Durham_TQ_Pct_Use_Stor
276
277 /* Udefs for Forecasts - ported from Durham model */
278 Udef : Release_storage
279 //Udef : _Trigger_1_On       init{0}
280 Udef : _Consvn_1_Demand
281 Udef : _Proj_1_Demand
282 Udef : _Proj_1_Evap
```

```
Udef : _Proj_1_Inflow
Udef : _Proj_1_WSPool init{19588} // all these values would need to be updated for 2035 sedimentation to be correct for the first week of a run
Udef : _Stage_1_Counter    init{0}
Udef : _Proj_1_WSPool_Refill init{19588}

//Udef : _Trigger_2_On       init{0}
Udef : _Consvn_2_Demand
Udef : _Proj_2_Demand
Udef : _Proj_2_Evap
Udef : _Proj_2_Inflow
Udef : _Proj_2_WSPool init{19588}
Udef : _Stage_2_Counter    init{0}
Udef : _Proj_2_WSPool_Refill init{19588}


//Udef : _Trigger_3_On       init{0}
Udef : _Consvn_3_Demand
Udef : _Proj_3_Demand
Udef : _Proj_3_Evap
Udef : _Proj_3_Inflow
Udef : _Proj_3_WSPool init{19588}
Udef : _Stage_3_Counter    init{0}
Udef : _Proj_3_WSPool_Refill init{19588}


//Udef : _Trigger_4_On       init{0}
Udef : _Consvn_4_Demand
Udef : _Proj_4_Demand
Udef : _Proj_4_Evap
Udef : _Proj_4_Inflow
Udef : _Proj_4_WSPool init{19588}
Udef : _Stage_4_Counter    init{0}
Udef : _Proj_4_WSPool_Refill init{19588}

Udef : _Proj_WSPool_Refill init{19588}

Udef : _Proj_5_Inflow

// Udefs for drought plan triggers
:FOR: { [Util] = { Burl, Burl1, Burl2, Gree, Gree1, Gree2, High, Reid, Rams, GramMeb, Siler, Cary,
    RTP, Morris, ChatNo, Dunn, Benson, Carth, Ral, Durham, SGWASA, Wilson } }

:FOR: { [level_num] = { 1, 2, 3, 4, 5, 6 } }

   Udef :  _[Util]_Consvn_[level_num]_Demand

   Udef :  _[Util]_Trigger_[level_num]_On         init {0}
```

```
330   Udef :  _[Util]_Stage_[level_num]_counter     init {0}
331   Udef :  _[Util]_Ph_[level_num]_event_counter    init {0}
332
333  :NEXT:
334
335  :NEXT:
336
337  // Setting Durham's drought trigger level
338  Udef :  _Trig_Level_Durham
339
340
341  Udef : _CaryApex_WW_Consvn init{1}
342
343  :FOR: { [level_num] = { 1, 2, 3 } }
344
345   :For: { [hrz] = {08, 12, 16, 20, 24, 52} }
346
347      Udef :  _OWASA_ProjInflow[level_num]_[hrz]
348      Udef :  _OWASA_ProjDemand[level_num]_[hrz]
349      Udef :  _OWASA_ProjMinFlow[level_num]_[hrz]
350      Udef :  _OWASA_ProjEvap[level_num]_[hrz]
351      Udef :  _OWASA_ProjStorage[level_num]_[hrz]
352      Udef :  _OWASA_ProjStorage_Pct[level_num]_[hrz]
353
354   :Next:
355
356      Udef :  _OWASA_Consvn_[level_num]_Demand
357
358      Udef :  _OWASA_Trigger_[level_num]_On          init {0}
359    Udef :  _OWASA_Stage_[level_num]_counter     init {0}
360    Udef :  _OWASA_Ph_[level_num]_event_counter    init {0}
361
362  :NEXT:
363
364  // Udefs for the Cary/Apex WW system
365  Udef : _CaryApexWW
366  Udef : _RTPWW
367  Udef : _MorrisWW
368  Udef : _CarySystemWW
369
370  // Allocate the total to the various discharge points, assigning monthly patterns and conservation factors (if any)
371  Udef : _CaryNorthWW
372  Udef : _CarySouthWW
373  Udef : _ApexWW
374  Udef : _CaryDTCWWTP
375  Udef : _CaryWestWakeWWTP
376
```

```
377
378
379
380  // For Fuquay IBT
381
382  Udef :  _Prelim_Max_JC_Neuse
383  Udef :  _Prelim_Max_Alt_Neuse
384  Udef :  _Prelim_Max_Sanford_Neuse
385  Udef :  _Prelim_Max_HC_Neuse
386  Udef :  _Prelim_Max_Alt_CF_to_Neuse
387  Udef :  _IBT_CF_to_Neuse
388  Udef :  _Final_Max_Flow_Alt
389  Udef :  _IBT_Neuse_to_CF
390
391
392  //For calculating actual shortages based on conservation plans
393  Udef : _Durham_Shortage_Calc    init{0}
394  Udef : _Ral_Shortage_Calc       init{0}
395  Udef : _SGWASA_Shortage_Calc    init{0}
396  Udef : _Wilson_Shortage_Calc    init{0}
397
398  Udef : _OWASA_Shortage_Calc     init{0}
399  Udef : _Burl_Shortage_Calc      init{0}
400  Udef : _Gree_Shortage_Calc      init{0}
401  Udef : _High_Shortage_Calc      init{0}
402  Udef : _Reid_Shortage_Calc      init{0}
403  Udef : _Rams_Shortage_Calc      init{0}
404  Udef : _GramMeb_Shortage_Calc   init{0}
405  Udef : _Siler_Shortage_Calc     init{0}
406  Udef : _Cary_Shortage_Calc      init{0}
407  Udef : _ChatNo_Shortage_Calc    init{0}
408  Udef : _Dunn_Shortage_Calc      init{0}
409  Udef : _Benson_Shortage_Calc    init{0}
410  Udef : _Carth_Shortage_Calc     init{0}
411  Udef : _RTP_Shortage_Calc       init{0}
412  Udef : _Morris_Shortage_Calc    init{0}
413
414
415
416
417  // ---------------------------------
418
419  // For use in output tables
420  :substitute: [accounts] = "CaryAp, Chatham, RTP, Other, Durham, Morris, Orange, OWASA, Holly, Pitt, Hillsb" // for WQ_WS accounting
421                                  // for Jordan Lake
422  :substitute: [level_num] = "1, 2, 3, 4"  // for drought trigger and level determination for Jordan Lake drought protocol
423
```

```
424
425 // Natural inflows in both basins
426 :substitute: [InflowNd_CFear] =   "0020, 0040, 0044, 0070, 0090, 0110, 0112, 0120, 0140, 0145, 0170, 0210, 0220, 0260, 0270, 0280, 0300,
427          0310, 0324, 0325, 0328, 0340, 0380, 0395, 0400, 0430, 0450, 0470, 0495, 0520, 0527, 0550, 0570, 0580,
428          0590, 0600, 0610, 0640, 0660, 0680, 0700, 0720, 0730, 0760, 0770, 0777, 0780, 0790, 0820"
429
430 :substitute: [InflowNd_Neuse] =   "1010, 1050, 1060, 1080, 1100, 1110, 1115, 1140, 1200, 1205, 1230, 1250, 1270, 1290, 1300, 1320, 1400,
431          1402, 1404, 1405, 1406, 1408, 1409, 1410, 1412, 1414, 1416, 1418, 1420, 1422, 1440, 1445, 1450, 1471,
432          1480, 1500, 1520, 1560, 1570, 1600, 1620, 1630, 1650, 1660, 1700, 1740, 1747, 1750, 1755, 1760, 1775,
433          1780, 1795, 1800, 1850, 1900, 1999"
434
435
436 // Reservoir nodes
437 :substitute: [ResNd_CFear] = "0030,  0070,  0112,  0120,  0140,  0220,  0270,  0300,  0320,  0324,  0325,  0340,  0390,  0395,
438         0430,  0470,  0520,  0528,  0760,  0777,  0790"
439 :substitute: [ResNd_Neuse] = "1010,  1050,  1060,  1080,  1100,  1120,  1140,  1200,  1230,  1250,  1270,  1290,  1300,  1420,
440         1440,  1445,  1450,  1500,  1647,  1648,  1740"
441
442 :substitute: [CrabtreeNd] = "1400, 1402, 1404, 1406, 1408, 1410, 1412, 1414, 1416, 1418, 1422"  // For Crabtree impoundments
443
444 // for reservoirs that are being modeled with rule curves.  for some of the Neuse reservoirs, we are not modeling with a
445 // "rule curve" - see reservoir rules table on GUI
446 :substitute: [ResNd_RCurves_CFear] = "0030,  0070,   0120,  0140,  0220,  0270,  0300,  0320,  0324,  0325,  0340,  0390,
447          0395,  0430,  0470,  0520,  0760"
448 :substitute: [ResNd_RCurves_Neuse] = "1050, 1060, 1140, 1200, 1230, 1250, 1290, 1300, 1420, 1440, 1500"
449
450
451 // For municipal and industrial demands
452 :substitute: [DemandNd_CFear] = "0031,  0123,  0223,  0261,  0301,  0321,  0327,  0341,  0401,  0431,  0471,  0473,  0474,  0475,
453          0477,  0483,  0487,  0491,  0521,  0551,  0601,  0605,  0663,  0701,  0719,  0721,  0733,  0771,
454          0781,  0785,  0823,  0825,  0903,  0904,  0906,  0921,  0923"
455
456 :substitute: [DemandNd_Neuse] = "1046,  1106,  1116,  1162,  1256,  1258,  1306,  1506,  1646,  1666,  1706,  1766,  1786,  1806,
457         1906"
458
459 //  For WW returns linked to demands
460 :substitute: [LinkedWWRetArc_CFear] = "0031.0040,  0341.0072,  0072.0100,  0072.0350,  0341.0350,  0121.0140,  0122.0170,  0122.0180,
461          0223.0222, 0261.0280,  0904.0224,  0301.0570,  0321.0100,  0401.0410,  0431.0440,  0473.0470,
462          1162.0453,  1162.0463,  0483.0480,  0487.0490,  0491.0490,  0491.0610,  0521.0520,  0554.0686,
463          0554.0664,  0554.0550,  0554.0556,  0601.0610,  0327.0328,  0663.0680,  0663.0690,  0733.0740,
464          0733.0770,  0771.0770,  0781.0790,  0785.0790,  0923.0520, 0471.0472,  0474.0472,  0477.0472,
465          0472.0453,  0472.0930,  0479.0470"
466
467 :substitute: [LinkedWWRetArc_Neuse] = "1046.1100,  1106.1109,  1162.1163,  1259.1300,  1306.1620,  1306.1500,  1306.1320,  1646.1630,
468          1646.1675,  1666.1675,  0663.1756,  1756.1757,  1766.1770,  1675.1747,  1786.1780,  1806.1795,
469          1806.1850,  1806.1845, 1506.1560,  1906.1999,  1706.1409,  1706.0554, 0472.1401,  0472.1471,
470          0472.1405"
```

```
471
472  //  For independent WW returns
473  :substitute: [IndepWWRetNd_CFear] = "0148,  0192,  0227,  0282,  0464,  0591,  0592,  0772,  0774,  0910,  0960,  0962"
474
475  :substitute: [IndepWWRetNd_Neuse] = "1307,  1407,  1563,  1565,  1567,  1569,  1643,  1645,  1705,  1753,  1759,  1787,  1847"
476
477
478  //  For agricultural demand
479  :substitute: [AgricNd_CFear] = "0021,  0041,  0043,  0051,  0075,  0077,  0081,  0083,  0111,  0161,  0211,  0231,  0263,  0281,  0311,
480          0331,  0361,  0371,  0381,  0403,  0411,  0441,  0461,  0481,  0511,  0531,  0541,  0553,  0581,  0593,
481          0595,  0603,  0621,  0623,  0671,  0674,  0681,  0691,  0713,  0741,  0773,  0775,  0783,  0801,  0811,
482          0821,  0940"
483
484  :substitute: [AgricNd_Neuse] = "1052,  1062,  1112,  1142,  1202,  1302,  1318,  1482,  1502,  1562,  1632,  1752,  1756,  1782,  1802,
485          1902"
486
487  //all added for task b1+b2 for Durham
488  UDef : _Durham_estim_spill
```

Upper_Eno_Ops.ocl

```
1  /*  UPPER_ENO_OPS.OCL  */
2  /* Operation policy the Upper Eno, based on the Capacity Use Plan */
3
4  /*  Compute channel loss factor, which is used in the Lake Orange and WFER min release computations,
5     and to calculate channel loss at the Hillsborough Gage.  Based on the values in the WFER dam safety permit.  */
6  Set  :  _Eno_Channel_Loss
7  {   condition : flow1110.1115 < convert_units{4,cfs,af}
8     Value     : 0.2
9
10    condition : flow1110.1115 <= convert_units{12,cfs,af}
11    Value     : 0.1
12
13    condition : default
14    Value     : 0
15 }
16
17 /*  Determine the maximum release from Lake Orange for Hillsborough demand; based on stage. */
18 Set :  _Max_Hills_WD
19 {      /* For Dead Storage */
20       Condition : storage1060 / max_stor1060 <= 0.1365
21       Value     : 0
22
23       /* Stages 6 */
24       condition : storage1060 / max_stor1060 <= 0.3
25       Value     : convert_units { 0.68, mgd, af }
26
27       /* Stages 5 */
28       condition : storage1060 / max_stor1060 <= 0.4
29       Value     : convert_units { 1.13, mgd, af }
30
31       /* Stages 3 & 4 */
32       condition : storage1060 / max_stor1060  <= 0.6
33       Value     : convert_units { 1.28, mgd, af }
34
35       /* Stage 2 */
36       condition : storage1060 / max_stor1060 <= 0.8
37       Value     : convert_units { 1.36, mgd, af }
38       /* Stage 1 */
39       condition : default
40       Value     : convert_units { 1.51, mgd, af }
41 }
42
43 /*  Determine the maximum release from Lake Orange for Orange-Alamance demand; based on stage. */
44 Set :  _Max_OrAl_WD
45 {      /* For Dead Storage */
46       Condition : storage1060 / max_stor1060 <= 0.1365
47       Value     : 0
```

```
48
49        /* Stages 6 */
50        condition : storage1060 / max_stor1060 <= 0.3
51        Value     : convert_units { 0.37, mgd, af }
52
53        /* Stages 5 */
54        condition : storage1060 / max_stor1060 <= 0.4
55        Value     : convert_units { 0.62, mgd, af }
56
57        /* Stages 3 & 4 */
58        condition : storage1060 / max_stor1060  <= 0.6
59        Value     : convert_units { 0.70, mgd, af }
60
61        /* Stage 2 */
62        condition : storage1060 / max_stor1060 <= 0.8
63        Value     : convert_units { 0.74, mgd, af }
64        /* Stage 1 */
65        condition : default
66        Value     : convert_units { 0.82, mgd, af }
67  }
68
69  /*  Determine the maximum release from Lake Orange for Piedmont Minerals demand; based on stage. */
70  Set :  _Max_Pied_WD
71  {      /* Stages 6 */
72        condition : storage1060 / max_stor1060 <= 0.3
73        Value     : convert_units { 0.00, mgd, af }
74
75        /* Stages 5 */
76        condition : storage1060 / max_stor1060 <= 0.4
77        Value     : convert_units { 0.19, mgd, af }
78
79        /* Stages 4 */
80        condition : storage1060 / max_stor1060  <= 0.5
81        Value     : convert_units { 0.32, mgd, af }
82
83        /* Stages 3 */
84        condition : storage1060 / max_stor1060  <= 0.6
85        Value     : convert_units { 0.36, mgd, af }
86
87        /* Stage 2 */
88        condition : storage1060 / max_stor1060 <= 0.8
89        Value     : convert_units { 0.38, mgd, af }
90        /* Stage 1 */
91        condition : default
92        Value     : convert_units { 0.43, mgd, af }
93  }
94
```

```
/*  Determine the Lake Orange required streamflow augmentation; based on stage. */
Set :  _Orange_streamflow
{      /* Stages 6 */
       condition : storage1060 / max_stor1060 <= 0.3
       Value     : 0

       /* Stages 5 */
       condition : storage1060 / max_stor1060 <= 0.4
       Value     : 0

       /* Stages 3 & 4 */
       condition : storage1060 / max_stor1060  <= 0.6
       Value     : convert_units { 0.45, mgd, af }

       /* Stage 2 */
       condition : storage1060 / max_stor1060 <= 0.8
       Value     : convert_units { 0.65, mgd, af }
       /* Stage 1 */
       condition : default
       Value     : convert_units { 1.10, mgd, af }
}

/*  Lake Orange minimum release, based on Eno Capacity Use plan.  Includes a streamflow augmentation release plus
    a release for downstream demands.  The release for Hillsborough, Or-Al and Pied. Minerals' demand is only up to
    the maximum specified in the plan. A multiplier for channel loss, the same as for WFER, is also included.  */
Set :  min_flow1060.1080
{      /* All stage-dependant streamflow augmentation and max. WDs have been determined above  */
       condition : default
       Value     : (1 + _Eno_Channel_Loss) * (_Orange_streamflow + min { demand1046, _Max_OrAl_WD }
     + min { demand1106, _Max_Hills_WD } + min { demand1116, _Max_Pied_WD })
}

/*  Determine which Phase WFER is in.  Set to Tier 3 if elevation < 624.  Set to Tier 2 if elevation is between 624 and 628 ft.
 Otherwise set to Tier 1 */

Set : _WFER_Tier
{    Condition : elevation1050 < 624
      Value     : 3

   Condition : elevation1050 < 628
      Value     : 2

      Condition : default
      Value     : 1
}

/*  WFER Minimm release - depends on storage tier, and remaining Hillsborough demand that cannot be met by Lake Orange.
```

```
    From Eno Capacity Use pland and WFER dam safety permit; either enough to meet downstream requirements, or the specified
    seasonal pattern, whichever is greater  */
Set :  min_flow1050.1080
{    /* If in Tier1 */
     condition : _WFER_Tier = 1
     Value     : max { (1 + _Eno_Channel_Loss) * (convert_units{1.0,cfs,af}
       + max { 0, demand1106 - _Max_Hills_WD }) ,
      convert_units{pattern(Tier1),cfs,af} }

     /* If in Tier2 */
     condition : _WFER_Tier = 2
     Value     : max { (1 + _Eno_Channel_Loss) * (convert_units{1.0,cfs,af}
       + max { 0, demand1106 - _Max_Hills_WD }) ,
      convert_units{pattern(Tier2),cfs,af} }

     /* If in Tier3 */
     condition : _WFER_Tier = 3
     Value     : max { (1 + _Eno_Channel_Loss) * (convert_units{1.0,cfs,af}
       + max { 0, demand1106 - _Max_Hills_WD }) ,
      convert_units{pattern(Tier3),cfs,af} }
}

/*  Compute channel loss at Hills. Gage (computed) */
Target Channel_Loss  :  dflow1110.1107
{   condition : default
    priority  : 1
    penalty+  : 1000
    penalty-  : 1000
    Value     : max { 0, _Eno_Channel_Loss * (flow1105.1110 + inflow1110) }
}

```

WW_Returns.ocl

```
/*  File is WW_Returns.ocl. */

// Note that WW only returns are handled as inflows (see inflow pattern under the Node tab for the monthly patterns).


/* Set inflow fractions for WW returns associated with demands  */

// Cape Fear River Basin discharges

Constraint ReidsvilleWW_nc0024881_WTP_WW_nc0046345 : {dFlow0031.0040 = lookup {ReidsvilleWWTP_NC0024881, month}
        * dDelivery0031 + lookup {ReidsvilleWTP_WW_nc0046345, month} * dDelivery0031}
Constraint BurlingtonTotalWW          : {dFlow0341.0072 = lookup {BurlingtonTotalWWRF, month} * dDelivery0341}
Constraint BurlingtonEastWW_nc0023868       : {dFlow0072.0100 = lookup {BurlingtonTotalWWRF, month} * (dDelivery0341
        + dDelivery0075) * 0.41} // Eastside is 41% of total
Constraint BurlingtonSouthsideWW_NC0023876   : {dFlow0072.0350 = lookup {BurlingtonTotalWWRF, month} * dDelivery0341
        * 0.59} // Southside is 59% of total
Constraint HawRiverWW_to_Burlington   : {dflow0075.0072 = lookup {BurlingtonTotalWWRF, month} * dDelivery0075}
Constraint BurlingtonMackintoshWW_NC0023828  : {dFlow0341.0350 = lookup {BurlingtonMackintoshWW_NC0023828, month}
        * dDelivery0341}
Constraint GreensboroLakeTownsendWW_NCG590017  : {dFlow0123.0140 = lookup {GBTownsendWTPNCG590017, month} * dDelivery0123}
Constraint GreensboroMitchellWTPNC0081426      : {dFlow0122.0170 = lookup {GBMitchellWTPNC0081426, month} * dDelivery0123}
Constraint GBOzborneWWNC0047384          : {dFlow0122.0180 = lookup {GBOzborneWWNC0047384, month} * dDelivery0123}
Constraint GBHighPointWW      : {dFlow0122.0224 = lookup {GBHighPointWW, month} * dDelivery0123}
Constraint HighPointWW_nc0081256_nc0024210     : {dFlow0223.0222 = lookup {HighPointWW, month} * dDelivery0223}
Constraint RandlemanWW_nc0025445          : {dFlow0261.0280 = lookup {RandlemanWW_nc0025445, month} * dDelivery0261}
Constraint ArchdaleWW             : {dFlow0904.0224 = lookup {ArchdaleWW, month} * dDelivery0904}
Constraint RamseurWW_nc0026565            : {dFlow0301.0570 = lookup {RamseurWW_nc0026565, month} * dDelivery0301}

/* For Graham Mebane, we had all WW returns lumped together.  Graham's asre permits 0045292 to Haw River (WW, with avg.day
 = 1.8 mgd in 2020) and 0021211 to Back Creek (WTP process, with avg day = 0.3 mgd); and Mebane's is 0021474 to Moadam's
 Creek (avg day = 1.5 mgd).  Separate the WTP process return since that can be counted toward the min release.
 Monthly pattern can be left as is.  */
Constraint GrahamMebaneTotWW_nc0045292_nc0021474 : {dFlow0321.0100 = lookup {GrMebTotWW_nc0045292, month} * dDelivery0321}
// Assume 5% based on historical data (0.28 mgd vs. raw water WD from G-M lake of 4.5 mgd).  Transfer included from Orange County,
// but this may be finished water, not raw water, which means it would be plumbed to the demand node itself.  However, an
// emergency interconnection that hasn't been used in recent years.
Constraint GrahamMebane_WTP_Process_Return : {dFlow0319.0100 = 0.05 *  (dflow0320.0319 + dflow0920.0319) }

Constraint PittsboroWW_nc0020354        : {dFlow0401.0410 = lookup {PittsboroWW_nc0020354, month} * dDelivery0401}
Constraint OWASA_WW_nc0025241           : {dFlow0431.0440 = lookup {OWASA_WW_nc0025241, month} * dDelivery0431}
Constraint NorthChathamWWWTP_nc0084093    : {dFlow0473.0470 = lookup {NorthChathamWTP_nc0084093, month} * dDelivery0473}
Constraint DurhamCtyTriangleWW_nc0026051   : {dFlow1162.0453 = lookup {DurhamCtyTriangleWW_nc0026051, month} * dDelivery1162}
Constraint DurhamReclamationWW_nc0047967   : {dFlow1162.0463 = lookup {DurhamReclamationW_nc0047597, month} * dDelivery1162}
Constraint AlliedSignalWW_NC0001899      : {dFlow0483.0480 = lookup {AlliedSignalWW_NC0001899, month} * dDelivery0483}

// Multiple demands met from Sanford; must use the flow to the junction node since that represents the total withdrawal on which the process
// loss is calculated.  Otherwise, we'd be undercounting process loss since it would be calculated on deliveries to the demand node3,
```

```
// which represent finished water.
Constraint SanfordPW_WTP_nc0002861    : {dFlow0489.0490 = lookup {Sanford_WTP_dis_nc0002861, month} * dflow0490.0489 }

Constraint Sanford_WWTP_nc0024147     : {dFlow0491.0610 = lookup {Sanford_WWTP_nc0024147, month} * dDelivery0491}

Constraint GoldstonGulf_nc0024147  : {dFlow0605.0610 = lookup {GoldstonGolfWW_nc0024147, month} * dDelivery0605}
Constraint BroadwayWW_nc0059242       : {dFlow0940.0540 = lookup { BroadwayWW_nc0059242, month} * dDelivery0940}
Constraint CarolinaTraceWW_nc0038831  : {dFlow0674.0660 = lookup { CarolinaTraceWW_nc0038831, month} * dDelivery0674}
Constraint ProgressHarrisWW_nc0039586 : {dFlow0521.0520 = 0 * dDelivery0521}  // Accounted for in the consumptive use
                    // represented by the demand value
Constraint AngierWW_HarnettCo         : {dFlow0654.0664 = lookup { AngierWW_to_HarnettCo, month} * dDelivery0654}

:Substitute: [HarnettWTP_process] = 0.066  //placeholder based on 2019&2020 LWSP data process/total demand [internal + sales]

Constraint North_Harnett_WWTP         : {dFlow0551.0664 = lookup {HarnettWW_North, month} * dDelivery0551 }

// Same logic for Sanford above applies to the Harnett County WTP process water; tie it to total withdrawal.
Constraint HarnettWTP_process             : {dFlow0549.0550 = dflow0550.0549  * [HarnettWTP_process] }
Constraint SouthHarnettRegionalWWTP         : {dFlow0551.0556 = lookup {HarnettWW_South, month} * dDelivery0551 }

Constraint PilgrimsPride_nc0083852              : {dFlow0601.0610 = lookup {PilgrimsPride_nc0083852, month} * dDelivery0601}
Constraint SilerCityWW_nc0026441                : {dFlow0327.0328 = lookup {SilerCityWW_nc0026441, month} * dDelivery0327}
Constraint DunnWTP_nc0078955                    : {dFlow0663.0680 = lookup {DunnWW_nc0078955, month} * dDelivery0663}
Constraint DunnWWTP_nc0043176                   : {dFlow0663.0690 = lookup {DunnWWTP_nc0043176, month} * dDelivery0663}
Constraint FtBraggWW_NC0003964                  : {dFlow0721.0722 = lookup {FtBraggWW_NC0003964, month} * dDelivery0721}
Constraint FayettevilleCrossWWTP_nc0023957    : {dFlow0733.0740 = lookup {FayCrossWW_NC0023957, month} * dDelivery0733}
Constraint FayettevilleRockfishCreekWWTP_nc0050105 : {dFlow0733.0770 = lookup {FayRockfishCkWW_NC0050105, month}
              * dDelivery0733}
Constraint HokeRockfishCreekWTP_nc0089176    : {dFlow0735.0770 = lookup {HokeRockfishCkWW_NC0089176, month} *dDelivery0735}
Constraint MonsantoWW                        : {dFlow0771.0770 = lookup {MonsantoWW_NC0003719, month} * dDelivery0771}
Constraint DupontWW                          : {dFlow0781.0790 = lookup {DupontWW_nc0003573, month} * dDelivery0781}
Constraint LCFWSA-BladenBluffsWW_nc0078344          : {dFlow0785.0790 = 0 * dDelivery0785} // No return in 2010 scenario
Constraint HollySpringsWW_nc0063098                 : {dFlow0923.0520 = lookup {HollySpringsWW_nc0063098, month}
              * dDelivery0923}  // Capped at 1.0 to ignore I and I.


// Neuse River Basin discharges

Constraint OrAlaReturn_nc0082759       : {dFlow1046.1100 = lookup {OrAlaReturn_nc0082759, month} * dDelivery1046}
Constraint Hillsborough_nc0026433       : {dFlow1106.1109 = lookup {HillsReturn_nc0026433, month} * dDelivery1106}
Constraint Durham_nc0023841             : {dFlow1162.1163 = lookup {DurhamReturn_nc0023841, month} * dDelivery1162}
Constraint SGWASA_nc0026824    : {dFlow1256.1300 = lookup {SGWASAReturn_nc0026824, month}
            * dDelivery1256} // Creedmoor now part of SGWASA
Constraint Raleigh_NeuseWWTP_nc0029033    : {dFlow1306.1625 = lookup {RaleighReturn_nc0029033, month} * dDelivery1306}
Constraint Raleigh_LittleCreek_nc0079316 : {dFlow1306.1500 = lookup {RalLitCrReturn_nc0079316, month} * dDelivery1306 }
Constraint Raleigh_SmithCreek_nc0030759   : {dFlow1306.1320 = lookup {RalSmithCrReturn_nc0030759, month} * 0.05 * dDelivery1306}
Constraint ClaytonWW_nc0064564&nc0025453 : {dFlow1646.1630 = lookup {ClaytReturn_nc0064564&nc0025453, month}
```

```
            * dDelivery1646} // Clayton demand is included in Johnst Co.
Constraint JohnstReturn_nc0030716   : {dFlow1646.1675 = lookup {JohnstReturn_nc0030716, month} * (dDelivery1646)}
Constraint JohnstReturn_Benson    : {dFlow1646.1757 = 0.015 * (dDelivery1646)}
Constraint JohnstonCoWTP_Retur    : {dFlow1655.1650 = 0.1 * (dflow1650.1654)} // This is the 10% process water return to the river
Constraint SfieldReturn      : {dFlow1666.1675 = lookup {SfieldReturn, month} * (dDelivery1666)}
Constraint BensonWW_nc0020389            : {dFlow1756.1757 = lookup {BensonWW_nc0020389, month} * dDelivery1756}
Constraint ProgressEnergy                : {dFlow1766.1770 = 0.0 * dDelivery1766}
Constraint KenlyWW_nc0064891             : {dFlow1675.1747 = lookup {KenlyReturn_nc0064891, month} * dDelivery1646}
Constraint GoldsboroWW_nc0023949   : {dFlow1786.1780 = lookup {GoldsReturn_nc0023949, month} * dDelivery1786}
Constraint NRWASA_nc0088111              : {dFlow1806.1795 = lookup {NRWASAReturnWTP_nc0088111, month} * dDelivery1806}
Constraint KinstonWW_nc0024236           : {dFlow1806.1850 = lookup {KinstonWW_nc0024236, month} * dDelivery1806}
Constraint AydenGriftonWW                : {dFlow1806.1845 = lookup {AydenGriftonWW, month} * dDelivery1806}
Constraint WilsonWW_nc0023906            : {dFlow1506.1560 = lookup {WilsonReturn_nc0023906, month} * dDelivery1506}
Constraint Weyerhauser_nc0003191         : {dFlow1906.1999 = lookup {WeyerReturn_nc0003191, month} * dDelivery1906}

/* Note:  in the past, F-V WW return was a function of the total demand x the lookup fractions.  For the updates, it is a function
 of how much demand is in the Neuse and Cape Fear. WW from the Neuse service area is returned to the Terrible Creek plant
 (in the Neuse); the WW from the Cape Fear service area is returned to North Harnett County plant (in the Cape Fear). Adjust
 the monthly WW return fractions in the lookup table for FuquayWW_nc00516&nc0066150 above.  The return fraction is capped at
 100% of the respective demand (i.e., I and I is ignored).*/

Constraint   Terrible_Creek_WW_Return : {dflow1706.1409 = lookup {FuquayReturn_nc0066516&nc0066150, month}
            * dDelivery1706  * [Demand_FV_Neuse] }
Constraint   Harnett_County_WW_Return : {dflow1706.0664 = lookup {FuquayReturn_nc0066516&nc0066150, month}
            * dDelivery1706 * (1 - [Demand_FV_Neuse])  }


// Compute Cary/Apex system separately
// First compute the amount of reductions to WW discharges expected if the drought plan is active (stages 3-4 only)

:If: {[Drought_Plans_On] = 1} // First check if drought plan variable is on

Set : _CaryApex_WW_Consvn
{ Condition : _Cary_Trigger_4_On
  {
  Condition : month > 4 and month < 11
  Value     : 1 - 14 / 100 // 14% reduction for Stg. 4, May-Oct

  Condition : default
  Value     : 1 - 19 / 100 // 19% reduction for Stg. 4, Nov-Apr
  }

 Condition : _Cary_Trigger_3_On
  {
  Condition : month > 4 and month < 11
  Value     : 1 - 6 / 100 // 6% reduction for Stg. 3, May-Oct

```

```
  Condition : default
  Value     : 1 - 7 / 100 // 7% reduction for Stg. 4, Nov-Apr
  }

    Condition : default
    Value     : 1
}

:else:

Set : _CaryApex_WW_Consvn
{ Condition : default
    Value     : 1
}

:EndIf:


// Now compute various WW flows and discharges as Udefs, since they'll be used in multiple constraints

//Total WW for Cary/Apex, RTP and Morrisville
Set : _CaryApexWW { Value : lookup {CaryApexReturn, month} * demand0471 * _CaryApex_WW_Consvn }
Set : _RTPWW  { Value : lookup {RTPReturn, month} * demand0474 * _CaryApex_WW_Consvn }
Set : _MorrisWW  { Value : lookup {MorrisReturn, month} * demand0477 * _CaryApex_WW_Consvn }
Set : _CarySystemWW { value : _CaryApexWW + _RTPWW + _MorrisWW }

// Allocate the total to the various discharge points, assigning monthly patterns and conservation factors (if any)
Set : _CaryNorthWW  { Value : _CarySystemWW * 0.29 * lookup{CaryNWRFReturn, month}}
Set : _CarySouthWW  { Value : _CarySystemWW * 0.24 * lookup{CarySWRFReturn, month}}
Set : _ApexWW   { Value : _CarySystemWW * 0.07 * lookup{ApexWRFReturn, month}}
Set : _CaryDTCWWTP  { Value : _CarySystemWW * 0.00 }

/* For Western Wake WRF, put in an adjustment factor of 1.4 since our computed returns to Western Wake WRF relative to 2022
 data are about 40% too low.  Also computed system WW relative to finished water demand was only about 80%; this adjustment
 factor raises that to almost 90%, which is more consistent with 2022 data. This adjustment is important since IBT
 compliance (described below) is dependent on it.  */
Set : _CaryWestWakeWWTP { Value : _CarySystemWW * 0.40 * lookup{WestWakeWRFReturn, month} * 1.4 }

// Next set the constraints that will force the flows to match the udefs
Constraint CaryApexTotalWW  : {dflow0471.0472 = (_CaryApexWW / _CarySystemWW)
        * (_CaryNorthWW + _CarySouthWW + _ApexWW + _CaryDTCWWTP + _CaryWestWakeWWTP) }
Constraint RTPWW      : {dFlow0474.0472 = (_RTPWW / _CarySystemWW)
        * (_CaryNorthWW + _CarySouthWW + _ApexWW + _CaryDTCWWTP + _CaryWestWakeWWTP) }
Constraint MorrisvilleWW  : {dFlow0477.0472 = (_MorrisWW / _CarySystemWW)
        * (_CaryNorthWW + _CarySouthWW + _ApexWW + _CaryDTCWWTP + _CaryWestWakeWWTP) }
```

```
Constraint CaryNorthWW  : {dFlow0472.1401 = _CaryNorthWW}
Constraint CarySouthWW  : {dFlow0472.1471 = _CarySouthWW}
Constraint ApexWW   : {dFlow0472.1405 = _ApexWW}
Constraint CaryDTCWWTP  : {dFlow0472.0453 = _CaryDTCWWTP}
Constraint CaryWestWakeWWTP : {dFlow0472.0930 = _CaryWestWakeWWTP}

// Finally,compute the WTF discharge back into Jordan based on the raw water withdrawal from the lake.
// Do not use delivery since that represents finished water based on the plumbing.
Constraint CaryApexWTFWW : {dflow0479.0470 = lookup {CaryApexWTFReturn, month} * (dflow0470.0479)}

/* The 2015 IBT certificate for Cary-Apex allows for a 33 mgd WD from the Haw River basin to the Neuse (31 mgd) and Cape Fear
 basins (2 mgd).  A consent order was later issued requiring that WW be returned to the Cape Fear basin = Neuse demand
 (finished water including non-revenue water) - 9.756 mgd.  In 2022, Cary finished water use was 20.82 (raw) -
 3.08 (process loss) = 17.7 mgd, with 96% going to the Neuse, or 17.0 mgd.  Apex used 5.6 - 0.84 = 4.8 mgd, with 29%
 going to the Neuse, or 1.4 mgd.  So total Neuse finished water use was 18.4 mgd.  So required discharge back to the
 Cape Fear would be 18.4 - 9.8 = 8.6.  Process water (from the Cary-Apex WTP on the east side of Jordan Lake) can be
 included in the discharge since it goes into Jordan Lake and amounted to 3.1 + 0.8 mgd (listed above), or 3.9 mgd.
 So required remaining discharge (through the Western Wake WRF) would be 8.6 - 3.9, or 4.7 mgd.  In 2022, the facility
 discharged 6.5 mgd from Cary and 3.7 mgd from Apex, for a total of 10.2 mgd.  All compliance is based on 3-year running
 annual average daily amounts.

 The model is not imposing any restrictions; to view whether the return requirements are met, the user can track the
 returns with user-defined output tables.  Also note that CaryApex demand (demand473) lumps CaryApex, RTP, and Morrisville
 demands (demands for RTP [node 474] and Morrisville [node 477] are set to 0).  Also, when calculating the return amount,
 since Apex demand is a reasonable amount of the CaryApex  demand (based on 2022 data above), assume the Neuse demand
 (finished) = 85% of the CaryApex demand (finished).  This should be a conservative estimate of the required return amount.
 Assume the same in the Neuse for future year planning runs.  Note if the percentage were 95% or higher, then there might be
 a deficit in terms of meeting the required IBT return.

 Need to add constraints on the WW returns for High Point, IBT and Spring Lake.  Weren't in there before.  For now, set to 0
 for the first -- meaning WW return from upstream nodes will now go back to the Deep River in full.  For Spring Lake,
 assumed 100% of the delivery.  Delivery is insignificant.  */

Constraint HighPt     : {dflow0222.0225 = 0 }
Constraint SpringLake   : {dflow0719.0720 = 1.0 * ddelivery0719 }


// There is another WW transfer out of basin in the model, but in this case water is not diverted here since there is no
// benefit to doing so.  WW returns instead to the Cape Fear.  However, a constraint is always safe to impose, in this
// case assume 0 flow in the IBT.

Constraint HokeCounty       : {dflow0735.0737 = 0 }
```

Appendix G: Public and Agency Comments

Public Scoping Comments, 2020

Hazen

TECHNICAL MEMORANDUM

To:
Jay Meyers, PE, Town of Fuquay-Varina
Vic Czar, PE, City of Sanford

Copies:
Michael Wang, PE, Hazen and Sawyer
Reed Palmer, PE, Hazen and Sawyer
Linda Diebolt, Hazen and Sawyer
Keven Arrance, Hazen and Sawyer

From:
Mary Sadler, PE

Date:
January 7, 2021

Subject:
Summary of Public and Agency Scoping Comments
Town of Fuquay-Varina Water Supply and Interbasin Transfer Project

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General Statute §143-215.22L outlines the requirements for public notification that are triggered when an applicant files a Notice of Intent to File (NOI) a Petition. The Town submitted the NOI to the Environmental Management Commission (EMC) on September 3, 2020. Three public meetings were required within 90 days of the NOI submittal. The public meetings were held in specific locations as mandated by the Statute. The meetings were held in the Town of Cary (receiving basin), Chatham County (source river basin upstream of point of withdrawal), and the City of Fayetteville (source river basin downstream of the point of withdrawal). The public comment period closed on November 20, 2020.

Concurrent with the public notification process, agency scoping comments were solicited in accordance with the State Environmental Policy Act (SEPA). A scoping letter was submitted to the Department of Administration (DOA) Review Clearinghouse on October 7, 2020. The project was assigned the number SCH File # 21-E-0000-0754. The Clearinghouse comment period closed on November 9, 2020.

Hazen assembled a database of all comments received during the scoping process. Attachment A provides a summary of the comments as entered into the comment database.

The following is a summary of the comments received from the public:

- General opposition to transfer.
- “Massive” amount of water being “stolen” from the Cape Fear River.
- Triangle communities need to establish sustainable water supply mechanisms that do not deprive downstream residents.
- “Strong” water flow in the Cape Fear River crucial to provide a buffer for times of drought, to dilute chemicals and pollutants contaminating water supply, and to provide recreational opportunities.
- Water conservation and efficiency lacking. Consider incorporating measures into Town’s Municipal Ordinance.

- Impact of climate change on future condition.
- Drought impacts.
- Reduction in stream flow and the impact of pollution and chemical releases.
- Social inequity of diverting “critical water resources” from poorer more diverse downstream users to sprawling, wealthier, and whiter suburban communities.
- Return water to the Cape Fear River at a reasonable rate and quality.
- Public education and awareness to encourage property owners to conserve water.
- Request for City and Town to actively participate in the Triangle Water Partnership to facilitate evaluation of Sanford as a regional water and wastewater provider and as neighboring communities evaluate costs and benefits of multiple regional water supply and regional wastewater treatment options.
- Request for Town to consider buying water from other regional suppliers to satisfy peak day demand.
- Consider change in growth patterns if transfer is not approved.
- Assess impervious surface impacts of growth.
- Assess cost of service (water, sewer, stormwater, civic) for the growth that transfer will support. Excess revenue as a result of the transfer should be used to offset impacts of induced development on water quality and environment in receiving basin.
- Assess cost of energy between alternatives and impact of carbon reduction limits shifting land use spatial patterns.
- Consider the impact of future total withdrawal from the Cape Fear River by Sanford and its partners and not just the incremental increase in withdrawal to serve Fuquay-Varina.
- Address condition and fate of Buckhorn Dam and impact on fish passage.
- Contamination concern regarding PFAS compounds, 1,4-dioxane, and other emerging contaminants.
- Recommendation for Sanford and partners to develop a conservation plan for the lower Deep and lower Haw Rivers that would identify properties with high conservation and water resources values. The Triangle Land Conservancy, Triangle J Council of Governments, and the Fund developed a Watershed Conservation Plan as a component of the Jordan Lake One Water Initiative in 2019. More at https://www.triangleland.org/cms/wp-content/uploads/2019/08/jordan-river-watershed.pdf. The Triangle Land Conservancy also prepared a conservation assessment of the Lower Deep and Upper Cape Fear Rivers in 2001. More at https://www.triangleland.org/cms/wp-content/uploads/2015/12/deep-riv-public-complete.pdf.
- Potential impact to protected and candidate species in each watershed.
- Question regarding the Town’s stormwater management ordinances and policies relative to the capture, reuse, infiltration, treatment, and reduction of stormwater and flooding from new development. Provide incentives to capture and reuse rainwater and stormwater for non-potable purposes or incentives for nature-based green stormwater infrastructure to both reduce flooding

and prevent water pollution.

- Trends in per capita usage.
- Impact of transfer on financing the project.
- Wake County should consider strengthening its stormwater management/flood reduction policies.
- Request that Town propose a sustainable solution to the water management issue in the Cape Fear and the Neuse River basins.
- Consider water supply protection policies for Hector Creek, Neils Creek, and Harnett County's water supply.

The following is a summary of the comments from utilities, persons representing utilities, or municipal government:

- General opposition to transfer.
- Water quality issues from industrial dischargers and emerging contaminants.
- Town's Local Water Supply Plan (LWSP) does not reflect interbasin transfer.
- Impacts to communities downstream have not been identified.
- Other alternatives have not been explored or identified.
- Concern over water diversion and long-term water supply impact on downstream communities in the Cape Fear River basin.
- Negative ecological impacts.
- Concern that an adjustment in the 7Q10 will affect downstream users and increase the likelihood of water shortages. Consider USGS work to update the 1994 report "Low-flow Characteristics of Streams in North Carolina."
- Reduction of streamflow will exacerbate pollutant concentrations and algal blooms, particularly in low flow.
- No guaranteed reservoir storage (e.g., Jordan Lake) during drought conditions.
- Precedent for significant IBT (Cary, Apex) returning water to Cape Fear River.
- No evidence that the Town is unable to obtain water from the Neuse.
- Town is required to prove that the amount of the transfer does not exceed the amount of the projected shortfall under the applicant's water supply plan after first accounting for all other sources of water available to the applicant.
- Instream flow studies to assess the quantity and quality of wildlife habitat as a function of flow is appropriate for addressing fish and wildlife habitat.
- Return of water to the Cape Fear as mitigation for adverse water quantity and quality effects of IBT.
- Fayetteville region depends on having surplus water supply to attract new industry. Approximately 72 mgd is needed by 2060.

- Town should review water system improvements in lieu of the transfer, including replacing existing water meters and developing a leak detection program.
- Implement water conservation measures and a program to educate residents, particularly through better irrigation practices.
- Fayetteville did not receive an allocation from Jordan Lake. The Jordan Lake Allocation Recommendation and Surface Water Supply Plan did not account for any future withdrawals between Jordan Lake outfall and Fayetteville Lock and Dam #3. This study should be updated before additional transfers or withdrawals can be permitted.
- Lower Cape Fear Water and Sewer Authority, Brunswick County, and Cape Fear Public Utilities do not support any action that reduces the available water supply to the Lower Cape Fear, as significant capital investments have been made to use the 106 mgd permitted allocation.

The following is a summary of agency comments from SEPA scoping through the Review Clearinghouse:

- Include an analysis for a return of water to the Cape Fear River.
- Include verification that Town's wastewater treatment plant has the capacity to treat any increase in overall volume and waste load to the Neuse River to remain in compliance with the NPDES permitted nitrogen limit.
- Based on the City's LWSP, future sales of 6 mgd will cause the City to exceed their total available supply. The preferred alternative must show that the demand-supply ratio for the City is maintained at no more than 80%.
- Concern over stormwater from highly urbanized areas (e.g., Swift and Middle Creeks are of particular concern due to several state listed threatened and endangered species).
- Secondary impacts from increased water supply will facilitate growth and an increase in impervious surface and severe stormwater runoff. Increased runoff may cause degradation of aquatic habitats through accelerated stream bank erosion, channel changes, bedload changes, altered substrates and scouring of stream channels.
- Consider additional measures to protect aquatic and terrestrial wildlife species in developing landscapes.
- Concern over habitat loss, degradation, or fragmentation of wildlife.
- Reduction in water flow in the Cape Fear River could impede reproduction of sensitive species.
- Discuss cumulative impacts of secondary development facilitated by the proposed project. Weigh economic benefits of growth against costs of associated environmental degradation.
- Address specific measures to control stormwater, stream corridor protection, riparian habitat, and floodplain development.

American Rivers ● NC Conservation Network ● Sound Rivers

November 20, 2020

Mary Sadler, PE
Hazen and Sawyer,
4011 WestChase Blvd, Suite 500,
Raleigh, NC 27607

Re: Scoping comments on the proposed Fuquay-Varina interbasin transfer

Dear Ms. Sadler,

We appreciate the opportunity to offer our thoughts during this scoping process for the proposed interbasin transfer to feed growing demand in and around Fuquay-Varina. The request comes at a time of ongoing rapid growth in the Triangle, substantial ongoing impacts in the receiving basin, and increasing concerns about the availability and quality of water resources in the source basin. Below we have gathered a set of questions around potential impacts and mitigation measures, to fold into your environmental impact assessment and review of the proposal.

Perfluorinated compounds and water quality

Perfluorinated compounds are present at relatively high concentrations in the Haw and Deep Rivers and therefore in the Upper Cape Fear sourcewater for the proposed IBT. Does Fuquay-Varina intend to expose its customers to these contaminants? How does Fuquay-Varina intend to remove PFAS – most of which are not regulated – from drinking water? How much will it cost the utility to manage this pollution? Are these costs factored in to the relative costs of alternatives in the alternatives analysis?

If the utility plans to discharge wastewater into the Neuse rather than returning it to the Cape Fear, the transfer will release PFAS into a basin where they have not been found in significant concentrations, and will likely contaminate the sourcewater of downstream water users. How does the utility weigh its potential liability for that pollution and for increased water treatment costs incurred by downstream utilities?

Alternatives to the proposed transfer

Once approved, interbasin transfers are relatively permanent, even if in theory they could be rescinded – so tranfers tend to lock in patterns of capital investment and demand, excluding alternatives that were viable to that point. The alternative analysis for an interbasin transfer is often the last chance to seriously consider other potential futures, with all the ramifications of that for municipal finances and flexibility, along with impacts to residents' quality of life and jurisdictions' economic competitiveness.

What is the per capita water usage in the receiving jurisdiction, and what are the trends? Most utilities have found declining per capita usage over the last 15 years. What are the trends in Fuquay-Varina's per capita financial liability for infrastructure? What are the upcoming infrastructure burdens that Fuquay-

Varina expects to carry, and how will the new obligations of financing the interbasin transfer interact with that? What is the return on investment in greater efficiency of water use as compared to the anticipated return on investing in the transfer?

What are the options for Fuquay-Varina to continue to buy water from other regional water suppliers rather than taking on the infrastructure and compliance costs of becoming a supplier itself? To the extent that the town is managing risk, trying not to invest too little or too much, are there contractual instruments with other regional supplier that can help distribute or hedge this risk? For example, can Fuquay-Varina negotiate a contract with another regional supplier to ensure that, if demand spikes in Fuquay-Varina, the town will have access to the water it needs – but if, as a result of various factors, that growth mostly lands in the center cities, Fuquay-Varina won't have over-invested in expensive infrastructure?

Impacts of growth and mitigation of those impacts

How will Fuquay-Varina grow differently (population, spatial pattern, mix of uses) if the transfer is approved versus if the transfer is not approved? What is the anticipated increase in impervious surface area that will result from that growth? How will it be distributed across the subwatersheds served by the utility?

What is the anticipated marginal cost of service (for water, sewer, and stormwater, and for all civic services) for the growth that the transfer will support? Growth dependent on the transfer will increase the jurisdiction's revenue base, and presumably also the per capita demand for services. How will the jurisdiction capture a portion of that increased value, and how will it use that revenue to offset impacts of induced development to water quality and the environment in the receiving basin?

What are similar patterns of anticipated impacts across the jurisdictions to which Fuquay-Varina may sell or supply water?

Ideally, local stormwater, sediment, and floodplain regulations limit the impacts of induced development on the ecosystem services and natural resources of the receiving basin. In practice, that rarely happens. What policies and ordinances are in place in the receiving jurisdictions?

As a result of climate change, North Carolina is receiving more intense storms more frequently, and design standards for infrastructure are not performing as intended. What steps are the receiving jurisdictions taking to ensure their ordinances and standards continue to provide the intended level of protection in the face of ongoing climate change?

Both the Neuse basin and the Cape Fear basin are home to a number of state- and federal- protected species that are susceptible to changes in water chemistry and quantity, including impacts from induced development. What impacts will the proposed transfer and its impacts have on protected and candidate species in each watershed? How does the applicant propose to avoid or mitigate those impacts?

Interaction with a low-carbon future

Scientists have recognized that to limit climate change, we must transition to carbon neutral energy and transportation systems. Many states, towns, and policy leaders have articulated the goal of achieving carbon neutrality by 2050. While the mechanism by which North Carolina or the United States will reach

this goal is not clear, the probability that one or more mechanisms are adopted is sufficiently large that the Environmental Impact Statement (EIS) for the project should address that future.

Any mechanism to reduce carbon emissions is likely to raise the relative cost of fossil-fuel based energy, including the energy used to transfer water from the Cape Fear to Fuquay-Varina (and to return wastewater, if that ends up being a mitigation measure). How does the cost of energy factor in to the choice between project alternatives, including the 'no action' alternative?

Carbon reduction limits are very likely also to shift the spatial pattern of land uses – and therefore water demand – in southern Wake County. These shifts may move away from patterns that require significant individual travel and towards more dense patterns of development (if transit options are available) or towards lower overall growth in demand and tax base (if new residents instead gravitate towards Raleigh, Cary, and other larger cities). The EIS should assess the impact of these changing patterns on the demand for water, the cost of service, and the financial capacity of Fuquay-Varina to invest in and maintain the substantial infrastructure needed both to transfer and to distribute the water.

Source Water

Sanford's primary water intake is from the Cape Fear River near the Avents Ferry Rd bridge. This portion of the Cape Fear River has only minimal regulated protections as a Water Supply IV designated water body from contaminations associated with point and non-point source pollution. The study should address the feasibility of developing a watershed protection and restoration program funded via a fee on water utility bills.

The Buckhorn Dam creates a minimal impoundment from which water in the Cape Fear is withdrawn currently. That dam is reaching the end of its design life and no longer serves the purposes for which it was initially built. Additionally, it is a complete barrier to fish migration up and down stream and a hazard for recreational boaters. Will the study address options for water supply that could be implemented to improve the reliability of the water intake in a run-of-river condition?

Carrying capacity and other water supply needs

A perspective underlying many interbasin transfers in North Carolina to date has been the view that water is essentially fungible – that as long as sufficient demand is present, water can and should be moved from basin to basin to meet demand wherever that demand appears. Yet, ultimately, our watersheds have limits to the supply they can provide, and even tighter limits to the supplies they can provide and still serve other values. Where does Fuquay-Varina propose that state environmental managers draw that line? When would Fuquay-Varina say it has grown its raw water supply enough for the next century, or maxed out its proper share of the available resource? What policies is the town putting into place to ensure that it arrives at that point gently, without overshooting at the expense of surrounding towns and the natural environment?

We recognize this is essentially asking Fuquay-Varina, in the EIS, to propose a sustainable solution to the puzzle of water management not just for itself, but for the larger web of communities in both the source and receiving basins. We think that is appropriate, since by the terms of the proposed transfer, Fuquay-Varina intends to position itself to be a regional water supplier – the town is already not thinking of itself as a lone actor. We also suspect that the Triangle Water Supply Partnership could be a source of

information and analytical support as Fuquay-Varina wrestles with this challenge; such a complicated problem is often best solved together rather than through solo, uncoordinated strategies.

The Cape Fear River watershed has been the source of longstanding controversy over interbasin transfers, including most recently the contested transfer of water associated with the Western Wake Wastewater Treatment plant. Those cases have demonstrated that downstream water demand in places like Fayetteville is critical to the success of the region. How will Fuquay-Varina and the City of Sanford work collaboratively to ensure that enough water is returned to the Cape Fear River to protect existing and future needs of downstream communities, especially considering climate change?

Conclusion

We appreciate the chance to offer these comments in the scoping process, and look forward to reviewing and commenting on the draft environmental documents in depth.

Sincerely,

Peter Raabe
North Carolina Director
American Rivers

Grady McCallie
Policy Director
NC Conservation Network

Matthew Starr
Upper Neuse Riverkeeper
Sound Rivers

DARSWEIL L. ROGERS, COMMISSIONER
WADE R. FOWLER, JR., COMMISSIONER
EVELYN O. SHAW, COMMISSIONER
D. RALPH HUFF, III, COMMISSIONER
DAVID W. TREGO, CEO/GENERAL MANAGER

PWC
Fayetteville's
HOMETOWN UTILITY

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November 17, 2020

Ms. Mary Sadler, PE
Hazen and Sawyer
4011 West Chase Blvd, Suite 500
Raleigh, NC 27607

Subject: Town of Fuquay-Varina Proposed IBT

Dear Ms. Sadler,

The Fayetteville Public Works Commission submits the following comments concerning the Town of Fuquay-Varina Proposed Interbasin Transfer:

1. Fuquay-Varina is required to prove that there are no reasonable alternatives to the proposed inter-basin transfer, and to date, we have seen no analysis or other evidence that Fuquay-Varina is unable to get additional water from the Neuse River Basin or any other source. In considering such alternatives, the EMC is not limited to consideration of alternatives that have been proposed, studied or considered by Fuquay-Varina. Except in circumstances of technical or economic infeasibility or adverse environmental impact, the EMC's determination as to reasonable alternatives must give preference to alternatives that would involve a transfer from one sub-basin to another within the Neuse River Basin (i.e., major receiving river basin) over Fuquay-Varina's proposed alternative that would involve a transfer from one major river basin (Cape Fear) to another major river basin (Neuse).

2. Fuquay-Varina is also required to prove that the amount of the transfer does not exceed the amount of the projected shortfall under the applicant's water supply plan after first taking into account all other sources of water that are available to the applicant, and to date, we have seen no analysis or other evidence of that from Fuquay-Varina.

3. Fuquay-Varina is required to prove that the benefits of the proposed transfer outweigh the detriments of the proposed transfer and that the detriments have to be mitigated to the maximum degree practicable, and to date, we have seen no analysis or other evidence of that from Fuquay-Varina. In that regard, Fuquay-Varina must address, and EMC must consider all of the following:

    a. The EMC must consider the necessity and reasonableness of the amount of surface water proposed to be transferred and its proposed uses. The Sanford WTP is quite a distance from Fuquay-Varina. Fuquay-Varina should identify the geographic boundaries within which the water being requested would be used, including whether that area is entirely within Fuquay-Varina town limits.

b. The EMC must consider present and reasonably foreseeable future detrimental effects on the source river basin, including effects on wastewater assimilation and water quality. In recent years, the Cape Fear River upstream and downstream of Fayetteville has been fraught with numerous water quality issues stemming from industrial discharges and other sources. During low-flow periods, further reduction of streamflow can exacerbate pollutant concentrations. Environmental impact assessment of this proposed IBT must address both water quantity and water quality in the Cape Fear River.

c. The EMC must consider present and reasonably foreseeable future detrimental effects on the source river basin, including effects on fish and wildlife habitat. Instream flow studies which assess the quantity and quality of wildlife habitat as a function of flow levels are the appropriate means to assess this concern. Reduction of streamflow may negatively impact fish and wildlife which depend on the Cape Fear River.

d. The EMC must make a specific finding as to measures that are necessary or advisable to mitigate or avoid detrimental impacts on the source river basin. In this regard, Fuquay-Varina should identify how and in what quantities treated wastewater can be returned to the source basin to reduce the net transfer. Fuquay-Varina has decided to make a major water supply investment in expansion of the Sanford WTP. Consequently, Fayetteville PWC expects that major investments in wastewater pumping and treatment infrastructure will likewise be considered to return water to the source basin. The Cary-Apex IBT has established a clear precedent that return of wastewater to the Cape Fear River can serve as mitigation for adverse water quantity and quality effects of IBT.

In summary, unless Fuquay-Varina meets its substantial evidentiary burden, the certificate needs to be denied. If the certificate is granted without sufficient evidence to support it or without a condition to return sufficient quantities of treated wastewater to the Cape Fear River Basin, Fayetteville PWC will contest it, and it is anticipated that other water systems in the lower Cape Fear region would consider joining us in doing so.

Sincerely,

Fayetteville Public Works Commission

Mick Noland

Mick Noland, PE
Chief Operations Officer
Water Resources Division

Cc: David Trego
Elaina Ball
Jamie West
Paul Peterson

RESOLUTION OPPOSING THE PROPOSED INTERBASIN TRANSFER ("IBT") CERTIFICATE REQUEST BY THE TOWN OF FUQUAY-VARINA FOR WATER FROM THE CAPE FEAR RIVER BASIN TO THE NEUSE RIVER BASIN

WHEREAS, maintaining the quantity and quality of water in the Cape Fear River is of paramount importance to the public health, security and economic welfare of Cumberland County, North Carolina, and surrounding communities; and

WHEREAS, the County of Cumberland believes the Interbasin Transfer ("IBT") Certificate request submitted by the Town of Fuquay-Varina poses increased risks to the water supply of Cumberland County and other counties downstream; and

WHEREAS, the Cumberland County Board of Commissioners has determined it is in the public interest of Cumberland County citizens as well as the citizens of all communities benefited by the Cape Fear River and its waters to oppose any permanent transfer of water from the Cape Fear River to other river basins; and

WHEREAS, in recent years, the Cape Fear River upstream and downstream of Fayetteville has been fraught with numerous water quality issues stemming from industrial discharges and emerging contaminants from other sources; and

WHEREAS, reduction of streamflow through IBT would exacerbate pollutant concentrations and water quality issues such as algae blooms that are more likely during low-flow periods; and

WHEREAS, communities which are largely in the Triangle area have been successful in obtaining water supply allocations from Jordan Lake that leave Cumberland County and other downstream communities without guaranteed reservoir storage during drought; and

WHEREAS, significant IBT is already occurring from the Cape Fear Basin including the largest permitted IBT by the Towns of Cary and Apex, which established a clear precedent that return of wastewater to the source basin can help mitigate for the impacts of IBT; and

NOW, THEREFORE, BE IT RESOLVED THAT the Cumberland County Board of Commissioners opposes the interbasin transfer of water from the Cape Fear River Basin without the requirement that the same level of treated wastewater be returned back to the Cape Fear River Basin.

Adopted this 16th day of November, 2020.

Cumberland County Board of Commissioners
By:

W. Marshall Faircloth, Chair

Attest:

Candice H. White, Clerk to the Board

Sadler, Mary

From: Brian Gaskell <brian.gaskell@hotmail.com>
Sent: Tuesday, October 13, 2020 2:28 PM
To: Sadler, Mary
Subject: Fequay-Varina Interbasin Transfer Request Public Feedback

Caution! *External email – think before you click*

Dear Ms. Sadler,

I am a resident of Fayetteville and have intently followed the discussion regarding Fequay-Varina's Interbasin Transfer request from the Cape Fear River to the Neuse River. I regret that due to a previous commitment, I will not be able to attend the public hearing scheduled for Wednesday, October 21. Therefore, as a concerned citizen, Fayetteville Public Works Commission customer, and member of the Fayetteville Public Works Commission Citizen Advisory Board, I would like to share that I am opposed to the current request, due to the following reasons:

1. Nowhere in the plan to I see where the 4-8 million gallons of water withdrawn from the Cape Fear River must be returned to it. I also find it disturbing that related impacts to communities downstream have not been identified.

2. I find it unacceptable that there is no mention of other alternatives that have been explored or identified by Fequay-Varina. It would seem a transfer request would be a step of last resort, not the first.

3. I am concerned that diverting water flow away from the Cape Fear could inhibit the ability of adequate water resources for communities further down the Cape Fear River. After all, isn't it reasonable to expect that there could be additional growth in areas such as Fayetteville, Lillington and Wilmington, which also rely on this valuable resource? What alternatives would those communities have if this proposal is approved?

4. I do not see how this proposal could have any positive environmental impact on wildlife/fish habitats. Lower water levels almost always lead to negative ecological impacts.

5. It is my understanding that the proposed 4-8 million gallons/day is only an average figure, and that the actual withdraw could be higher or lower, depending on need. That is a significant amount of water...it is unsettling to consider that this amount could be withdrawn from its natural flow, especially considering this area's continued susceptibility to periods of dry weather/water shortage.

I appreciate the opportunity to share my concerns on this issue and thank you for your time. I look forward to a decision that will be in the best interest of **ALL** residents of North Carolina.

Please feel free to contact me if you would further like to discuss this matter.

Sincerely,

Brian Gaskell
brian.Gaskell@Hotmail.com

616-690-5236
558 Lambert Street, Fayetteville, NC 28305
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Sadler, Mary

From: Lindsey Hallock <Lindsey.Hallock@cfpua.org>
Sent: Wednesday, October 14, 2020 12:58 PM
To: Sadler, Mary
Cc: Jim Flechtner
Subject: Cape Fear Public Utility Authority Comments on Proposed Fuquay Varina IBT

Caution! *External email – think before you click*

Ms. Sadler,

North Carolina has experienced rapid growth over the past decade, a trend that has impacted communities up and down the Cape Fear River and is projected to continue. As communities begin to plan for a larger population, they are simultaneously working to understand the future impacts of climate change on the region. These two forces, increased demand and climate change, introduce uncertainty into water resources planning and may disproportionately impact downstream communities if interbasin transfers (IBTs) are approved in the basin.

The U.S. Environmental Protection Agency estimates that most of the state of North Carolina has already warmed between one-half and one degree over the last century. Additionally, sea levels on the North Carolina coast are rising nearly one inch every decade. For coastal communities like the one Cape Fear Public Utility Authority (CFPUA) serves, increased temperatures may increase local water demand while also drawing moisture out of the basin. In addition, reduced groundwater capacity and higher treatment costs resulting from saltwater intrusion could increase our reliance on the Cape Fear River as a source of raw water for the community.

Long-term supply allocations from the Cape Fear River are calculated using an estimate of expected low flow levels called the "7Q10." The 7Q10 is equal to the lowest average flow for seven consecutive days expected to occur once in 10 years on average based on the historic record. The maximum allowable withdrawal is 20 percent of the 7Q10, which is currently set at 106 million gallons per day (MGD) at Lock & Dam Number 1 –the raw water intake CFPUA shares with our partners in the region.

In 2019, CFPUA and its partners acknowledged that a regional approach to water resources planning was needed to formalize allocations at Lock & Dam Number 1 and provide a level of certainty to communities as they plan for future needs. That year CFPUA, Brunswick County, and the Lower Cape Fear Water and Sewer Authority signed an interlocal agreement (ILA) that allocated the 106 MGD allotment among the communities served by each partner. The ILA now serves as the foundation for several large capital investment projects in southeastern North Carolina. In addition, CFPUA and our partners have already invested public funds and constructed the permitted infrastructure necessary to withdraw up to 106 MGD from the Cape fear River at Lock & Dam #1 to supply their customers in southeastern North Carolina.

It is CFPUA's opinion that IBTs from upstream users, such as the proposed transfer from Fuquay Varina, may negatively impact source water availability for downstream communities that are already dealing with uncertainties related to future growth, climate change, and a 7Q10 number that has not been assessed in decades. By decreasing the amount of available surface water today, an approval of Fuquay Varina's IBT or any other upstream IBTs increases the risk that downstream communities may face shortages in the future.

As a result, CFPUA recommends that Fuquay Varina's request for an IBT certificate be denied.

CFPUA also recommends that future projections of various flow data scenarios for the Cape Fear River be made available to communities dependent on the river as source water. It is CFPUA's understanding that the U.S. Geological Survey is

currently considering an update to the 1994 report produced by Giese and Mason, "Low-flow Characteristics of Streams in North Carolina," to provide more complete river flow data for North Carolina. CFPUA recommends that NCDEQ support this project in any way possible and use the findings to assist all communities in planning for the future.

Thank you,

Lindsey Hallock, AICP
Director of Public and Environmental Policy
Cape Fear Public Utility Authority
o: 910-332-6625 | c: 470-208-0631
235 Government Center Dr., Wilmington, NC 28403
www.cfpua.org | Facebook | Twitter

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Sadler, Mary

From: O. C. Holloway <omegaman2212@gmail.com>
Sent: Monday, October 19, 2020 2:51 PM
To: Sadler, Mary
Subject: Opposition to Water Transfer

Caution! External email – think before you click

MS Sadler;

I am in opposition to the Cape Fear River Basin Water Transfer.

O C Holloway
Fayetteville, NC

Sent from my iPad

Sadler, Mary

From: David Trego <david.trego@faypwc.com>
Sent: Wednesday, October 21, 2020 5:23 PM
To: Sadler, Mary
Subject: Fuquay - Varina Proposed Inter basin Transfer Request Comments

Caution! *External email – think before you click*

I would like to provide the following comments related to the proposed request from Fuquay-Varina for an 4 MGD inter basin transfer from the Cape Fear Basin to the Neuse Basin via a proposed wholesale agreement with Sanford.

My comments are being provided in my official capacity as CEO and General Manager of PWC which depends upon the Cape Fear River for the water supply needs of 80,000 retail customers as well as providing wholesale water to Stedman, Spring Lake, Aqua Water of North Carolina as well as for Fort. Bragg.

As a growing community Fuquay-Varina as well as other communities in the Neuse River Basin have increasing needs for water supply. In order to meet these growing needs communities such as Fuquay-Varina examine options to increase supply and more and more they look to the Cape Fear Basin as a resource. As a utility that depends on the Cape Fear River for its water supply and who is downstream of Fuquay-Varina this is of a major concern for PWC. Such transfers can impact our ability to meet our customers' needs during drought conditions, reduce available future supply that might be needed for economic development and during periods of low flow can impact water quality by reducing the dilution effect of contaminants and increasing the possibility of algae blooms. Additionally, as I mentioned above, PWC supplies Fort Bragg the largest military installation in the United States with wholesale water. Thus, PWC ability to have a secure long term water supply to meet the current and future needs of this base, also has national security implications.

North Carolina Law requires that impacts of Inter Basin transfers such as these shall be mitigated to the maximum degree practicable. This sometimes means it is not the lowest cost option which should be considered when looking to increase water supply. Options such as seeking a supply source within the Neuse River basin or returning treated wastewater back into the Cape Fear basin should be the **first** options investigated and exhausted before an Inter Basin transfer is requested or considered. It is this standard that PWC requests Fuquay-Varina and any Inter Basin transfer request be held to by the State.

Thank you for allowing me to comment.

David W. Trego
CEO/General Manager
Fayetteville Public Works Commission

PWC
Fayetteville's
HOMETOWN UTILITY

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301 Springbrook Pl
Fayetteville, NC 20305
October 21, 2021

Hazen and Sawyer
Attn: Ms Mary Sadler PE

Dear Ms Sadler:

Subject: Response to Town of Fuquay-Varina IBT Request

As a resident of Fayetteville, I'm concerned about the IBT request initiated by the Town of Fuquay-Varina. We are dependent on the Cape Fear River for our water supply and I am concerned that IBT transfer request, if approved may have a permanent negative impact on our community as well as all other communities below the City of Sanford.

Previous IBT certificates included requirements for water to be returned to the Cape Fear River. It is my understanding that Fayetteville and PWC expect that:

1. A thorough process be completed that includes full consideration of the impact on all communities downstream/dependent on the Cape Fear River.
2. Before any IBT certificate is issued, it has been demonstrated that no alternate option that would eliminate the need for an IBT is available.

History has shown the potential disastrous result on a river's viability if indiscriminate water use without returning the water back to its basin. There is basically no water flow into the Gulf of California at the mouth of the Colorado River. Israel and Jordon are considering a Red Sea to Dead Sea canal to replace was removed from the Jordon River basin.

Previous decisions have exasperated the situation. Currently 96% of Jordon Lake's supply pool has already been allocated, with no allocation having been granted to PWC despite multiple requests. Fayetteville and other nearby communities are thus highly dependent on widely fluctuation flows n the Cape Fear River as opposed to stored water in Jordan Lake. As a result, during drought conditions, communities downstream of Jordan Lake must hope that the Corps of Engineers will release enough water to assimilate and flush out pollutants and maintain an adequate water supply. The more IBT out of the Cape Fear Basin which occurs, the more difficult this task.

Under NC law, when IBTs are approved, the impacts must be mitigated to the maximum degree practicable. Consequently, source alternatives within the Neuse River Basin should be fully evaluated by Fuquay-Varina and, for any remaining IBT, treated waste water should be returned to the Cape Fear Basin.

Fuquay-Varina has decided to make a major water supply investment in expansion of the Sanford WTP. Consequently, if this IBT goes forward, major investments in wastewater pumping and treatment infrastructure should likewise be considered to return water back into the Cape Fear Basin.

Thank you for your consideration.

James R Konneker

Sadler, Mary

From: Arleen Fields <arleen.fields@nc.rr.com>
Sent: Tuesday, November 10, 2020 9:59 PM
To: Sadler, Mary
Subject: Fuquay-Varina request for an IBWT from the Cape Fear River

Caution! *External email – think before you click*

Dear Ms. Sadler,

As a resident of Fayetteville **I adamantly oppose the town of Fuquay-Varina's request for a massive interbasin water transfer from the Cape Fear River to the Neuse River**. I understand that the Triangle area is developing rapidly, but those communities need to establish sustainable water supply mechanisms that don't deprive downriver residents. A strong water flow in the Cape Fear River is crucial to provide a buffer for times of drought, and to dilute the chemicals and pollutants which are contaminating our water supply in ever-increasing amounts, and to provide recreational opportunities for our residents.

Thank you for your attention.

All the best,
Arleen Fields
5318 Hampton Rd.
Fayetteville, NC 28311
910-797-0292

Sadler, Mary

From: anna.chott21 <anna.chott21@gmail.com>
Sent: Wednesday, November 11, 2020 9:09 AM
To: Sadler, Mary
Subject: Interbasin Water Transfer from Cape Fear River

Caution! *External email – think before you click*

Good morning Ms. Sadler,

I am reaching out to you as a friend of Sustainable Sandhills, an organization that notified my community of plans for implementation of an interbasin water transfer from the Cape Fear River.

I implore you to consider a water conservation strategy, rather than moving forward with the IBWT. Our water supply is not infinite, and IBWTs are not sustainable without clear replenishment plans.

There are many, many things we as citizens can do to conserve water. However, if the river flow is reduced, our options will be much more limited.

Thank you so much for your consideration of this request.

Kind regards,
Anna

Sent from my Galaxy

Sadler, Mary

From: Ruth Gillis <ruthgillis@gmail.com>
Sent: Wednesday, November 11, 2020 10:54 AM
To: Sadler, Mary
Subject: Water

Caution! *External email – think before you click*

I'm sorry you are having water problems in Fuquay-Varina, but taking Cape Fear River water doesn't solve problems for anyone - especially Cape Fear River water users.
You will need to find another solution to your water needs - like maybe a big campaign for water conservation.
Anyway, please leave our water alone.

Ruth Gillis
Fayetteville NC

Sadler, Mary

From: Jaye White <jayebrdwht@gmail.com>
Sent: Wednesday, November 11, 2020 4:15 PM
To: Sadler, Mary
Subject: Cape Fear River water transfer

Caution! *External email – think before you click*

Dear Ms. Sadler,

Do the people of Fuquay-Varina really want to deprive their neighbors to the south? Does hoarding natural resources seem prudent? I am adamantly opposed to the plan to take so much water from the Cape Fear to deposit it into the Neuse, as many North Carolinains will suffer as a consequence.

"Hundreds of thousands of people in the Sandhills rely on our Cape Fear River for accessible and dependable municipal water resources as well as transportation and recreation opportunities. We want to ensure the viability of our river for current and future generations.

Several municipalities and utilities across North Carolina currently draw water from our Cape Fear River. Continuous interbasin transfers are not sustainable without clear replenishment and conservation plans so we are advocating for improved water efficiency and public education campaigns in these municipalities to save water and alleviate their supply issues.

Droughts have affected our Cape Fear River in the past. IBWTs further reduce river flows during droughts. We want to insulate our water supply against droughts as much as possible.

Our Cape Fear River has been impacted by pollution from chemical releases and other recent water quality issues. A reduction in flow as a result of another IBWT will only exacerbate these concerns."

Please reconsider your proposal. It seems selfish and unreasonable.

Sincerely,

Rev. Jaye White 1008 Clarendon St.
Fayetteville, NC 28305

Sadler, Mary

From: Jennessa Peterson <jennessa.peterson@outlook.com>
Sent: Tuesday, November 17, 2020 12:59 PM
To: Sadler, Mary
Subject: IBWT

Caution! External email – think before you click

Hi Mary,

I'm a resident of Fayetteville and highly concerned about the proposed IBWT from the cape fear river. Particularly because the town requesting has zero water conservation or mitigating strategies in place.

Kindest regards,
Jennessa Peterson

Sadler, Mary

From: Starling, Jane <jstarling@townofhopemills.com>
Sent: Thursday, November 19, 2020 8:43 AM
To: Sadler, Mary
Cc: PWC Rep Carolyn Hinson; PWC Venus Durant; Sally Shutt
Subject: Town of Hope Mills Resolution requesting limits on Interbasin Transfer - related to Fuquay Varina proposed
Attachments: RES R2020-36 - Requesting Limits on Interbasin Transfer from Cape Fear River Basin.pdf

Caution! *External email – think before you click*

Ms. Sadler,

Please see the attached resolution passed unanimously by the Town of Hope Mills Board of Commissioners, regarding the Proposed Interbasin Transfer for the Town of Fuquay-Varina.

Very respectfully,

Jane G. Starling, CMC, NCCMC
Town Clerk
Town of Hope Mills
5770 Rockfish Road
Hope Mills, NC 28348
Ph: 910-426-4113
jstarling@townofhopemills.com
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RESOLUTION REQUESTING LIMITS ON INTERBASINTRANSFER FROM THE CAPE FEAR RIVER BASIN

RESOLUTION NO. R2020-36

WHEREAS the Town of Fuquay-Varina is requesting an Interbasin Transfer; and

WHEREAS, maintaining the quantity and quality of water in the Cape Fear River is of paramount importance to the public health, security and economic welfare of Fayetteville and surrounding communities.

- Approximately 250,000 people depend on PWC being able to provide a safe and reliable water supply.
- Fort Bragg, which plays a key role in our national security, depends on PWC being able to provide the military base with a safe and reliable water supply 8 million gallons per day on a daily basis and 16 million gallons per day on an emergency basis.
- Fayetteville region depends on having surplus water supply to attract new industry and jobs. By 2060, it is projected that PWC water demands will reach approximately 72 million gallons per day; and

WHEREAS, Communities which are largely in the Triangle area have been successful in obtaining water supply allocations from Jordan Lake --- leaving Fayetteville and other downstream communities without guaranteed reservoir storage during drought.

- 96% of Jordan Lake's water supply pool has already been allocated, with no allocation having been granted to PWC despite multiple requests.
- Fayetteville and other nearby communities are thus highly dependent on widely fluctuating flows in the Cape Fear River as opposed to stored water in Jordan Lake.
- During drought conditions, communities downstream of Jordan Lake must hope that the Corps of Engineers will release enough water to assimilate and flush out pollutants and maintain an adequate water supply. The more Interbasin-transfer out of the Cape Fear Basin which occurs, the more difficult this task; and

WHEREAS, Significant Interbasin transfer is already occurring from the Cape Fear Basin.

- Piedmont Triad Regional Water Authority (30.5 million gallons per day), Brunswick County (17 million gallons per day) and Pender County (14.5 million gallons per day) each have permitted Interbasin-transfer from the Cape Fear Basin
- Towns or Cary and Apex have the largest permitted Interbasin-transfer from the Cape Fear Basin (31 million gallons per day) and have established a clear precedent that return of wastewater to the source basin can help mitigate for the impacts of Interbasin-transfer.
- Now Fuquay-Varina is requesting significant Interbasin transfer from the Cape Fear Basin. If the Neuse River Basin has a chronic water supply issue combined with rapid growth in the Triangle area, are we to expect more and more Interbasin-transfer requests

impacting the Cape Fear Basin, or will Neuse River Basin water supply solutions be developed that don't depend on depleting their neighbor's water; and

WHEREAS, in recent years, the Cape Fear River upstream and downstream of Fayetteville has been fraught with numerous water quality issues stemming from industrial discharges and emerging contaminants from other sources. During low-flow periods, algae blooms become more likely and further impact water quality. Reduction of streamflow through Interbasin-transfer would exacerbate pollutant concentrations and water quality issues; and

WHEREAS, Climate is not static, but changes over time. This means that droughts experienced in the future will look different than in the past. We won't know how low river flows will be until they happen. Interbasin-transfer further reduces minimum flows experienced during droughts; and

WHEREAS, Under NC law, when Interbasin-transfers are approved, the impacts must be mitigated to the maximum degree practicable. Consequently, source alternatives within the Neuse River Basin should be fully evaluated by Fuquay-Varina and, for any remaining Interbasin-transfer, treated wastewater should be returned to the Cape Fear Basin; and

NOW, THEREFORE, BE IT RESOLVED BY THE Board of Commissioners of the Town of Hope Mills to request; since Fuquay-Varina has decided to make a major water supply investment in expansion of the Sanford WTP, major investments in wastewater pumping and treatment infrastructure should likewise be considered to return water back to the Cape Fear Basin, if this Interbasin-transfer goes forward.

ADOPTED the 2nd day of November, 2020.

Jackie Warner

JACKIE WARNER, MAYOR

ATTEST:

Jane G. Starling

Jane G. Starling, CMC, NCCMC
Town Clerk

TOWN OF HOPE MILLS
SEAL
HOPE MILLS, N.C.

DARSWEIL L. ROGERS, COMMISSIONER
WADE R. FOWLER, JR., COMMISSIONER
EVELYN O. SHAW, COMMISSIONER
D. RALPH HUFF, III, COMMISSIONER
DAVID W. TREGO, CEO/GENERAL MANAGER

PWC
Fayetteville's
HOMETOWN UTILITY

FAYETTEVILLE PUBLIC WORKS COMMISSION
955 OLD WILMINGTON RD
P.O. BOX 1089
FAYETTEVILLE, NORTH CAROLINA 28302-1089
TELEPHONE (910) 483-1401
WWW.FAYPWC.COM

November 17, 2020

Ms. Mary Sadler, PE
Hazen and Sawyer
4011 West Chase Blvd, Suite 500
Raleigh, NC 27607

Subject: Town of Fuquay-Varina Proposed IBT

Dear Ms. Sadler,

The Fayetteville Public Works Commission submits the following comments concerning the Town of Fuquay-Varina Proposed Interbasin Transfer:

1. Fuquay-Varina is required to prove that there are no reasonable alternatives to the proposed inter-basin transfer, and to date, we have seen no analysis or other evidence that Fuquay-Varina is unable to get additional water from the Neuse River Basin or any other source. In considering such alternatives, the EMC is not limited to consideration of alternatives that have been proposed, studied or considered by Fuquay-Varina. Except in circumstances of technical or economic infeasibility or adverse environmental impact, the EMC's determination as to reasonable alternatives must give preference to alternatives that would involve a transfer from one sub-basin to another within the Neuse River Basin (i.e., major receiving river basin) over Fuquay-Varina's proposed alternative that would involve a transfer from one major river basin (Cape Fear) to another major river basin (Neuse).

2. Fuquay-Varina is also required to prove that the amount of the transfer does not exceed the amount of the projected shortfall under the applicant's water supply plan after first taking into account all other sources of water that are available to the applicant, and to date, we have seen no analysis or other evidence of that from Fuquay-Varina.

3. Fuquay-Varina is required to prove that the benefits of the proposed transfer outweigh the detriments of the proposed transfer and that the detriments have to be mitigated to the maximum degree practicable, and to date, we have seen no analysis or other evidence of that from Fuquay-Varina. In that regard, Fuquay-Varina must address, and EMC must consider all of the following:

    a. The EMC must consider the necessity and reasonableness of the amount of surface water proposed to be transferred and its proposed uses. The Sanford WTP is quite a distance from Fuquay-Varina. Fuquay-Varina should identify the geographic boundaries within which the water being requested would be used, including whether that area is entirely within Fuquay-Varina town limits.

Sadler, Mary

From: Starling, Jane <jstarling@townofhopemills.com>
Sent: Thursday, November 19, 2020 2:17 PM
To: Sadler, Mary
Cc: Sally Shutt; PWC Venus Durant; PWC Rep Carolyn Hinson
Subject: Cumberland County Mayor's Coalition Resolution Opposing Interbasin transfer
Attachments: DOC001.pdf

Caution! *External email – think before you click*

Ms. Sadler,

Please see the attached resolution passed unanimously by the Cumberland County Mayor's Coalition, in opposition of the Proposed Interbasin Transfer for the Town of Fuquay-Varina. For the purpose of clarification, this is a separate document from the one I sent earlier for the Town of Hope Mills.

Very respectfully,

Jane G. Starling, CMC, NCCMC
Secretary Treasure
Cumberland County Mayor's Coalition
5770 Rockfish Road
Hope Mills, NC 28348
Ph: 910-426-4113
jstarling@townofhopemills.com

b. The EMC must consider present and reasonably foreseeable future detrimental effects on the source river basin, including effects on wastewater assimilation and water quality. In recent years, the Cape Fear River upstream and downstream of Fayetteville has been fraught with numerous water quality issues stemming from industrial discharges and other sources. During low-flow periods, further reduction of streamflow can exacerbate pollutant concentrations. Environmental impact assessment of this proposed IBT must address both water quantity and water quality in the Cape Fear River.

c. The EMC must consider present and reasonably foreseeable future detrimental effects on the source river basin, including effects on fish and wildlife habitat. Instream flow studies which assess the quantity and quality of wildlife habitat as a function of flow levels are the appropriate means to assess this concern. Reduction of streamflow may negatively impact fish and wildlife which depend on the Cape Fear River.

d. The EMC must make a specific finding as to measures that are necessary or advisable to mitigate or avoid detrimental impacts on the source river basin. In this regard, Fuquay-Varina should identify how and in what quantities treated wastewater can be returned to the source basin to reduce the net transfer. Fuquay-Varina has decided to make a major water supply investment in expansion of the Sanford WTP. Consequently, Fayetteville PWC expects that major investments in wastewater pumping and treatment infrastructure will likewise be considered to return water to the source basin. The Cary-Apex IBT has established a clear precedent that return of wastewater to the Cape Fear River can serve as mitigation for adverse water quantity and quality effects of IBT.

In summary, unless Fuquay-Varina meets its substantial evidentiary burden, the certificate needs to be denied. If the certificate is granted without sufficient evidence to support it or without a condition to return sufficient quantities of treated wastewater to the Cape Fear River Basin, Fayetteville PWC will contest it, and it is anticipated that other water systems in the lower Cape Fear region would consider joining us in doing so.

Sincerely,

Fayetteville Public Works Commission

Mick Noland

Mick Noland, PE
Chief Operations Officer
Water Resources Division

Cc: David Trego
Elaina Ball
Jamie West
Paul Peterson

RESOLUTION OPPOSING THE PROPOSED INTERBASIN TRANSFER ("IBT") CERTIFICATE REQUEST BY THE TOWN OF FUQUAY-VARINA FOR WATER FROM THE CAPE FEAR RIVER BASIN TO THE NEUSE RIVER BASIN

WHEREAS, maintaining the quantity and quality of water in the Cape Fear River is of paramount importance to the public health, security and economic welfare of Cumberland County, North Carolina, and surrounding communities; and

WHEREAS, the Cumberland County Mayors' Coalition believes the Interbasin Transfer ("IBT") Certificate request submitted by the Town of Fuquay-Varina poses increased risks to the water supply of Cumberland County and other counties downstream; and

WHEREAS, the Cumberland County Mayors' Coalition has determined it is in the public interest of the citizens of our combined nine municipalities of Fayetteville, Spring Lake, Hope Mills, Godwin, Falcon, Wade, Linden, Eastover and Stedman, as well as the residents of all communities benefited by the Cape Fear River and its waters to oppose any permanent transfer of water from the Cape Fear River to other river basins; and

WHEREAS, in recent years, the Cape Fear River upstream and downstream of Cumberland County has been fraught with numerous water quality issues stemming from industrial discharges and emerging contaminants from other sources; and

WHEREAS, reduction of streamflow through IBT would exacerbate pollutant concentrations and water quality issues such as algae blooms that are more likely during low-flow periods; and

WHEREAS, communities which are largely in the Triangle area have been successful in obtaining water supply allocations from Jordan Lake that leave Cumberland County and other downstream communities without guaranteed reservoir storage during drought conditions; and

WHEREAS, significant IBT is already occurring from the Cape Fear Basin including the largest permitted IBT by the Towns of Cary and Apex, which established a clear precedent that return of wastewater to the source basin can help mitigate for the impacts of IBT; and

NOW, THEREFORE, BE IT RESOLVED THAT the Cumberland County Mayors' Coalition opposes the interbasin transfer of water from the Cape Fear River Basin without the requirement that the same level of treated wastewater be returned back to the Cape Fear River Basin.

Adopted this 6th day of November, 2020.

Cumberland County Mayors' Coalition

By:

Clifton Turpin, Coalition Chair and Mayor of Falcon

Attest:

Jane Starling, Clerk to the Coalition

Sadler, Mary

From: arthur ingalls <joanart.ingalls@gmail.com>
Sent: Thursday, November 19, 2020 3:47 PM
To: Sadler, Mary; arthur ingalls

Caution! *External email – think before you click*

Water supply
I just want to add my comments to the water supply issue. It sounds as if the water supply issue for our area has been resolved for now. The question is what will happen when severe drought occurs. Climatic changes may affect water supply and quality. How will demands be solved? What happens if water qualities are altered? Decisions made now may not be adequate in future. Those of us in Cumberland County may not like our status in years to come.Permanent installations are not easily changed.

SUSTAINABLE SANDHILLS

18 November 2020

Dear Ms. Sadler:

Please accept this letter as official comments on behalf of Sustainable Sandhills and its Board of Directors regarding the Town of Fuquay-Varina's proposed interbasin water transfer (IBWT) from the Cape Fear River to the Neuse River.

Sustainable Sandhills strives to strengthen communities in our nine-county region by creating resilient environmental, economic and social resources. One of our impact areas is water quality. We work to maintain accessible, dependable and affordable water for our residents and are concerned about the impact of the proposed IBWT on the Cape Fear River, which is the Sandhills' primary source of potable water.

Water demands are increasing in the Sandhills and throughout North Carolina, and several municipalities across the state currently draw water through IBWTs from the Cape Fear River. Our residents need our water in our Sandhills. Continuous IBWTs are simply not sustainable for us. Fort Bragg - the world's largest military installation and our neighbor - also relies on the Cape Fear River for water. Thus, our water resources here are a matter of national security.

Droughts have affected the Cape Fear River in the past, and potential flow reductions coupled with IBWTs are bound to have significant effects on the viability of our water in the Sandhills. Furthermore, the Cape Fear River and our residents have faced major water quality and pollution issues as a result of chemical releases into the river. Flow reductions will only exacerbate the concerns created by these threats.

Sustainable Sandhills is opposed to the proposed IBWT and encourages its prevention unless Fuquay-Varina can implement clear and forward-thinking stewardship plans for 1) returning our water to the Cape Fear River at a reasonable rate and quality; 2) incorporating and enforcing water efficiency considerations into Town construction codes, operation standards and other regulations that advocate for more sustainable development; and 3) creating and disseminating a public education and awareness campaign for Town property owners to encourage them to conserve as much water as possible.

We cannot afford to lose our water in the Sandhills.

Thank you for your consideration.

Sincerely,

Jonelle Kimbrough

Jonelle Kimbrough
Executive Director, Sustainable Sandhills

PO Box 144 Fayetteville NC 28302 • 910-484-9098 • sustainablesandhills.org
Sustainable Sandhills is a 501(c)(3) non-profit organization

THE CONSERVATION FUND

77 Vilcom Center Drive #340 Chapel Hill, North Carolina 27514| (919) 967-2223
www.conservationfund.org

November 20, 2020

Ms. Mary Sadler, PE
Hazen & Sawyer
4011 WestChase Boulevard #500
Raleigh, North Carolina 27607

Re: Scoping for Interbasin Transfer of Water from Sanford to Fuquay-Varina

Dear Ms. Sadler:

Thank you and the NC Division of Water Resources for requesting public comments on the request of the Town of Fuquay-Varina for an Interbasin Transfer (IBT) certificate to transfer an average of 4 MGD and a maximum of 8 MGD from the City of Sanford in the Cape Fear River Basin to Fuquay-Varina in the Neuse & Cape Fear River Basins.

I appreciated the opportunity to ask questions at the public meeting held in Pittsboro on October 14, 2020.

I am writing on behalf of the Conservation Fund and the Triangle Land Conservancy (TLC) to urge Fuquay-Varina, Sanford, DWR and Hazen & Sawyer to address the following questions and concerns in the environmental studies and documents for the proposed project.

Regional Water Supply & Wastewater Planning

Many communities share and depend upon water resources in both the Cape Fear and Neuse River Basins.

The Fund & TLC commend the high levels of planning and collaboration among water utilities, local governments, Triangle J Council of Governments, NC Division of Water Resources, conservation organizations and other partners in the Research Triangle Region, spanning both the Upper Cape Fear and Upper Neuse River Basins.

The Triangle Water Supply Partnership encourages collaboration, information sharing and identification of cost-effective investments to provide water supply and wastewater treatment for a growing region. Most utilities in the region are active members, including Harnett County, Chatham County, Holly Springs and Pittsboro. Sanford and Fuquay-Varina are currently not members.

We encourage Sanford and Fuquay-Varina to join their neighbors and actively participate in the Triangle Water Partnership. We believe this is particularly important as Sanford considers major expansions of capacity to become a regional water and wastewater provider and as neighboring communities evaluate the costs and benefits of multiple regional water supply and regional wastewater treatment options.

Sanford has the capacity to treat 12 MGD and already provides water to Broadway, Lee County and Chatham County. Sanford will likely increase sales of water to Lee and Chatham County in the future. We understand other communities like Pittsboro and Holly Springs are considering purchasing water from Sanford as well.

Environmental studies and documents should consider the impacts of future total withdrawal from the Cape Fear River by Sanford and its partners and not just the incremental increase in withdrawal to serve Fuquay-Varina.

Buckhorn Dam

Buckhorn Dam was constructed in 1908 to generate electricity. It is currently owned by Duke Energy. The dam creates Buckhorn reservoir. Sanford's intake is upstream from the dam near Avents Ferry/NC 42. The dam stopped generating electricity many years ago. Duke has decommissioned its former coal-fired Cape Fear Steam Station at Moncure, and the reservoir is no longer needed for cooling water.

The dam is a major barrier for fish passage, a major hazard for paddlers, and a liability for its owner, Duke Energy.

The condition and fate of Buckhorn Dam and reservoir should be addressed in the study.

The Fund has been a partner with the Town of Madison, NC Wildlife Resources Commission, US Fish & Wildlife Service, Dan River Basin Association and others to lower the Lindsey Bridge Dam on the Dan River to secure the Town's water supply, improve fish passage, provide canoe access and increase public safety. The Lindsey Bridge Dam project on the Dan River may be a good model for Buckhorn Dam.

Source Water Protection

The 2019 Annual Water Quality Report, prepared to comply with the Safe Drinking Water Act's Source Water Protection requirements, rates the Sanford's drinking water source as having a *higher* inherent vulnerability rating, a *moderate* contamination rating and a *higher* susceptibility rating.

The Environmental Management Commission has classified the Cape Fear River at Buckhorn as Water Supply IV, which provides minimal protection from point and non-point sources of pollution.

Like Pittsboro and other communities that withdraw from the Haw River and Cape Fear River Sanford is concerned about contamination of its drinking water by PFAS compounds, 1, 4-

dioxane and other emerging contaminants that neither US EPA nor the EMC have developed drinking water standards or maximum contaminant levels for.

EPA and the EMC will eventually establish standards or MCLs for these compounds to protect public health. Will expanded water treatment capacity be designed to anticipate and meet future standards or MCLs?

Will the EPA or DEQ increase their efforts to prevent and reduce pollution from wastewater discharges into the Haw, Deep and Cape Fear Rivers to protect public health and the environment?

The Fund & TLC commend the efforts of the Jordan Lake One Water Association (JLOW) and the Upper Neuse River Basin Association (UNRBA) in collaborating and jointly raising funds to reduce pollution in Jordan Lake and Falls Lake, respectively. The Fund & TLC note that the Town of Cary set aside $750,000 in its 2020-21 water utility budget for watershed protection efforts. Cary plans to make this an ongoing investment. Other users of Jordan Lake are expected to follow Cary's lead.

The Fund & TLC encourage Sanford, its existing partners, and its future partners, including Fuquay-Varina, to set aside funds to protect their water supplies as they also budget millions for expansion of drinking water treatment and distribution infrastructure. Cary and Raleigh budget their watershed protection efforts at 15 cents/1000 gallons consumed.

The Fund & TLC recommend that Sanford and its partners to develop a conservation plan for the lower Deep and lower Haw Rivers that would identify properties with high conservation and water resources values.

Triangle Land Conservancy, Triangle J Council of Governments, and the Fund developed a Watershed Conservation Plan as a component of the Jordan Lake One Water Initiative in 2019. More at https://www.triangleland.org/cms/wp-content/uploads/2019/08/jordan-river-watershed.pdf.

Triangle Land Conservancy also prepared a conservation assessment of the Lower Deep and Upper Cape Fear Rivers (from House in the Horseshoe to Raven Rock State Park) in 2001. More at https://www.triangleland.org/cms/wp-content/uploads/2015/12/deep-riv-public-complete.pdf.

Threatened & Endangered Species

Both the Neuse River Basin and the Cape Fear Basin are home to a number of state- and federal- protected species, including amphibians and fish that are susceptible to changes in water chemistry and quantity, including impacts from induced development. What impacts will the proposed transfer and its impacts have on protected and candidate species in each watershed?

Managing Growth

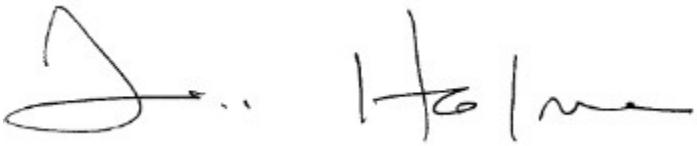
Southern Wake and Northern Harnett Counties are growing rapidly. Fuquay-Varina is seeking additional water from the Cape Fear River Basin to sustain its growth.

Will Fuquay-Varina's stormwater management ordinances and policies ensure the capture, reuse, infiltration, treatment, and reduction of stormwater and flooding that new development can cause? Does Fuquay-Varina provide incentives to capture and reuse rainwater and stormwater for non-potable purposes or incentives for nature based green stormwater infrastructure to both reduce flooding and prevent water pollution?
Wake County should also consider strengthening its stormwater management/flood reduction policies. Wake has little capacity to ensure that stormwater control measures are maintained. Wake County could also provide more technical and financial support for watershed planning and nature based green stormwater infrastructure projects that provide benefits to the county and municipalities.

Hector and Neils Creeks rise in Northern Harnett County just south of Fuquay-Varina and join the Cape Fear River just above Harnett Water's intake and treatment works in Lillington. Fuquay-Varina currently purchases water from Harnett Water. What policies will be put in place to protect Hector, Neils and other creeks and Harnett County's water supply?

Thank you for your consideration.

Sincerely,



Bill Holman
NC State Director

C: Sandy Sweitzer, Triangle Land Conservancy
Harold Brady, Division of Water Resources
Jay Meyers, Fuquay-Varina Public Utilities
Victor Czar, Sanford Public Works

Sadler, Mary

From: Mary Holmes <maryholmes2009@gmail.com>
Sent: Friday, November 20, 2020 3:47 PM
To: Sadler, Mary
Subject: Interbasin transfer

Caution! *External email – think before you click*

Hazen and Sadler
Attn: Mary Sadler, PE

I am writing to express my objection to the interbasin transfer request from Fuqua-Varina. There is no reason that the citizens of Fayetteville and downstream should bear the cost, environmental and otherwise, of poor planning of growth upstream. The Cape Fear River is already experiencing great distress due to GenX and other contamination and IBTs. Fuqua-Varina should pump water borrowed from the Cape Fear River Basin back to the same basin once it is used and cleaned.
Poorer, browner communities down river should not bear the cost of growth of wealthier, whiter communities. Do the right thing and pump the water back to the Cape Fear River Basin.

--
Mary M. Holmes
Fayetteville, NC

November 19, 2020

As residents of Fayetteville, we are writing to express our concern about the proposed Inter-basin water transfer request of Fuquay-Varina. Water is a finite resource and critical to us all. If a community uses water from upstream of Fayetteville, they should do the right thing by their neighbors and return it to the Cape Fear River Basin for other communities to use.

As we understand it, the water request is to help Fuquay-Varina grow. The communities of the Cape Fear River Basin should not pay the price for growth and development that will help Fuquay-Varina prosper. If Fuquay-Varina needs the water, they should pay to return it to the Cape Fear River Basin and not send elsewhere. While the amount of water and impact to the Fayetteville water supply may seem small, we must ensure that decisions today do not become bad decisions that have significant consequences in the future.

Please do the right thing for the citizens of Fayetteville and other communities that depend on the Cape Fear River for their water supply. Find alternatives and do not allow the water to be taken out of the Cape Fear River Basin without being returned.

Paul and Carolyn Hinson
6253 Lakehaven Drive
Fayetteville, NC 28304

Sadler, Mary

From: Rick Glazier <Rick@ncjustice.org>
Sent: Friday, November 20, 2020 4:21 PM
To: Sadler, Mary
Subject: Comment on proposed Fuquay-Varina Inter-basin transfer

Caution! *External email – think before you click*

I am writing as a former member of the NC House of Representatives in opposition to the proposed Fuquay-Varina inter-basin transfer. This proposal continues a distressing and ultimately hazardous and unsustainable path of diverting critical water resources to sprawling, wealthier, whiter suburban and exurban, and unplanned upstream users and polluters from more needed basic water resources for poorer, more diverse downstream users. That was never the purpose behind the inter-basin transfer process---indeed, it was intended to stop these grabs that occur whenever communities upstream grow in an unplanned regional manner to the detriment of those who exist downstream. Adding insult to injury, not to mention, exacerbating environmental injustice, this proposed diversion reeks of racial inequity and widens the systemic inequalities that permeate this state. More time and reflection, particularly given this moment in time, are needed before this transfer should be considered. Water resources are finite and the continued diversion of these resources to wealthier upstream users to the detriment of downstream base capacity is unfair, unnecessary, and ultimately destructive of the ecosystem, confidence in the interbasin, let alone regional planning process, and will lead to real degradation of the resource.
Sincerely,
Rick Glazier
NC Representative 2003-2015

Memo: **Town of Fuquay-Varina Proposed Interbasin Transfer**

To: Hazen Sawyer

From: Lower Cape Fear Water and Sewer Authority

Date: November 11, 2020

After reviewing Fuquay-Varina's water supply plan, Lower Cape Fear Water and Sewer Authority believes that Fuquay-Varina's intent to pursue an Interbasin Transfer is premature.

We believe that Fuquay Varina should look towards major system improvements of existing infrastructure. Replacing existing meters would better account for monitoring usage and provide revenue needed for system improvements. There are almost a thousand meters or approximately seven percent of their systems meters that are not being accounted for on a regular basis.

Also, the lack of a leak detection program is a key maintenance item. Although some pipes are being replaced annually, leak detection could pinpoint issues and provide better data for repairs to be included in a Capital Improvement Plan. At this point they are replacing less than one third of one percent of their existing lines annually.

Fuquay-Varina needs to show marked improvement in regards to conservation and education by implementing water conservation measures and a program to educate its residents about how to save water especially through better irrigation practices.

Fuquay proposes an eight million gallon per day maximum and four million gallon per day minimum withdrawal with little analysis of environmental impact and the accompanying need for waste treatment facilities to process the additional waste water and minimize the effect of withdrawal on the basin.

The Jordan Lake Allocation Recommendation and Surface Water Supply Plan did not account for any future withdrawals between Jordan Lake outfall and Fayetteville Lock and Dam #3 and this study needs updating before additional transfers or withdrawals can be permitted.

After the October 20, 2020 scoping meeting, it appears that the entities supplying Fuquay-Varina water may need those resources to meet their own future demands.

Before any consideration can be given to and interbasin transfer, Fuquay-Varina should be required to explore alternatives such as ground water sources, merging systems, etc. At this point, Lower Cape Fear Water and Sewer authority would like to echo Brunswick County, Pender County, Cape Fear Public Utility and Fayetteville PWC's objection to granting Fuquay-Varina an Inter Basin Transfer Permit.

Conditions that affect availability such as low flow need to be considered. The U.S. Geological Survey is considering an update to the 1994 Giese and Mason Report "Low-flow characteristics of Streams in North Carolina". This report should be considered to provide more detailed data for communities to use in future planning.

The Lower Cape Fear region is experiencing growth as well and does not support any action that reduces the available water supply to public water providers on the Lower Cape Fear. Lower Cape Fear Water, and Sewer Authority, Brunswick County and Cape Fear Public Utilities already made significant capital investment to utilize the one hundred and six million gallon per day allocation already permitted.

Agency Scoping Comments, 2020

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
MICHAEL SCOTT
Director

NORTH CAROLINA
Environmental Quality

November 3, 2020

To: Lyn Hardison, Environmental Assistance and SEPA Coordinator
Division of Environmental Assistance and Customer Service

From: Melodi Deaver, Administrative Specialist
Division of Waste Management, Hazardous Waste Section

RE: SEPA Review, Project# 21-0754, Town of Fuquay-Varina (Wake County)

The Hazardous Waste Section has reviewed the proposed for the Town of Fuquay-Varina's Water Supply and Interbasin Transfer project and would like to make the following comment:

Any hazardous waste generated from the demolition, construction, operation, maintenance, and/or remediation (e.g. excavated soil) from the proposed project must be managed in accordance with the North Carolina Hazardous Waste Rules. The demolition, construction, operation, maintenance, and remediation activities conducted will most likely generate a solid waste, and a determination must be made whether it is a hazardous waste. If a project site generates more than 220 pounds of hazardous waste in a calendar month, the HWS must be notified, and the site must comply with the small quantity generator (SQG) requirements. If a project site generates more than 2200 pounds of hazardous waste in a calendar month, the HWS must be notified, and the facility must comply with the large quantity generator (LQG) requirements.

Generators are required to determine their generator status and both SQGs & LQGs are required to obtain a site EPA Identification number for the generation of hazardous waste.

Should any questions arise, please contact Melodi Deaver at 919-707-8204

Respectfully,

Melodi Deaver

Compliance Branch
Hazardous Waste Section

North Carolina Department of Environmental Quality | Division of Waste Management
217 West Jones Street | 1646 Mail Service Center | Raleigh, North Carolina 27699-1646
919.707.8200

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
S. DANIEL SMITH
Director

NORTH CAROLINA
Environmental Quality

November 19, 2020

MEMORANDUM

To: Lyn Hardison
Department of Environmental Quality

From: David Wainwright
SEPA Coordinator, Division of Water Resources

Subject: SCH #21-0754
Scoping
Proposed Fuquay-Varina Interbasin Transfer
Wake County

The Division of Water Resources' (DWR) Central Office staff have reviewed the scoping letter for the Town of Fuquay-Varina's proposed interbasin transfer and purchase of water from the City of Sanford. Staff provides the following comments:

Basin Planning Branch (Nora Deamer – Nora.Deamer@ncdenr.gov or 919-707-9116):

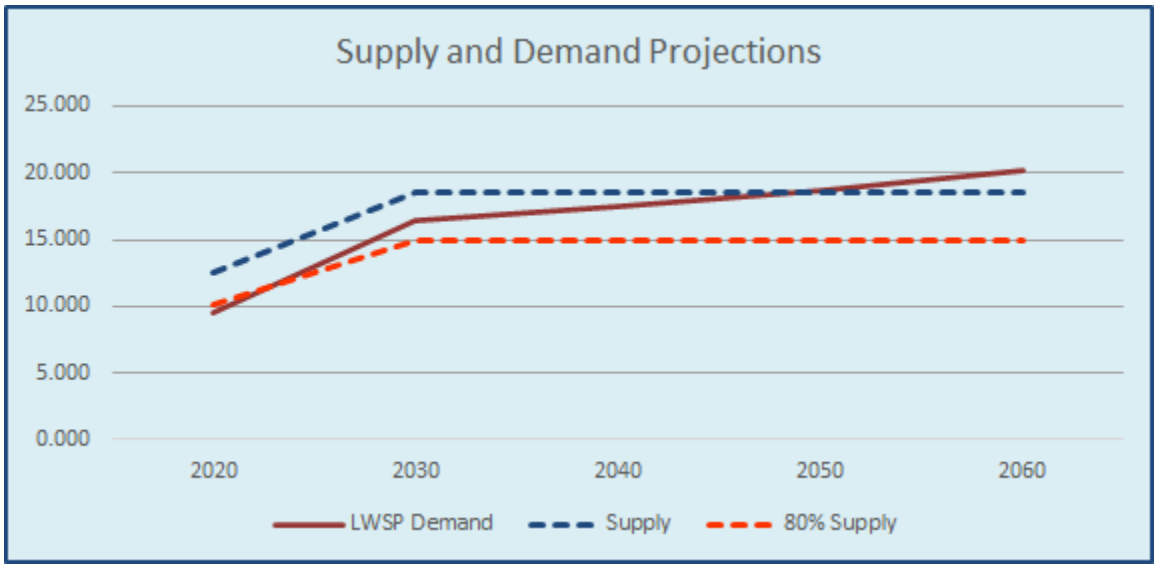
- Please include a discussion regarding the feasibility of piping treated wastewater back to the Cape Fear basin in order to limit or reduce the interbasin transfer.
- Please include verification that the Town has the capacity to treat any increase in overall volume and waste load to the Neuse River NSW basin and remain in compliance with the NPDES permitted nitrogen limit.

Modeling and Assessment Branch (Neela Sarwar – Neelufa.Sarwar@ncdenr.gov or 919-707-9028):

- No comment at this time.

Water Supply Planning Branch (Vardry Austin – Vardry.Austin@ncdenr.gov or 919-707-9002):

- Based on data in Sanford's 2019 LWSP, future sales of 6.0 MGD will cause them to exceed their total available supply as shown in the following chart. Although a timeframe has not been noted, the chart shows the demand-supply situation for Sanford if the additional water sales occurred by 2030. In order for the preferred alternative to be acceptable, the demand-supply ratio for Sanford would need to be maintained at no more than 80%.



The Division of Water Resources, Central Office, thanks you for the opportunity to comment. Should you have questions regarding any of the above comments, please contact the listed staff. I can be reached at either David.Wainwright@ncdenr.gov or 919-707-9045.

ec: Nora Deamer, Basin Planning Branch
Neela Sarwar, Modeling and Assessment Branch
Vardry Austin, Water Supply Planning Branch

Control No.: 21-E-0000-0754

County.: WAKE

Date Received: 10/8/2020

Agency Response: 11/9/2020

Review Closed: 11/9/2020

LYN HARDISON
CLEARINGHOUSE COORDINATOR
DEPT OF ENVIRONMENTAL QUALITY

Project Information

Type: State Environmental Policy Act ping

Applicant: Town of Fuquay-Varina

Project Desc.: Proposed project is for the Town of Fuquay-Varina's Water Supply and Interbasin Transfer project.

As a result of this review the following is submitted:

☐ No Comment ☐ Comments Below ☑ Documents Attached

Reviewed By: LYN HARDISON Date: 11/9/2020

Control No.: 21-E-0000-0754

County.: WAKE

Date Received: 10/8/2020

Agency Response: 11/9/2020

Review Closed: 11/9/2020

JINTAO WEN

CLEARINGHOUSE COORDINATOR

DPS - DIV OF EMERGENCY MANAGEMENT

Project Information

Type: State Environmental Policy Act ping

Applicant: Town of Fuquay-Varina

Project Desc.: Proposed project is for the Town of Fuquay-Varina's Water Supply and Interbasin Transfer project.

As a result of this review the following is submitted:

☑ No Comment ☐ Comments Below ☐ Documents Attached

Reviewed By: JINTAO WEN Date: 11/5/2020

Control No.: 21-E-0000-0754

County.: WAKE

Date Received: 10/8/2020

Agency Response: 11/9/2020

Review Closed: 11/9/2020

DEVON BORGARDT

Clearinghouse Reviewer

DEPT OF NATURAL & CULTURAL RESOURCE

Project Information

Type: State Environmental Policy Act ping

Applicant: Town of Fuquay-Varina

Project Desc.: Proposed project is for the Town of Fuquay-Varina's Water Supply and Interbasin Transfer project.

As a result of this review the following is submitted:

☐ No Comment ☐ Comments Below ☑ Documents Attached

Reviewed By: DEVON BORGARDT Date: 11/9/2020

STATE OF NORTH CAROLINA
DEPARTMENT OF ADMINISTRATION

Roy Cooper
GOVERNOR

Machelle Sanders
Secretary

November 12, 2020

Mary Sadler
Town of Fuquay-Varina
c/o Hazen and Sawyer
4011 West Chase Blvd., Suite 500
Raleigh, NC 27607-

Re: SCH File # 21-E-0000-0754 Proposed project is for the Town of Fuquay-Varina's Water Supply and Interbasin Transfer project.

Dear Mary Sadler:

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 comments made in the review of this 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 (919) 807-2425.

Sincerely,

CRYSTAL BEST
State Environmental Review Clearinghouse

Attachments

Mailing Address:
NC DEPARTMENT OF ADMINISTRATION
1301 MAIL SERVICE CENTER
RALEIGH, NC 27699-1301

Telephone: (919)807-2425
Fax: (919)733-9571
COURIER: #51-01-00
Email: state.clearinghouse@doa.nc.gov
Website: www.ncadmin.nc.gov

Location:
116 WEST JONES STREET
RALEIGH, NORTH CAROLINA

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
JAMIE RAGAN
Director

NORTH CAROLINA
Environmental Quality

MEMORANDUM

To: Crystal Best
State Clearinghouse Coordinator
Department of Administration

From: Lyn Hardison
Division of Environmental Assistance and Customer Service
Environmental Assistance and Project Review Coordinator
Washington Regional Office

RE: 21-0754
Scoping - Proposed project is for the Town of Fuquay-Varina's Water Supply and Inter-basin Transfer project.
Wake County

Date: November 9, 2020

The Department of Environmental Quality has reviewed the proposal for the referenced project. Based on the information provided, several of our agencies have identified permits that may be required and offered some valuable guidance that will help the applicant in preparing the necessary environmental documents. The comments are attached for the applicant's review.

I failed to collect comments for the Division of Water Resources within the set timeline. However, I should receive those comments at a later date. Upon receipt, I will send it to you to be forwarded to the applicant for their review.

The Department agencies will continue to be available to assist the applicant through any environmental review or permitting processes.

Thank you for the opportunity to respond.

Attachments

North Carolina Wildlife Resources Commission

Gordon Myers, Executive Director

MEMORANDUM

TO: Lyn Hardison, Environmental Assistance Coordinator
NCDEQ Division of Environmental Assistance and Customer Services

FROM: Gabriela Garrison
Eastern Piedmont Coordinator
Habitat Conservation

DATE: November 4, 2020

SUBJECT: Request for Environmental Scoping for the Town of Fuquay-Varina's Water Supply and Interbasin Transfer, Wake County, DEQ Project No. 21-0754.

Biologists with the North Carolina Wildlife Resources Commission (NCWRC) have reviewed the subject document. Comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-667e), North Carolina Environmental Policy Act (G.S. 113A-1 through 113A-10; 1 NCAC 25) and North Carolina General Statutes (G.S. 113-131 et seq.).

The Town of Fuquay-Varina (Town) has requested an Interbasin Transfer (IBT) from the Cape Fear to Neuse River Basin. The Town owns and operates a 3 million gallon/day (mgd) wastewater treatment plant (WWTP) that discharges to Terrible Creek, as well as a 0.117 mgd WWTP that discharges to Middle Creek, both in the Neuse River Basin. The Town also has wastewater treatment capacity in the North Harnett Regional WWTP in the Cape Fear River basin.

The Town initiated discussion with the City of Sanford (City) to purchase 6 mgd of finished water capacity from the City's water treatment plant, located in the Cape Fear River basin. However, the Town is now requesting an IBT certificate for an average day over a maximum month transfer of 4 mgd from the Cape Fear River basin.

The NCWRC has concerns with an IBT from the Cape Fear to Neuse River basin because of impacts to receiving streams from added effluent. Streams in the Neuse River watershed have already been adversely impacted by effluent and stormwater from highly urbanized areas. The proposed effluent from the IBT could further impact aquatic resources and water quality in affected areas. Swift and Middle Creeks are of particular concern because there are records for several state listed threatened and endangered species in these systems.

The Cape Fear River basin supports several listed species as well as important sport fish populations. American shad, striped bass, Atlantic sturgeon and shortnose sturgeon are anadromous fish that use the Cape Fear River for spawning. Significant reductions in water flows could impede the reproductive

Mailing Address: Habitat Conservation Division • 1721 Mail Service Center • Raleigh, NC 27699-1721
Telephone: (919) 707-0220 • **Fax:** (919) 707-0028

success of these and other species. Reductions in water levels may also result in the dewatering of nursery areas.

Secondary impacts from increased water supply will facilitate a surge in industrial, commercial and residential development. This will lead to increased impervious surfaces, resulting in more severe stormwater runoff. In addition to changing stream morphology, increased runoff may cause degradation of aquatic habitats through accelerated stream bank erosion, channel changes, bedload changes, altered substrates and scouring of stream channels.

The NCWRC encourages the applicant to consider additional measures to protect aquatic and terrestrial wildlife species in developing landscapes. The NCWRC's *Guidance Memorandum to Address and Mitigate Secondary and Cumulative Impacts to Aquatic and Terrestrial Wildlife Resources and Water Quality* (August 2002; http://www.ncwildlife.org/Portals/0/Conserving/documents/2002_GuidanceMemorandumforSecondaryandCumulativeImpacts.pdf) details measures to minimize secondary and cumulative impacts to aquatic and terrestrial wildlife resources; in addition, the NCWRC's Green Growth Toolbox (https://www.ncwildlife.org/conserving/programs/Green-Growth-Toolbox) provides information on nature-friendly planning.

In addition to addressing the concerns outlined above, the environmental document should include a detailed assessment of existing natural resources within the areas of potential development and should discuss the potential of mitigating development impacts to wetlands, waters and high-quality upland habitat. To provide a meaningful review of proposed project impacts on fish and wildlife resources, the consultants, project sponsors or permit applicants should provide the following information in the environmental document:

1. Include descriptions of fish and wildlife resources within the project area, and a listing of federally or state designated threatened, endangered or at-risk species. When practicable, potential borrow areas to be used for any anticipated project construction should be included in the inventories. A listing of designated species can be developed through consultation with the NC Natural Heritage Program.

2. Surveys should be conducted by biologists with both state and federal endangered species permits.

3. Include descriptions of any streams or wetlands affected by the project.

4. Include project maps identifying wetland areas. Identification of wetlands may be accomplished through coordination with the U.S. Army Corps of Engineers (COE). If the COE is not consulted, the person delineating wetlands should be identified, and criteria listed.

5. Provide information on existing, planned and projected sewer and water infrastructure service throughout the service area. A map showing the location of the existing and projected lines and areas containing special resources should be included.

6. Define the service area for the project, including any ETJs (extra-territorial jurisdiction), and provide a map of the service area. The map and description should provide the NCDEQ designated 14-digit hydrologic unit codes (HUC) included in the service area.

7. Provide a description of project activities that will occur within wetlands, such as fill or channel alteration. Acreage of wetlands impacted by alternative project designs should be listed.

8. Provide a description and a cover type map showing acreage of upland wildlife habitat impacted by the project.

9. Discuss the extent to which the project will result in loss, degradation or fragmentation of wildlife habitat (wetlands and uplands).

10. Discuss any measures proposed to avoid or reduce impacts of the project or to mitigate unavoidable habitat losses.

11. Discuss the cumulative impacts of secondary development facilitated by the proposed project. Such discussion should weigh the economic benefits of such growth against the costs of associated environmental degradation.

    (a) Include specific measures that will be used to address stormwater at the source. Include specific requirements for both residential and industrial developments and Best Management Practices that will be required.

    (b) Include specific measures that will be used to protect stream corridors, riparian habitat and a minimum of the 100-year floodplain from filling and development. Commitments by the project sponsors to protect area streams with riparian buffers through purchase or conservation easement are of particular interest.

12. Include a list of document preparers that shows professional background and qualifications.

Although some of the information, requests and comments may not be applicable to certain projects, these guidelines should facilitate preparation of fish and wildlife impact assessments. This information will be very useful in the preparation of an environmental document.

Thank you for the opportunity to review and comment on this project. If I can be of further assistance, please contact me at (910) 409-7350 or gabriela.garrison@ncwildlife.org.

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
MICHAEL SCOTT
Director

NORTH CAROLINA
Environmental Quality

Date: November 4, 2020

To: Michael Scott, Director
Division of Waste Management

Through: Janet Macdonald
Inactive Hazardous Sites Branch – Special Projects Unit

From: Bonnie S. Ware
Inactive Hazardous Sites Branch

Subject: SEPA Project #21-0754, Town of Fuquay-Varina, Wake County, North Carolina

The Superfund Section has reviewed the proximity of sites under its jurisdiction to the Town of Fuquay-Varina project. Proposed project is for the Town of Fuquay-Varina's Water Supply and Interbasin Transfer project.

Nineteen (19) sites were identified within one mile of the project as shown on the attached report. The Superfund Section recommends that site files be reviewed to ensure that appropriate precautions are incorporated into any construction activities that encounter potentially contaminated soil or groundwater. Superfund Section files can be viewed at: http://deq.nc.gov/waste-management-laserfiche.

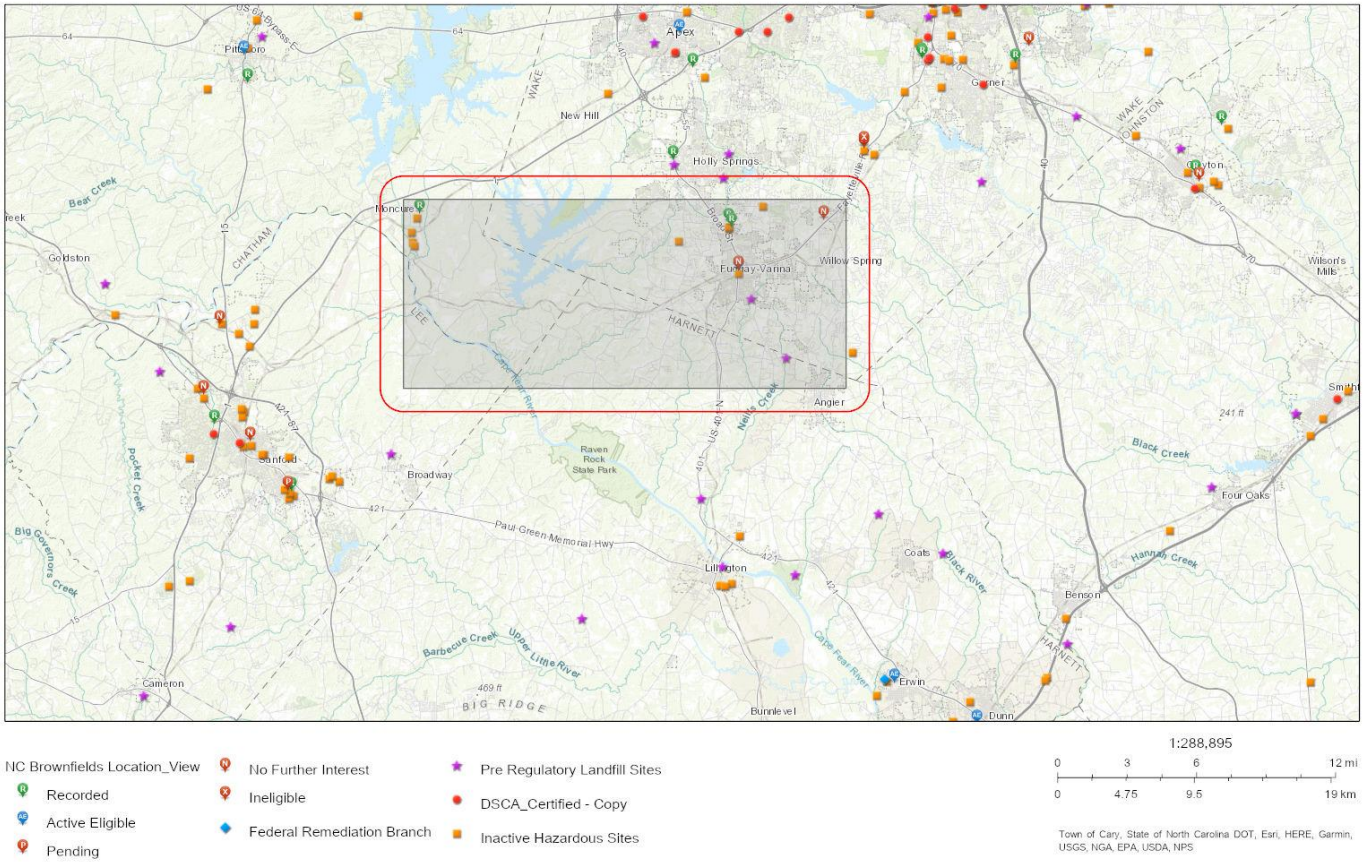
Please contact Janet Macdonald at 919.707.8349 if you have any questions.

SEPA/NEPA Review Report

Area of Interest (AOI) Information

Area : 136,204.13 acres

Nov 4 2020 15:04:01 Eastern Standard Time



21-0754 Wake County

Summary

Name	Count	Area(acres)	Length(mi)
Certified DSCA Sites	0	N/A	N/A
Federal Remediation Branch Sites	0	N/A	N/A
Inactive Hazardous Sites	10	N/A	N/A
Pre-Regulatory Landfill Sites	3	N/A	N/A
Brownfields Program Sites	6	N/A	N/A

Inactive Hazardous Sites

#	EPAID	SITENAME	Count
1	NCD049845548	REICHHOLD CHEMICAL, INC.	1
2	NCD053488409	ALLIED CHEMICAL CORP/PERFORMANCE FIBERS	1
3	NCN000410369	JAMES AUSTIN RD TCE	1
4	NONCD0000014	BOISE CASCADE	1
5	NONCD0001064	GUILFORD MILLS PLANT	1
6	NONCD0001650	DYNEA	1
7	NONCD0001980	LAN-O-SHEEN, INC.	1
8	NONCD0002882	NEEDMORE GENERAL STORE	1
9	NONCD0002953	CORNELL DUBLIER ELECTRONICS (FRMR)	1
10	NONCD0003099	BASF	1

Pre-Regulatory Landfill Sites

#	EPAID	SITENAME	Count
1	NONCD0000349	Angier Refuse Dump	1
2	NONCD0000606	Fuquay Varina	1
3	NONCD0000605	Holly Springs Dump	1

Brownfields Program Sites

#	BF_ID	BF_Name	Count
1	1904715019	Allied Chemical (RN)	1
2	1804114092	RayChem Corp.	1
3	2100317092	Fuquay Varina Arts Center	1
4	2105317092	Guilford Mills Development	1
5	2308319092	Cornell Dubilier	1
6	1600112092	Liebherr Mining	1

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
MICHAEL SCOTT
Director

NORTH CAROLINA
Environmental Quality

November 3, 2020

To: Lyn Hardison, Environmental Assistance and SEPA Coordinator
Division of Environmental Assistance and Customer Service

From: Melodi Deaver, Administrative Specialist
Division of Waste Management, Hazardous Waste Section

RE: SEPA Review, Project# 21-0754, Town of Fuquay-Varina (Wake County)

The Hazardous Waste Section has reviewed the proposed for the Town of Fuquay-Varina's Water Supply and Interbasin Transfer project and would like to make the following comment:

Any hazardous waste generated from the demolition, construction, operation, maintenance, and/or remediation (e.g. excavated soil) from the proposed project must be managed in accordance with the North Carolina Hazardous Waste Rules. The demolition, construction, operation, maintenance, and remediation activities conducted will most likely generate a solid waste, and a determination must be made whether it is a hazardous waste. If a project site generates more than 220 pounds of hazardous waste in a calendar month, the HWS must be notified, and the site must comply with the small quantity generator (SQG) requirements. If a project site generates more than 2200 pounds of hazardous waste in a calendar month, the HWS must be notified, and the facility must comply with the large quantity generator (LQG) requirements.

Generators are required to determine their generator status and both SQGs & LQGs are required to obtain a site EPA Identification number for the generation of hazardous waste.

Should any questions arise, please contact Melodi Deaver at 919-707-8204

Respectfully,

Melodi Deaver

Compliance Branch
Hazardous Waste Section

North Carolina Department of Environmental Quality | Division of Waste Management
217 West Jones Street | 1646 Mail Service Center | Raleigh, North Carolina 27699-1646
919.707.8200

State of North Carolina Department of Environmental Quality
INTERGOVERNMENTAL REVIEW PROJECT COMMENTS

Reviewing Regional Office: Raleigh
Project Number: 21-0754 Due Date: 11/4/2020
County: Wake

After review of this project it has been determined that the DEQ 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 are 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, non-standard sewer system extensions & sewer systems that do not discharge into state surface waters.	Application 90 days before begins construction or award of construction contracts. On-site inspection may be required. Post-application technical conference usual.	30 days (90 days)
☐	Permit to construct & operate, sewer extensions involving gravity sewers, pump stations and force mains discharging into a sewer collection system	Fast-Track Permitting program consists of the submittal of an application and an engineer's certification that the project meets all applicable State rules and Division Minimum Design Criteria.	30 days (N/A)
☐	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 begins 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	Complete application must be received and permit issued prior to the installation of a groundwater monitoring well located on property not owned by the applicant, and for a large capacity (>100,000 gallons per day) water supply 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
☒	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	Please Note - The Health Hazards Control Unit (HHCU) of the N.C. Department of Health and Human Services, must be notified of plans to demolish a building, including residences for commercial or industrial expansion, even if no asbestos is present in the building.	60 days (90 days)
☒	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 are to be disturbed. Plan must be filed with and approved by applicable Regional Office (Land Quality Section) at least 30 days before beginning activity. A NPDES Construction Stormwater permit (NCG010000) is also usually issued should design features meet minimum requirements. 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)
☐	Sedimentation and erosion control must be addressed in accordance with _____ Local Government'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.		Based on Local Program
☒	Compliance with 15A NCAC 2H .0126 - NPDES Stormwater Program which regulates three types of activities: Industrial, Municipal Separate Storm Sewer System & Construction activities that disturb ≥1 acre.		30-60 days (90 days)
☐	Compliance with 15A NCAC 2H 1000 -State Stormwater Permitting Programs regulate site development and post-construction stormwater runoff control. Areas subject to these permit programs include all 20 coastal counties, and various other counties and watersheds throughout the state.		45 days (90 days)

State of North Carolina Department of Environmental Quality
INTERGOVERNMENTAL REVIEW PROJECT COMMENTS

Reviewing Regional Office: Raleigh
Project Number: 21-0754 Due Date: 11/4/2020
County: Wake

	PERMITS	SPECIAL APPLICATION PROCEDURES or REQUIREMENTS	Normal Process Time (statutory time limit)
☐	Mining Permit	On-site inspection usual. Surety bond filed with DEQ Bond amount varies with type mine and number of acres of affected land. Affected area greater than one acre must be permitted. The appropriate bond must be received before the permit can be issued.	30 days (60 days)
☐	Dam Safety Permit	If permit required, application 60 days before begin construction. Applicant must hire N.C. qualified engineer to: prepare plans, inspect construction, and certify construction is according to DEQ approved plans. May also require a 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)
☐	Oil Refining Facilities	N/A	90-120 days (N/A)
☐	Permit to drill exploratory oil or gas well	File surety bond of $5,000 with DEQ running to State of NC conditional that any well opened by drill operator shall, upon abandonment, be plugged according to DEQ rules and regulations.	10 days N/A
☐	Geophysical Exploration Permit	Application filed with DEQ 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 fee 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	Compliance with the T15A 02H .0500 Certifications are required whenever construction or operation of facilities will result in a discharge into navigable water as described in 33 CFR part 323.	60 days (130 days)
☐	Compliance with Catawba, Goose Creek, Jordan Lake, Randleman, Tar Pamlico or Neuse Riparian Buffer Rules is required. Buffer requirements: http://deq.nc.gov/about/divisions/water-resources/water-resources-permits/wastewater-branch/401-wetlands-buffer-permits/401-riparian-buffer-protection-program		
☐	Nutrient Offset: Loading requirements for nitrogen and phosphorus in the Neuse and Tar-Pamlico River basins, and in the Jordan and Falls Lake watersheds, as part of the nutrient-management strategies in these areas. DWR nutrient offset information: http://deq.nc.gov/about/divisions/water-resources/planning/nonpoint-source-management/nutrient-offset-information		
☐	CAMA Permit for MAJOR development	$250.00 - $475.00 fee must accompany application	75 days (150 days)
☐	CAMA Permit for MINOR development	$100.00 fee must accompany application	22 days (25 days)
☒	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.		
☒	Plans and specifications for the construction, expansion, or alteration of a public water system must be approved by the Division of Water Resources/Public Water Supply Section prior to the award of a contract or the initiation of construction as per 15A NCAC 18C .0300 et. seq., Plans and specifications should be submitted to 1634 Mail Service Center, Raleigh, North Carolina 27699-1634. All public water supply systems must comply with state and federal drinking water monitoring requirements. For more information, contact the Public Water Supply Section, (919) 707-9100.		30 days
☒	If existing water lines will be relocated during the construction, plans for the water line relocation must be submitted to the Division of Water Resources/Public Water Supply Section at 1634 Mail Service Center, Raleigh, North Carolina 27699-1634. For more information, contact the Public Water Supply Section, (919) 707-9100.		30 days
☐	Plans and specifications for the construction, expansion, or alteration of the _____ water system must be approved through the _____ delegated plan approval authority. Please contact them at _____ for further information.		

State of North Carolina Department of Environmental Quality
INTERGOVERNMENTAL REVIEW PROJECT COMMENTS

Reviewing Regional Office: Raleigh
Project Number: 21-0754 Due Date: 11/4/2020
County: Wake

Other Comments (attach additional pages as necessary, being certain to comment authority)

Division	Initials	No comment	Comments	Date Review
DAQ	MRF	☐	See checked boxes above	10/12/2020
DWR-WQROS	JSB	☐	See checked boxes above.	10/16/2020
DWR-PWS	SG	☐	See checked boxes above.	11/4/2020
DEMLR (LQ & SW)	CDA	☐	See checked boxes above	10/16/2020
DWM – UST		☐		/ /
Other Comments		☐		/ /

REGIONAL OFFICES

Questions regarding these permits should be addressed to the Regional Office marked below.

☐ **Asheville Regional Office**
2090 U.S. 70 Highway
Swannanoa, NC 28778-8211
Phone: 828-296-4500
Fax: 828-299-7043

☐ **Fayetteville Regional Office**
225 Green Street, Suite 714,
Fayetteville, NC 28301-5043
Phone: 910-433-3300
Fax: 910-486-0707

☐ **Mooresville Regional Office**
610 East Center Avenue, Suite 301,
Mooresville, NC 28115
Phone: 704-663-1699
Fax: 704-663-6040

☒ **Raleigh Regional Office**
3800 Barrett Drive,
Raleigh, NC 27609
Phone: 919-791-4200
Fax: 919-571-4718

☐ **Washington Regional Office**
943 Washington Square Mall,
Washington, NC 27889
Phone: 252-946-6481
Fax: 252-975-3716

☐ **Wilmington Regional Office**
127 Cardinal Drive Ext.,
Wilmington, NC 28405
Phone: 910-796-7215
Fax: 910-350-2004

☐ **Winston-Salem Regional Office**
450 Hanes Mill Road, Suite 300,
Winston-Salem, NC 27105
Phone: 336-776-9800
Fax: 336-776-9797

North Carolina Department of Natural and Cultural Resources

State Historic Preservation Office

Ramona M. Bartos, Administrator

Governor Roy Cooper
Secretary Susi H. Hamilton

Office of Archives and History
Deputy Secretary Kevin Cherry

November 9, 2020

MEMORANDUM

TO: Crystal Best
North Carolina State Clearinghouse
Department of Administration

FROM: Ramona M. Bartos, Deputy
State Historic Preservation Officer

RMB for Ramona M. Bartos

SUBJECT: Town of Fuquay-Varina Water Supply and Interbasin Transfer Project,
SCH # 21-E-0000-0754, Wake County, ER 20-2212

Thank you for your submission concerning the above referenced project. We have reviewed the materials provided and offer the following comments.

The effects of the proposed undertaking on archaeological sites will depend on the precise extent and depth of ground disturbance. Once this information is available, we request draft project plans be forwarded to this office for review and comment.

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, contact Renee Gledhill-Earley, environmental review coordinator, at 919-814-6579 or environmental.review@ncdcr.gov. In all future communication concerning this project, please cite the above referenced tracking number.

Agency Review Comments on Draft EIS, March 2023

ROY COOPER
Governor
ELIZABETH S. BISER
Secretary
RICHARD E. ROGERS, JR.
Director

NORTH CAROLINA
Environmental Quality

February 28, 2023

MEMORANDUM

FROM: Harold Brady, SEPA Review Coordinator - DWR – WPS

TO: Mary Sadler, Hazen

SUBJECT: Town of Fuquay-Varina –Interbasin Transfer request for water supply from the Cape Fear River to the Neuse River

The Division of Water Resources (DWR) has reviewed the initial draft Environmental Impact Statement (EIS) document and has the following comments,

Neela Sarwar (Modeling and Assessment Branch):

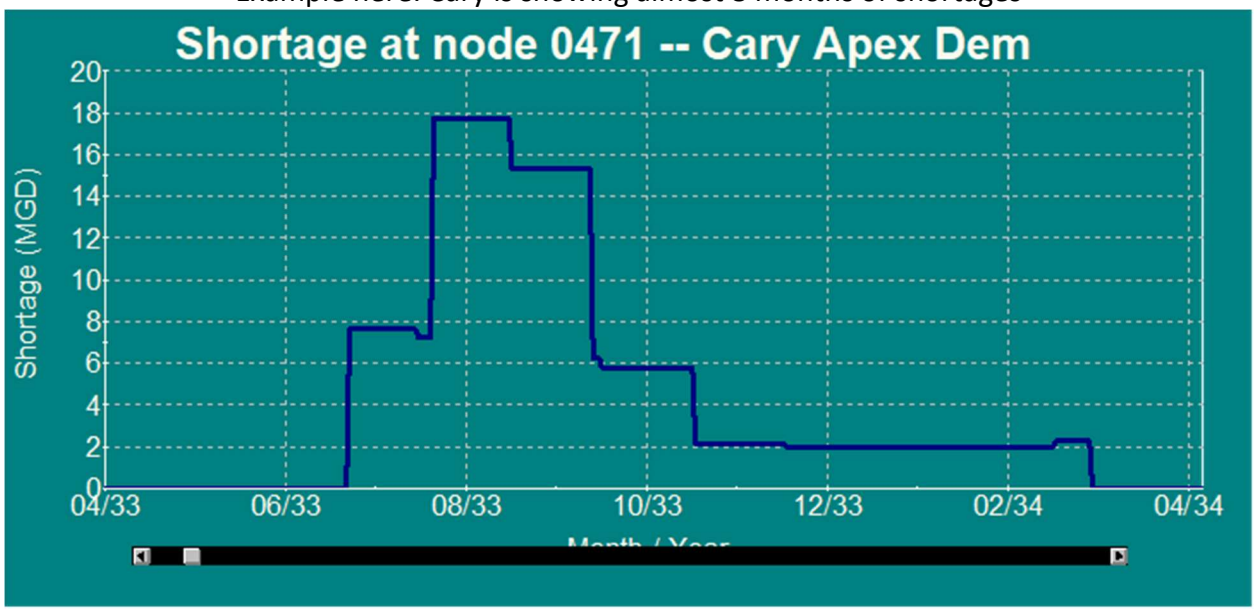
- Model Set up:
  - Raleigh Little River Reservoir (LRR):
    - Is Raleigh LRR still an option as a future source? In the model even though it said the connection is turned off, the max flow is set to 20 mgd from LRR to Raleigh. In the set up, the initial storage is set at 1851 AF. Therefore, it's delivering up to 20 mgd as needed and reducing stress on the other Raleigh sources. This might not impact the F-V IBT that much, but it's diverting flow from LR to Neuse River and ultimately flowing through Clayton Gage.

[from F-V IBT-2055 scenario OASIS NOTE: "And finally...turned off operations and set storage to 0 for Little River Reservoir since there is no guarantee this will be built. It was in there to meet the projected 2055 demand of 109 mgd for Raleigh"]

- Summary Table for Shortage Calculations:
  - The alternatives are simulated with drought plan on. However, the shortages shown in the table are calculated without drought plan. With drought plan, the systems without WSRP would show their regular shortages or no shortages anyway. Valid shortages in few systems [like Cary] shown in Table 3, Appendix C might create more questions.
  - Adding two more columns might give a different perspective of the shortage periods as is done for the climate change in Appendix C - Table 8
    - Longest duration (in days) of the shortage period.
    - No. of years impacted.

- Frequencies/stages of drought triggered.

Example here: Cary is showing almost 8 months of shortages



- Minor flow differences noticed.
  - Climate yr 7Q10 flows are little different (even though ~1 % difference) as I calculated in the post processor.
    - Appendix C Table 2.5. Example Alt 1 and 9A-B. [just checked randomly at few key points]. At Fayetteville, my 7Q10 values are 4.56 and 3.62 mgd more than the values in the table.
    - Fayetteville 7Q10 flow for 2055 is abruptly low from 2025: 351.7cfs down to 294.9 cfs for 2025/2055 where water withdrawals are 34.74 and 62.34 mgd, respectively. Please explain the declines.
    - Between Lillington gage and Fayetteville intake there are not many major withdrawals like Fort Bragg and Fayetteville; rather, there are few returns from upstream withdrawals plus three local inflow locations with one having a few days of zero flows. Could it be for cut back of flows thru Jordan Lake for higher drought stages?

<u>Shawn Guyer (Public Water Supply Section – Raleigh Regional Office):</u>
On Page 3-55. Section 3.11.1 Well Yield, The EIS states: "Per the Administrative Code, a minimum of a 100 by 100-foot area is required around every well for well point protection."

15A NCAC 18C .0203(a)(1) - The well shall be located on a lot so that the area within 100 feet of the well is owned or controlled by the person supplying the water. The supplier of water shall be able to protect the well lot from potential sources of pollution and to construct landscape features for drainage and diversion of pollution.

The rule specifies a 100’ radius, not a 100’ square.

Fred Tarver (Basin Planning Branch):

1. Does the OASIS model capture the proposed raw-water intake just downstream of the Haw/Deep confluence for the Moncure Megasite? This appears to be a reasonable expectation given the construction of the EV manufacturing facility in the next few years. There may be a cumulative impact on storage in Jordan to offset the combined deficits at the Lillington gage. Also, is a withdrawal from behind Buckhorn Dam of make-up water into Harris Lake included in the OASIS model? This would be a likely occurrence when the nuclear facility is expanded sometime in the future.
2. Pages 3-10, 3-19, 3-20. Table 3-8. Although a reservoir on Middle Creek is a rejected alternative, it is not prudent to be conjecturing on the flow release regime or the safe yield prior to any studies. A comparison to Lakes Benson and Wheeler on Swift Creek is not appropriate because, as mentioned in the document, a new flow regime on an existing reservoir cannot reduce the safe yield by more than 10 percent, according to the Dam Safety Rules. A hypothetical reservoir on Middle Creek would not be under such a restriction.
3. Page 5-28, Section 5.14.1. "For all stream crossings except the Cape Fear River, stream crossings will be performed by excavating an open trench, installing the transmission line, and backfilling the trench. Instream work will be performed in dry stream conditions, using a pump- around system or diversion as necessary. Transmission line crossings of the Cape Fear River and streams in which federally protected species or designated critical habitats are known to be present, if applicable, will be installed using trenchless technologies." All perennial streams should be crossed perpendicularly and using trenchless boring.
4. No mention is made in the document of the designation of the Cape Fear River as being in the Sustainable Rivers Programs (SRP), a cooperative partnership between the US Army Corps of Engineers and The Nature Conservancy. No mention is made of how the various cumulative withdrawals from the Cape Fear River will impact water quality storage and thus flow manipulations from Jordan to benefit downstream water quality and anadromous fish passage by the locks, which are associated with the SRP.
5. It is unclear whether water demand shortfalls downstream of the Lillington gage would be addressed by the water quality pool, as stated in the document, or by the water supply pool. Is this issue addressed specifically in operations protocols for Jordan?
6. Page 5-40. Typo at ninth bullet?
7. Tables 5-11 and 5-12. An accompanying table should be included in the document to present the number of days of the flow record that the benchmarks could not be attained, as well as the longest duration. Two percent may not seem like a lot but using a flow record of 33,000 days equates to 660 days.
8. Table 5-13 states "flow statistics" but does not indicate what flow statistic is being presented.

9. Although these low flows were pre-2008 they would represent Stage 3 or 4 drought conditions. I think it would be informative to model all the way downstream to L&D1 gage. It's unclear if Jordan has the capacity or will to make up flows in the Lower Cape Fear during these types of conditions. Where does the 600 cfs target come from for Fayetteville mentioned in the document? It would be interesting to see in the model whether the water systems could meet their demand during these flow events, whether or not they had WSRP in place. Perhaps the Annual 7-day minimum would be a good statistic to examine, in addition to the longest duration low flow value.

   02102500 CAPE FEAR RIVER AT LILLINGTON, NC -
   Water Years 1982 - 2021

Lowest daily mean	155.0	Aug 06, 2002
Annual 7-day minimum	206.3	Oct 09, 2007

   02105769 CAPE FEAR RIVER AT LOCK 1 NEAR KELLY, NC
   Water Years 1982 – 2021

Lowest daily mean	179.0	Aug 10, 2002
Annual 7-day minimum	322.7	Oct 13, 2007

<u>Nora Deamer (Basin Planning Branch):</u>

Section 3.8

Section 3.8 of this report captures many of the issues in both the Neuse and Cape Fear River Basins accurately. The Neuse River basin is NSW and Fuquay-Varina has a nitrogen allocation which they must meet in order to discharge their waste into any stream in the Neuse River Basin.

The Cape Fear River basin is not officially classified as NSW, but it has been recognized as being nutrient over enriched. A model is required before additional nutrients can be allowed into the segment of the river basin. The information provided about the latest water quality data is likely accurate but what was missing is that during periods of extended low flow, water quality conditions decline which results in high chlorophyll a concentrations. The latest water quality data doesn't include extended low flow conditions. It is also important to note that due to the water quality concerns in the central portion of the Cape Fear River basin, the Division is participating in a nutrient criteria development plan with the goal of understanding and potentially developing nutrient criteria for flowing streams. This could result in instream nitrogen and/or phosphorus concentration criteria as well as development of a different chlorophyll a criterion for flowing streams. It is recognized that the current chlorophyll a standard is not likely appropriate for flowing streams (would likely be less than 40 µg/L).

Communities in NC need to evaluate their resources prior to developing their long-term growth plans. At some point these resources can no longer support continued development. The

location of certain communities make growth more challenging. It needs to be recognized that in order to grow they will need to have in place the best available technologies to support their water supply and wastewater management needs.

Section 5.14.2

5.14.2.3

I believe this was also referenced in section 3.8.

On page 5-33 "Utilities seeking a new discharge are required to conduct independent water quality modeling to support the discharge request."

It should be noted that the Division completed data collection in 2020 and is currently working directly with the USEPA on a modeling effort of the central portion of the Cape Fear River Basin.

This work is scheduled to be completed at the end of 2023. At that point the Nutrient Criteria Development Plan (NCDP) process can use this model to establish if there is a need for instream criterion for N and P or other response variables (like Chl A). This information is needed prior to understanding what nutrient loading can be supported in the central Cape Fear River basin and allow for nutrient allocations, reductions, or other possible steps to address over enrichment in the Cape Fear River. This could lead to refinement of the permitting strategy, a specific watershed strategy to address all sources of nutrients to the basin, a TMDL or other voluntary and/or required measures.

Note: I did not verify the actual water quality findings. I don't think this is necessary. My comments indicate that during low flow periods there are serious water quality concerns and this is why we need to address nutrients in this section of the Cape Fear.

Forest Shepherd (Basin Planning Branch):

Comment #1:

The following statements are from the Environmental Impact Statement for Interbasin Transfer for Water Supply from Cape Fear River to Neuse River: *"The ILA with Harnett County is for the purchase of up to 2 mgd. The contract expires in 2040; however, the Town anticipates a contract renewal with Harnett County in 2040. Additionally, the Town has negotiated with Harnett County for an additional 2 mgd increase until 2035."* (pdf page 35; document page 1-3). Table 1-1 stating: *"The Town has negotiated an additional 2 mgd until 2035 (2022)."* (Table 1-1 image below).

This *"additional 2 mgd increase until 2035"* was not included in Tables 2-5, Table 2-6, and Table 3-1 (table images below). Specifically, this *"additional 2 mgd increase until 2035"* does not appear to be included in the "Water Supply Source By Seller, mgd" column of data under the "Harnett County (Cape Fear)" data column, any other columns of data, calculated values. Please consider including the *"additional 2 mgd increase until 2035"* comment throughout the

document when discussing the water supply available to the Town of Fuquay-Varina and including it in any calculations and tables.

Additionally, if an additional 2 mgd contract for water supply is available until 2035 from Harnett County, please consider obtaining that additional water supply and/or explaining why the Town of Fuquay-Varina is not pursuing it. It appears that additional 2 mgd would improve the Town of Fuquay-Varina's projected water supply deficit (Table 2-4). An additional 2 mgd from Harnett County would provide the Town of Fuquay-Varina with a total water supply of 4 mgd from Harnett County until 2035, instead of the 2 mgd as stated in the tables. If this additional 2 mgd can be obtain it will afford the Town of Fuquay-Varina a total water supply of 7.25 mgd instead of the current 5.25 mgd. This would provide the Town of Fuquay-Varina with a water supply that could potentially meet the Maximum Day Water Demand (Table 3-1) until at least 2030 and possibly into 2035; depending on future growth.

Comment #2:
Could you please provide a citation for the sentence: "The Round 4 allocation increased the total Jordan Lake allocation to 95.9 percent. Raleigh Water rescinded their 4.7 mgd allocation from Jordan Lake in March 2019 as a result of the Falls Lake Reallocation Process for additional storage in the Falls Lake reservoir. The revised Jordan Lake allocation is 91.2 mgd.".

Comment #3:
Related to these two statements:
"The Jordan Lake water quality storage never drops less than 20 percent in any alternative using either historic or climate change inflows. The water quality storage declines to less than 40 percent infrequently (e.g., less than 2 percent of the time)." "The two most concerning climate scenarios, there is a significant increase in the number of days with little or no additional runoff from the watershed area below the Lillington gage (e.g., no downstream flow gain). So, the combination of increased downstream demand, more severe drought scenarios, and cutbacks in the Jordan Lake release protocol under Stage 3 and 4 drought conditions combine to allow these brief shortages to materialize. It seems likely that with a significant volume of water left in the Jordan Lake Water Quality Pool, a change in policy and/or discretionary action by the USACE, in consultation with other stakeholders, would allow for additional releases to be made to meet these needs."

Could you please elaborate on what change in policy is expected and the timeline needed to fulfill that change in policy based on the statements above. Also, how would the discretionary action by the USACE, in consultation with other stakeholders, allow for additional releases and how long would that process take.

Comment #4:
In Table 3-21, Please explain why other municipalities (i.e. Chatham, Pittsboro, Siler City, and Holly Springs) will not be seeking water supplies from the City of Sanford.

Adrienne Weaver (Classifications and Standards Branch):
The information in Subsection 1.5.6 (Surface water reclassification) is correct.
The critical area and protected area definitions in that same subsection are correct.

Paul Clark (Water Supply Watershed Protection Coordinator, Stormwater Branch, Division of Energy, Mineral, and Land Resources):
Recommended edits to the fifth paragraph in Subsection 3.4.1 (Proposed Middle Creek Reservoir) to make it clearer and more accurate:

"A surface water reclassification process per 15A NCAC 2B .0100 and .0200 would be required to reclassify the Middle Creek watershed as a WS-IV water supply watershed. Similar to Alternative 1 (Purchase of Finished Water from Raleigh Water), a proposed reservoir would have a significant impact on the development potential of the Middle Creek basin. The critical area is a one-half mile buffer area as measured from the normal pool elevation. The protected area is 5 miles as measured from normal pool elevation. In the protected area, the low-density option limits impervious surface to 24 percent (or 20,000 square foot lot excluding roadway ROW or one dwelling unit per half acre for single family residential development. Only the 24 percent impervious cover measurement is allowed for non-residential and all other residential development. The low-density option allows for higher density (e.g., 70 percent) in 10 percent of a jurisdiction's service area. The WS-IV high-density option limits built upon area to 24 to 70 percent in the protected area; however, the jurisdiction must assume responsibility for operation and maintenance for engineered stormwater controls to handle the additional stormwater flow generated from greater impervious cover."

Recommend using "area" instead of "buffer" because buffer implies little to no development in this region. One can develop in the critical area associated with a water supply, but there are restrictions associated with the development.

Mark Durway (Groundwater Management Branch):
In summary, Hazen & Sawyer concludes that Fuquay-Varina would need a 9100 acre well field and 388 wells to meet its 2055 water demand of 8.4 mgd. The study is based on 1000-ft well spacing and average well yield of 30 gpm. Hazen & Sawyer notes that groundwater within the area is vulnerable to contamination and that a full-scale water treatment plant would be required for blending, softening, iron and manganese removal, chlorination, potential contaminant treatment and removal, etc.

If further evaluation of groundwater as an IBT alternative is warranted, the following is recommended:

1. Identify one or more potential wellfield locations. The well system and wellfield should meet DWR Public Water Supply siting requirements including Wellhead Protection Area standards. Discuss site suitability and projected well yield with the Wake County hydrogeologist and DWR Groundwater Management Branch staff.

2. Conduct a Phase I Environmental Site Assessment to identify areas of known or potential groundwater contamination which could affect water quality and availability and result in additional treatment requirements and operating costs. Identify how potential water system issues will be overcome, such as reduced well yields during drought.
3. Modify the proposed wellfield plan to include a DWR-approved Wellhead Protection Area and a wellfield expansion area should additional wells be required because of unforeseen water quantity and water quality issues.

Renee Kramer (NCDEQ Title VI and Environmental Justice Coordinator):

I think overall the EJ portion is well done, and I commend them for including such a section in the report. I have reviewed the EJ portion and have the following comments:

1. In the section 4.15.2, 50% threshold for low-income is the highest I have ever seen, and I think is too high to use. For example, we use 10% greater than the state or county levels to flag as the potential for impact. I believe they also use that comparison for other metrics, so it is unclear why they don't use that for low-income.
2. I want to make sure they are aware of the DEQ Community Mapping System and our potentially underserved community layer-that can be a great way to conduct maps and visually demonstrate potential EJ impacts of projects.
3. I also didn't see any portion about community outreach and if they plan to conduct any engagement in their identified underserved communities-they should outline some outreach plan to connect with those communities if there is opportunity for public input to shape or change the project outcome.

Vann Stancil (Research Coordinator, NCWRC Habitat Conservation Division):

In general, does this project present any cause for concern regarding the cumulative transfer of water from the Cape Fear to the Neuse or to any other river basin?

There is increased discussion about possibly removing Buckhorn Dam on the Cape Fear River. Some of the biggest concerns are the intake(s) within the impoundment above Buckhorn Dam. This might be a great opportunity to reconfigure Sanford's intake to ensure it is sustainable even if the dam is removed. The DEIS alludes to that somewhat, saying that they want to move it lower in the river, but the DEIS should be clearer that the intake is in the impoundment formed by Buckhorn Dam and future plans should not assume that the dam will always be there.

SPECIFICALLY ABOUT RARE SPECIES:

The list of species on page 4-26 is somewhat misleading. First of all, while NCWRC does do some stream surveys for fish, we are usually targeting certain rare species, not doing a fish community assessment. The community assessment of stream fish is more similar to the work of the Biological Assessment Branch of DEQ. Biological Assessment Branch | NC DEQ. In

addition, some of those species are only found much farther southeast, in the lower Coastal Plain of the Neuse or Cape Fear River basins. So, the list is somewhat misleading, not necessarily comprehensive, and not representative of the species found near the project.

It would be useful to include the type of taxa for species listed in Table 4-13 starting on page 4-33/173. It's confusing when the lists jumps around from fishes to birds, to mammals since they are alphabetical and separated only by vertebrates and invertebrates and vascular and non-vascular plants. I'd prefer headings for fish, mussels, crayfish, bats, mammals, etc., otherwise it is difficult to determine what some species are. In addition, it would be helpful to identify if aquatic species are found only in the Cape Fear or Neuse basin or both.

The list of state listed species includes some species that can be removed. While I do not know the background behind the record(s), the American alligator is not typically found in Harnett Co. so that record deserves further investigation. Robust redhorse should be removed, in NC they are only found in the Pee Dee River below Blewett Falls Dam. Therefore, I am not sure why Chatham Co. is included. The list should be checked again for any other anomalies or errors.

The descriptions of listed species starting on pages 4-45/185 are very generic. The descriptions would be much more useful if they focused on habitat and occurrence within NC and within the counties of concern here. For instance, Atlantic sturgeon is limited to our large coastal rivers below dams. They can move upstream to Falls Lake Dam, at least theoretically, but won't pass all 3 locks and dams or Buckhorn Dam on the Cape Fear River and won't be in tributaries to the Neuse or Cape Fear River. American alligators are coastal, a Harnett Co. record is anomalous. Neuse River waterdog and Carolina madtom are also endemic to the Tar River basin (not just the Neuse). There's little discussion about the distribution and habitat of the Atlantic Pigtoe, which is what is most useful to include. The Tar spiny description is more comprehensive and would be a good template to follow for other species.

On page 4-60/200 the authors talk about Significant Aquatic Endangered Species Habitats (SAESH) designated by the WRC. That is an old designation that we no longer use, therefore all references to SAESH should be removed. This would be a good place to include Critical Habitat (designated by the FWS) as applicable, instead. For instance, Middle Creek is Critical Habitat for Neuse River waterdog for approximately 7 miles as it flows from Wake to Johnston County.

The NHP's lists of rare plants and rare animals have been updated in their 2022 publication. The state status of some species has changed since the DEIS was written. [2022 Rare Animal List | NHP (ncnhp.org)]

If there are records for Federally listed species near the project, the US Fish & Wildlife Service will need to be consulted. If they believe a Federally listed species may be impacted by the project, they will issue a Biological Opinion and address take. That is not discussed or listed in the permitting section.

Shelton Sullivan (401 & Buffer Permitting Branch):

For any of the proposed options, an environmental assessment of the jurisdictional and non-jurisdictional streams, wetlands, waters, and riparian buffers is required to accurately depict the environmental features along with the proposed temporary and permanent impacts for DWR review and evaluation. These impacts from any of the proposed alternatives will require the coverage of a 401 Water Quality Certification, as per 15A NCAC 02H Section .0500, an Isolated Wetlands and Waters (non-404) Permit, as per 15A NCAC 02H Section .1300, and/or a Federally Non-jurisdictional Wetlands or Waters permit, as per 15A NCAC 02H Section 01400. In addition, if there are proposed temporary or permanent impacts within the regulated Neuse River Riparian Buffers, as per 15A NCAC 02B .0714, then these should be evaluated to determine if a Buffer Authorization should be sought and submitted to DWR for review and approval, as per 15A NCAC 02B .0611. Please note that the applicant must also obtain and comply with all applicable federal, other state, and local regulations regarding the construction and development of this project.

David Wainwright (Water Supply Planning Branch):

- In Table ES-4, and in other places in the document, the term "politically unacceptable" is used to describe a negative aspect of some alternatives considered, primarily those associated with Johnston County. After reviewing the document, the term is understood, but is probably not a good term to use, as without context it could be taken out of context and appear that the project is politically motivated. Perhaps something like "May not be acceptable to local government" or something similar would be a better way to phrase the argument.
- At the top of page 1-2, 01 North Carolina Administrative Code (NCAC) 25 .0100 is referenced as a SEPA rule. I can see why the reference to these rules was chosen. However, it may be more appropriate to reference G.S. 143-215 .22L(d), which specifically references the requirement of an EA or EIS for a proposed IBT project and the requirements of the document.
- The very last bullet item at the bottom of page 1-4 states "Interbasin transfers are explicitly exempt from Session Law 215-90. All interbasin transfers are required to submit environmental documentation for SEPA review." This statement is a little confusing, stating in the first sentence that IBT projects are exempt from SEPA then saying that they are required. Session Law 215-90 does not exempt IBT projects from SEPA; quite to the contrary. Section 7 of 215-90 (G.S. 143-215 .22L(d)) explicitly states that an EA or EIS for IBT projects is required.
- The purpose and need statement does not clearly define those aspects of the project. The purpose and need for any project needs to be explicitly and clearly stated as they define the project and are used to determine whether the alternatives should be carried forward for additional analysis as well as to what extent the alternative does (or does not) satisfy the purpose and need. For example, and simply stated, the purpose could be to provide additional drinking water to the Town of Fuquay-Varina; the need could be to address the anticipated growth, and hence water demands, within the Town's water service limits. By defining the purpose in such a manner, it allows each alternative to be compared to these – does the alternative provide additional drinking water to the

Town? Will the alternative provide enough water to supply future needs? These are yes/no questions that can easily compare each alternative and whether it meets the purpose and need of the project. The degree to which each alternative meets the purpose and need can further be used to discount alternatives – if an alternative does supply water but doesn't supply enough to meet the need then it can perhaps be discounted based on this. Part of the need could be to supply the Town with an additional 4.2 MGD by 2025 (and explain why this is necessary – the P&N section does not explain why 2025 is critical to having the water supply in place) and then discount certain alternatives because they cannot meet the stated need.

- In Section 5.14.2, with respect to wastewater discharges, it is stated that, "Direct and indirect permanent and temporary impacts as a result of the discharge of treated effluent will be negligible, as these impacts are addressed in an existing CWA permit." The additional wastewater discharge created because of the transfer of water is a direct impact resulting from this project and will likely not be a negligible impact; the increased discharge is being generated due to additional water supply being made available. The effects of the additional wastewater discharge to surface waters, water quality, wild and aquatic life, etc. needs to be taken into consideration and addressed and not just stating that it will be addressed through the NPDES permit, which will likely need to be amended to account for the additional discharge as a result of this project.
- On page 1-2 in Section 1.4.1, second paragraph, line five, "Ten Road" I think should be "Ten-Ten Road." Also, page 3-38, Section 3.7.3, paragraph 4, line 2, "Har" should probably be "Haw".

Louis Murray (Water Supply Planning Branch):

I have reviewed Sections 2 and 3 based on evaluating consistency with Fuquay's LWSPs.

Section 2. Purpose and Need

1. **Section 2. Purpose and Need/Population** – historic population numbers in Table 2-1 are consistent with those referenced in the LWSPs. However, the reported 5-yr moving average growth rates should be checked, as most look a little off; for example, annualized 5-yr ma growth rates for:
   2004 to 2009 = (8.53+7.86+0.95+0.94+0.93)/5 = 3.84% (not 3.78%);
   2012 to 2017 = (0.66+9.34+5.85+13.90+5.73)/5 = 7.10% (not 7.00%);
   2015 to 2020 = (13.90+5.73+6.70+4.00+7.74)/5 = 7.61% (not 7.56%)

2. **2.1.2 Population Projections** – the fourth paragraph states, "The percent of population served in the Neuse and Cape Fear River basins at build-out is approximately 62 percent and 38 percent, respectively. The ratio of anticipated growth in the Cape Fear and Neuse River basins is fairly consistent throughout the planning period." Just a **comment here -** the 2021 LWSP indicates a 50/50 service-area split between the Neuse and Cape Fear Basins, different than the 62/28 shown above. It is something to keep in mind when we assume a system's demand is proportional to the areal distribution in our Basin Water Quantity plans.

3. **Table 2-2. Population Projections** – projected populations in Table 2-2 are consistent with those reported in the 2021 LWSP.

4. **2.2 Water Demand Analysis** – the first paragraph reads, "Residential accounts contributed approximately 72 percent of the water use in the service area between 2015 and 2021." However, I get 66% if referring to the percentage of residential use to the total service-area demand.

"The number of residential accounts has increased an average of 5.5 percent per year since 2015." However, I get 6.6% per year if accounts are equated to metered connections.
"Residential use contributes 73 percent of the total water demand." Assuming reference to the most recent (2021) LWSP, I get 61% (1.714 mgd/2.791 mgd). If averaged over the six years from 2015-2021, I get 66%.
"Commercial use contributes 17 percent of the total water demand." Assuming reference to the most recent (2021) LWSP, I get 15% (o.407 mgd/2.791 mgd). If averaged over the six years from 2015-2021, I get 16%.

5. **2.2.1 Per Capita Demand** – the first paragrpah reads, "Since 2016, the residential per capita use is less than 54 gpcd." However, per capita demand averaged 56 gpcd in 2019.

"The sum of industrial and institutional per capita use has averaged approximately 4 gpcd over the last few years." However, I get 6.5 gpcd over the past four years.
3rd para – "The Town's percentage of non-revenue water has declined since 2016 at 13.8 percent to 7.6 percent in 2021**."** However, assuming non-revenue water includes system process use as indicated in this paragraph, I get 12.7% in 2016 and 7.6% in 2021 (Non-revenue water equals unaccounted-for-water plus process water).

6. **Table 2-3. Summary of total Water Billed and Purchased Water Per Capita Demand – the** footnote [2] at the bottom of this table defines 'non-revenue' water as "unaccounted-for water in Local Water Supply Plans (Section 5. Planning)." However, non-revenue water was earlier defined in this document to also include process water use.

I reviewed the data for years 2015 to 2021. If Total Billed water = Total Water Purchased - (process water + unaccounted for water), then the following corrections are needed:
2020: total water billed and purchased should be 2.173 mgd and 2.517 mgd, respectively.
2019: total water billed and purchased should be 2.253 mgd and 2.478 mgd, respectively.
2018: total water billed and purchased should be 2.067 mgd and 2.306 mgd, respectively.
2017: total water billed and purchased should be 1.949 mgd and 2.186 mgd, respectively.
2016: total water billed and purchased should be 1.864 mgd and 2.136 mgd, respectively.
2015: total water billed and purchased should be 1.822 mgd and 2.008 mgd, respectively.

I would suggest also reviewing years 2002-2014. Changes likely needed here also.

7. **Table2-4 Summary of Annual Average, Max Month, and Max Day Water Demand Projections**

Correction needed – 2050 max monthly demand should be 8.9 mgd. All other values are correct and consistent with 2021 LWSP.
Suggest revising footnote [1] to indicate that the projected populations are consistent with those in the 2021 LWSP. For example, "[1] Population projections from linear best fit regression method used for the 2021 Local Water Supply Plan."

- **2.3 Interbasin Transfer Projections –** first paragraph indicates that "Post 2049, all of the Town's water supply will originate from the Cape Fear River basin (2-3). The maximum month transfer in 2055 is anticipated to be 6.13 mgd. The maximum day transfer amount is anticipated to be 7.8 mgd. By 2055, approximately 12.6 mgd of water supply will be required to support peak day needs." However, the 2021 LWSP indicates future purchases from Sanford at 11.0 mgd (avg. day) by 2055 which, using the previously referenced max month and max day peaking factors of 1.18 and 1.5, would equate to a max month supply of 13.0 mgd and a max day supply of 16.5 mgd, amounts greater than those referenced here. Please explain.

9. **2.4 Summary of Purpose and Need –** revise first paragraph to indicate the current population is now over 34,000 people.

Section 3. Alternative Analysis

10. **3.1 No Action** – Fuquay's 2021 LWSP does not show an additional supply of 2.0 mgd coming from Harnett County until 2035 as mentioned in the first paragraph (maybe I am misreading this?).

11. **Table 3-2.** Sale agreement with Franklin County is not shown in Raleigh's 2021 LWSP (maybe it was not finalized in time to include it).

12. **3.2.1 Existing Water Supply and Treatment Infrastructure** – the third paragraph indicates a safe yield of 84 mgd for Falls Lake but Raleigh's 2021 LWSP shows a 50-yr safe yield of 88.2 mgd. The 5th paragraph indicates a capacity of 20 mgd for the Dempsey Benton WTP but the LWSP shows 16 mgd.

13. **3.3.4 Summary** -- first paragraph reads "Johnston County is unlikely to accept a new wholesale customer or water supply partner. The County's continued long range water supply planning effort has identified a potentially feasible alternative that will satisfy the 2050 water supply deficit in the County's service area. ***The identified alternative will not yield sufficient water supply capacity for additional wholesale customers or water supply partners, including the Town of Fuquay-Varina***. However, this alternative was carried forward in the EIS for an environmental impact analysis". **Agree. Johnston County's 2021 Plan, still unapproved, shows a demand-to-supply ratio of 82% by 2030 and 86% by 2040.**

14. **3.5.1. Population and Water Demand Projections for City of Dunn –** the first paragraph states that the average day water demand in 2050 is 5.9 mgd. However, Table 3-10 below (as well as the LWSP) indicate 4.85 mgd.

15. **3.5.3 Cape Fear River Instream Flow Characterization at Dunn –** first paragraph reads **"**A 7Q10 value near Dunn is not documented in the 1998 USGS report. However, DWR published a Cape Fear River Basin Water Supply Plan (2002) that estimated the available water withdrawal at Dunn to be **69.8** mgd." What does 'available' water withdrawal mean? Wondering how this was defined in DWRs report. It is much greater than the 12.0 mgd shown in the LWSP as the 20-yr safe yield.

16. **Table 3-20 Summary of City of Sanford Wholesale Water Sales Contracts –** the City sold approximately 0.87 mgd **(not 0.83 mgd)** of bulk finished water out of a total contract amount of 2.3 mgd in 2021, excluding emergency use contracts. Also, the avg. day sale to Chatham County (Asbury) in 2021 was 0.445 mgd, not 0.401 mgd.

17. I briefly reviewed the twelve alternatives and, based on my very limited knowledge of the specifics, feel comfortable with the rationale used to accept some while rejecting others. Other than no action, the GW alternative is one of the more obvious rejections.

Vardry Austin (Water Supply Planning Branch):

EIS Page 2-4 and Appendix A – Page 13:

- In the first bullet, commercial accounts should be 7.4 percent.

EIS Page 2-5:

- In the third paragraph, correct the percent of commercial accounts to 7.4 percent of total accounts.

EIS Page 3-69:

- Fifth paragraph, commercial accounts should be 7.4 percent.

Appendix A – Table 4:

- Correct the LWSP population for 2019

Appendix A – Table 8:

- Correct UAFW per capita demand as noted in the LWSP

Appendix A – Table 9 and EIS Table 2-3 (as appropriate):

- Revise total water billed and total water purchased to calculate non-revenue water (unaccounted-for water) as shown in the LWSP
- Complete table for non-revenue water for 2021
- Change heading for non-revenue water to read MGD

Appendix A – Table 11:

- Correct the maximum month water demand for 2050

EIS Page 3-27:

- Section 3.6.1 states the county's average day withdrawal in 2020 was 19.93 mgd with a maximum day of 27.85 mgd. Confirm the source of these numbers since they are not in the 2020 LWSP.

EIS Page 3-49:

- The third paragraph states the average day water demand in 2021 for Sanford was 6.4 mgd with a maximum day demand approaching 12 mgd. Confirm the source of these numbers since they are not in the 2021 LWSP.

Harold Brady (Water Supply Planning Branch):

Executive Summary

1. Cover Page: Need to state that this Draft EIS document has been written for NCDEQ – Division of Water Resources. "Completeness review" language should be removed before issuance of the draft for public review.
2. Back Cover Page: Replace "River Basin Management" with "Water Supply Planning"
3. Executive Summary, ES.1, second paragraph, second sentence: Consider opening with, "Per GS 215-143.22G,"
4. Executive Summary, ES.1, second paragraph, last sentence: Consider referencing this location on a map, as well as identifying the HUC number.
5. Executive Summary, ES.2, second paragraph, first sentence: Consider adding that Harnett County is the Town's current primary water supplier. The use of "temporary" is questionable, considering nearly all water supply purchase agreements are time-limited, including the ILA with Harnett County. Perhaps provide an explanation that these will not be renewed. Please include any documentation from the sellers regarding this issue. Please revise accordingly throughout the document.
6. Executive Summary, ES.2, second paragraph, third sentence: Need to describe the proposed project or preferred alternative before stating that an IBT is necessary.
7. Executive Summary, ES.2, third paragraph, third sentence: Include, "met or" between "is" and "exceeded".
8. Executive Summary, ES.2, third paragraph, fifth sentence: Change "amount" to "amounts", as there are multiple contract amounts.
9. Executive Summary, ES.3, second paragraph, first sentence: Replace "will support the" to "has been prepared for". Add, "as part of the" between "(DEQ)" and "decision-making".
10. Executive Summary, ES.3, second paragraph, last sentence: Please double-check the Administrative Code SEPA citation. Please also reference, GS 113-A, making specific note of its various subsections depending upon the subject throughout the draft document.
11. Executive Summary, Table ES-2: Include the definitions of footnotes on every page that they are used. This should be done throughout the document. The portion of table with no information on page vi should be deleted.
12. Executive Summary, ES.5, first paragraph, last sentence: These qualifiers will need to be quantitatively defined for each impact type throughout the document.

13. Executive Summary, ES.6, second paragraph, fifth bullet: Need to note specifically what the noted impacts are for downstream water users. Please ensure that the 99.9% value is not misleading. Furthermore, the four downstream water users noted are following the statutory requirements for Water Shortage Response Plans (WSRP). The document should contain an analysis (i.e., post-process) of potential impacts to those water systems whose WSRP triggers are not in the model to fully evaluate all potential impacts.
14. Executive Summary, ES.6, second paragraph, eighth bullet: Please provide the value or a quantifiable definition for “nominal”.
15. Executive Summary, ES.6, second paragraph, ninth bullet: Please explain the context and importance of this statement.
16. Executive Summary, ES.6, second paragraph, tenth bullet: Please cite the source for the 600 cfs flow target at Fayetteville.
17. Executive Summary, ES.6, fourth paragraph: Need to note the specific withdrawal amounts from the City of Sanford intake that are used in the model runs.
18. Table ES-3: All qualifiers need to be defined, quantitatively, if possible, otherwise the determinations are entirely the author’s discretion. All footnotes used on the page should defined on each page throughout the document.
19. Executive Summary, ES.6, first paragraph, fourth sentence: Limiting the available alternatives to only those that can fully achieve the 2055 (study period) project goals by 2025 is an overly restrictive consideration to the other alternatives. Due to this proposal coming to the DEQ so close to this “deadline”, the applicant may need to resolve the short-term maximum day demand issues outside of the proposed long-term IBT project.
20. Executive Summary, ES-6, Table ES-4, Alternative 5: Explain why there is no alternative that proposes expansion the Harnett County WWTP beyond the 6.0 mgd under the current long-term ILA.
21. Executive Summary, Table ES-4, Alternative 8A/B: This would have been a regional solution had the City of Raleigh been considered a partner in developing this alternative as originally discussed in Feb. 2020 with the applicant. This alternative was initially discussed with the applicant in terms of the proposal that the City of Raleigh provided to the DEQ during the Round 4 Jordan Lake Allocation process, in which the City of Raleigh proposed withdrawing water, from their proposed Jordan Lake allocation, from the Cape Fear River and returning all but 2 mgd; thereby avoiding issuance of an IBT Certificate.
22. Executive Summary, Table ES-4, Alternative 12: Consider clarifying that the Town’s water conservation measures/plan must meet or exceed those by other water systems in the Cape Fear River (source) basin. The document states that the IBT projections account for water conservation; however, these measures need to meet or exceed the most stringent measures by other water systems in the Cape Fear (source) basin to fully account for this alternative to not be viable.
23. Global: Consider embedding all maps and figures where the discussion of the topic first occurs, instead of in the back of the document.

Section 1.0

24. Section 1.4: The document needs to address the practicality and logistics of avoiding an IBT Certificate request, by utilizing the existing collection system to route flows toward the North Harnett WWTP instead of Terrible Creek WWTP. Consider providing information related to any improvements to the collection system that routed greater flows toward Terrible Creek WWTP, particularly those activities that occurred after issuance of the NOI. Where this information is presented in the document is left to the authors discretion.
25. Section 1.4.2, second paragraph, last sentence: Need documentation from Harnett County as to their interest in a cooperative expansion of the North Harnett WWTP. Also, the document needs to define the constrictive element to the 6 mgd "carrying capacity" of the interceptor line and what would be entailed in expanding that line. Perhaps this would best be addressed as an additional alternative.
26. Section 1.5.1, second paragraph: Please review this entire paragraph for accuracy avoiding misconstruing the statute. 1) The Session Law is 2015-90. 2) This session law does not modify the Administrative Rules 15A NCAC 01C, rather it added specific thresholds in statute, needed to be met before a SEPA document would be required for specific projects. 3) The statute includes more context and requirements to the third bullet than provided in the document. 4) The Session Law includes considerable language regarding IBTs; therefore, the subject and associated projects should not be characterized as "exempt".
27. Section 1.5.4, second paragraph: Please explain the relevance of this subject to the proposed project.
28. Section 1.5.8, first paragraph, first sentence: The statute referenced compels the Department to develop hydrologic models with approval and modification responsibilities granted to the Commission. Please correct accordingly.

Section 2.0

29. Section 2, second paragraph, second sentence: Based on the most recent data presented the population growth rate based on the previous 5-year average is 5.5%, not 7%. Please correct accordingly. This change appears to be consistent with the 1st paragraph in Section 2.2.
30. Section 2.1.2, second paragraph, last sentence: Please explain the population of 17,500 that are unserved in the service area. How the value was determined and generally why they are currently not served.
31. Section 2.1.2, fourth paragraph, third sentence: Please provide details/estimates for the service population growth over the next 5-7 years, describing both the population currently unserved in the service area and the anticipated new residential growth in the service area.
32. Section 2.1.2, fifth paragraph, eighth sentence: Please consider providing a demonstration for how the linear best fit method is consistent with the TAZ build-out projections, particularly considering that the population is projected to nearly double in this relatively short time period.
33. Section 2.1.2, fifth paragraph, sentences 10 and 11: It appears that these sentences saying the same thing. Please explain the differences between these two sentences.

34. Section 2.2.1, last paragraph, last sentence: Please explain why the Town expects no reductions in the per capita demand over the planning period. Considering that the past 5-year per capita average (2017-2021) is 79.5 gpcd, please explain why 80 gpcd isn't a more reasonable, yet still conservative, per capita value when estimating long-term demand growth. NCGS 143-355(l) compels water systems to provides plans for reductions in per capita water demand. The historic record provided by LWSPs are our most commonly used method to provide a check on demand projections; however, over the past 15 years the Town has consistently not provided the necessary information to approve their LWSPs or not provided the maximum daily values in the monthly table, critical for IBT calculation of average day maximum month statistic. Therefore, the DWR is left with limited means to adequately validate the historic demands presented in this document. Below is an account of the status of the Town's LWSPs since 2007.
    - 2007: not submitted
    - 2008: not submitted
    - 2009: incomplete
    - 2010: incomplete
    - 2011: incomplete
    - 2012: approved
    - 2013: incomplete
    - 2014: incomplete
    - 2015: approved (no max day values)
    - 2016: incomplete
    - 2017: approved
    - 2018: approved
    - 2019: incomplete
    - 2020: approved
    - 2021: approved (no max day values)

35. Section 2.2.2, first paragraph, sixth sentence: Please explain why Harnett County's peaking factor was used instead of data from the Town of Fuquay-Varina.
36. Section 2.2.2, first paragraph, seventh sentence: Please present the data with the names of the communities used to make this maximum day calculation.
37. Table 2-4: Please double-check the 2050 Maximum Month Water Demand value.
38. Section 2.3, first paragraph, eighth sentence: Throughout the document, please ensure that the language is clear regarding the statistic, average day over the maximum month, instead of simply maximum month.
39. Section 2.3, first paragraph, last sentence: Consider providing clarity that this is for system-wide demand.
40. Section 2.3.1, first paragraph: Please provide a citation for this definition for consumptive use. The DWR water supply planning branch uses the term "consumptive" demand as the portion of the demand that is not collected into a centralized wastewater system, primarily lost to the ground in various ways. Based on this, please clarify what the 17.5% represents.

41. Section 2.3.1, second paragraph, third and fourth sentences: Please clarify, is the author referencing HUC boundaries and state IBT boundaries? A map embedded with the discussion would be very helpful.
42. Section 2.3.1, second paragraph, fifth sentence: Please explain where the Town directly discharges to the Neuse River.

Section 3.0

43. Section 3.1, first paragraph, first sentence: For ease of reading, please consider spelling out acronyms that haven't been used in several sections throughout the document. Also, ensure that all acronyms are appropriately defined throughout the document.
44. Section 3.1, first paragraph, third sentence: Please consider including correspondence with Harnett County to avoid expectations or assumptions when discussing alternative selections.
45. Section 3.1, first paragraph, last sentence: Please consider including correspondence with Raleigh to avoid expectations or assumptions when discussing alternative selections.
46. Table 3-1: Consider including the current year or 2020 to provide context for the starting point of the projections. Please clarify what the positive or negative values represent. As presented, it appears there is a 1.02 deficit in 2025.
47. Table 3-2: Consider including totals.
48. Section 3.2.1, fourth paragraph, fourth sentence: Consider including "targets" following "instream flow", as these are targeted flows, that can be reduced or not met, as needed.
49. Section 3.2.1, fifth paragraph, first sentence: Please explain the "source" or the "storage" that is located at the intersection of the two roads.
50. Section 3.2.1, fifth paragraph, fifth sentence: Please provide a citation and the lead agency involved in the Biological Opinion.
51. Section 3.2.1, fifth paragraph, last sentence: Please provide the year of the drought of record for this site.
52. Section 3.2.2, first paragraph, fourth sentence: Consider replacing, "will" with "is projected", as these are values projected into the future that lack certainty. Likewise, consider adding "projected" between "combined" and "2050".
53. Section 3.2.2, first paragraph, fifth sentence: Please explain further.
54. Section 3.2.2, first paragraph, last sentence: Please state if this is based on current demand.
55. Section 3.2.2, second paragraph, last sentence: Please explain why the 25th percentile is used.
56. Table 3-3: Please explain why the total average day demand is less than the average day service area demand in 2021 and then again in 2060.
57. Section 3.2.3, first paragraph, last sentence: Consider replacing "suggested that" with "compelled", as it was the environmental review process that necessitated an alternative analysis.
58. Section 3.2.3, second paragraph, second sentence: Please provide a citation for this statement.

59. Section 3.2.3, fourth paragraph, third sentence: Please provide the value and citation for Raleigh Water's referenced current allocation in Jordan Lake.
60. Section 3.2.3.2, first paragraph, third sentence: The second paragraph in Section 3.2.3 states that the reallocation of Falls Lake would satisfy the City's demands for 30 years; however, this sentence states that demands will exceed supply in 25 to 30 years. Please clarify.
61. Section 3.2.3.2, second paragraph, first sentence: Consider adding "The Town of" at the start of the sentence.
62. Section 3.2.3.2, sixth paragraph, last sentence: Consider stating the county where the dam will be located as well as the county(s) where the impounded waters would be in.
63. Section 3.2.3.2, seventh paragraph, first sentence: Without maps embedded in the document where the discussion occurs it is difficult for the reader to visualize these types of topics.
64. Section 3.2.3.2, eighth paragraph, fourth sentence: Please consider stating that the minimum release was assumed for the purposes of estimating yield, and please provide a source or methodology for these proposed minimum flow rates.
65. Section 3.2.3.2, eighth paragraph, fifth sentence: Please replace "developed" with "revised".
66. Section 3.2.3.2, ninth paragraph, fifth sentence: Please consider replacing "defacto reuse" with "guidance", as this common situation is not generally viewed as "reuse" water since the treated waters have been discharged into a flowing body of water.
67. Section 3.2.3.2, ninth paragraph, sixth sentence: Likewise, from the previous comment, please consider changing the statement "recycle loop" as it suggests that the treated waters are not being discharged into a body of water, but directly "recycled" by another water system. "Inputs" seems like an acceptable replacement.
68. Section 3.2.3.2, ninth paragraph, last sentence: Consider avoiding the term "returned" as most of this treated wastewater originated in the Cape Fear River Basin, not the Neuse River Basin.
69. Section 3.2.4, second paragraph: Consider acknowledging that the alternative does satisfies the long-term demands for the Town. The Town's lack of long-term planning years ago should not be the burden of the lead agency to select a preferred alternative solely because it will take too long to fully meet the defined long-term purpose and need. If this is the situation, then a short-term solution may need to be initiated while the long-term solution is evaluated, permitted and instituted.
70. Section 3.3, second paragraph, first sentence: Please state if this is based on average day demand or other statistic or time scale.
71. Table 3-5: Considering that 4 water systems are regular purchasers of water without a contract amount, please explain the accuracy of 8.5 mgd.
72. Section 3.3, third paragraph, last sentence: Consider including a tabular breakdown of the 7.0 mgd in 2050 in Table 3-6.
73. Section 3.3.1, first paragraph, fourth sentence: Please consider avoiding the term "allocated" in this context. DWR has not allocated a specific amount of guaranteed water supply to Johnston County.

74. Section 3.3.1, first paragraph, last sentence: This sentence could be confusing to a reader as it lacks context that the projected plant discharges have been effectively subtracted from the 20% of the 7Q10 withdrawal limitation.
75. Section 3.3.2, second paragraph, fourth sentence: Please explain why the use of groundwater presents correlation issues.
76. Section 3.3.2, third paragraph, last sentence: Please consider including the projected demands of the ECIA developed by the Town and County.
77. Section 3.3.2, fourth paragraph, fourth sentence: Please consider including the projected growth rate between 2040 and 2050.
78. Section 3.3.2, fourth paragraph, last sentence: Recommend ending with “demands”.
79. Section 3.3.3, first paragraph, third & last sentence: These sentences appear to say the same thing, please explain any differences.
80. Section 3.3.3., second paragraph, last sentence: Please include the entire citation for the second general statute referenced.
81. Section 3.3.3.2.2, second paragraph, first sentence: Please consider adding, “option” or a similar word following “Richardson Bridge Road”.
82. Section 3.3.4, second paragraph, last sentence: Please double-check this statement to ensure accuracy.
83. Section 3.4.1, second paragraph: Please refer to comments #66, 67, & 68 and make appropriate corrections.
84. Section 3.4.2: Consider acknowledging that the alternative does satisfies the long-term demands for the Town.
85. Section 3.5, first paragraph: Please ensure clarity throughout the document that the subbasins mentioned referred to IBT defined basins to avoid confusion with HUC unit basins.
86. Section 3.5.1, first paragraph, fifth sentence: Please consider explaining the relevance of this statement.
87. Section 3.5.1, first paragraph, sixth & seventh sentences: Please ensure that the values presented are consistent with the values presented in Table 3-10. Please provide explanations for any differences in calculation.
88. Table 3-10: Please explain the fluctuating projected sales values (i.e., increasing, decreasing, and increasing again). The total demand in 2060 appears to be different based on the other values presented. Please ensure that the methodology for calculating peaking factors (i.e., previous 5-year average) are consistent throughout the document.
89. Section 3.5.3, first paragraph, first sentence: Please explain which portion of the Administrative Rule requirements are being referenced.
90. Section 3.5.3, fourth sentence: It is advisable that alternative analysis decisions should not be made based on environmental field data over 20 years old, particularly when more recent data is readily available or could be calculated.
91. Section 3.5.3, first paragraph, fifth sentence: Please use caution with use of the term “allowable”, as there is no specific water withdrawal permitting in this portion of North Carolina, and the referenced Administrative Rule allows for withdrawals greater

than the referenced statistic (not mentioned in this discussion) through site-specific investigations.

92. Section 3.5.3, first paragraph, last sentence: When mentioning “water withdrawal” is this a reference to available capacity?
93. Section 3.5.4, first paragraph, third sentence: Please define “re-rate” in this context.
94. Section 3.5.4, third paragraph, first sentence: Please explain what is meant by “re-rate for capacity recovery”.
95. Section 3.5.4, sixth paragraph: Please state if construction of a terminal raw water reservoir part of the proposed package for this alternative.
96. Section 3.6, second paragraph, second sentence: Please state if this breakdown represents the “service” population. If so, please consider also providing the demand percentages.
97. Global: Ensure that footnotes from tables presented have the referenced footnotes on every page they are used.
98. Section 3.6.1, first paragraph, fourth sentence: Please consider stating that the discharges are allowed through the issuance of an NPDES permit, instead of “via”.
99. Section 3.6.1, first paragraph, fifth sentence: Please explain the relevancy of this information.
100. Section 3.6.1, first paragraph, sixth sentence: Please state by type, name and number which permit is referenced. There are no specific water withdrawal permits in this part of the state. Please consider including a copy of the “permit” in the Appendix.
101. Section 3.6.2, first paragraph: Comments #89, 90, & 91 are also applicable to this paragraph. Please correct accordingly.
102. Section 3.6.2, second paragraph: Please consider providing documentation from the USGS if this revised 7Q10 calculation has been verified. Please provide relevant information from the EA and associated FONSI prepared for the Harnett County 42 mgd WTP expansion.
103. Section 3.6.3, first paragraph, last sentence: Provide an explanation for the 1.5% annual growth factor.
104. Global: Ensure the document is consistent when referring to Towns and Cities, that these entities should be referred to as the Town of… or the City of…
105. Section 3.6.3, second paragraph, fifth sentence: Please explain why this analysis is being conducted with TAZ data instead of using the full contract amounts as presented in the LWSP, as was done for all other similar analyses.
106. Section 3.6.3, fourth paragraph, third sentence: Table 3-12 appears to suggest that the annual growth rate between current and 2030 is 1.48%, not 1.34%. Please explain or correct.
107. Global: Ensure the document is consistent with use of significant digits.
108. Section 3.6.3, fourth paragraph, sixth sentence: It is important to note if the EA and associated FONSI from the Harnett County WTP expansion provide any details to future expansion.
109. Section 3.6.3, fourth paragraph, sixth sentence: Please explain if the “planning numbers” referenced related to the values presented in Table 3-12 or are they from the “Master Plan”. If they are from the “Master Plan”, please provide these values and

provide explanations if they are significantly different to the values presented in Table 3-12.

110. Table 3-12: Please provide an explanation for the large jump in demand between 2021 and 2030 as compared to the other years.
111. Section 3.6.4, second paragraph, first sentence: Please explain the contracted amount of 23.9 mgd, in context with the reported contract amounts of 10 mgd for the Town of Holly Springs and 2 mgd to the Town of Fuquay-Varina in 2040. Please provide details and what is meant by the "Northwest and East Central Pressure Zones", as this is the reference in the document.
112. Section 3.6.4, second paragraph, second sentence: Is this a "firm pumping" capacity as stated in the proceeding sentence, or is this the capacity to meet the contractual amounts?
113. Section 3.6.4, third paragraph, first sentence: Please provide a date or state if this demand is through the planning period.
114. Section 3.6.4, fourth paragraph, second sentence: Table 3-12 references 2021 LWSP projection data; however, this sentence references 2020 LWSP projections. Please explain the differences and why both years are used in the analysis. The 2021 LWSP shows that Harnett County can meet projected demands and contractual operations well beyond 2040, without an expansion of the existing WTP. This is achievable through development of a proposed 10 mgd WTP near the Town of Erwin. This document should discuss the proposed WTP and how that might provide additional capacity in the existing Harnett County WTP.
115. Section 3.6.4, fourth paragraph, last sentence: Please provide details regarding the required improvements to the distribution system and raw water intake and how these would differ from other alternatives presented.
116. Section 3.6: Please include any correspondence from Harnett County detailing their position to provide additional water supply capacity to the Town of Fuquay-Varina. Similarly, the document needs to include any correspondence with Harnett County regarding their position regarding an expansion of the North Harnett WWTP beyond the 6 mgd expansion in an existing ILA. The best location for this information is left to the authors discretion (i.e., Sections: 3.6, 3.8.2.1, 3.10).
117. Section 3.6.5, first paragraph, first sentence: It has not been demonstrated that merely continuing the purchase of water from Harnett County would necessitate an IBT. Please consider rewording or strike from the document.
118. Section 3.6.5, second paragraph, first sentence: Table 3-11 only depicts a contractual amount for the Town of 2 mgd ending in 2040; however, this sentence suggests there is a new ILA that provides an additional 2 mgd (total of 4 mgd) that ends in 2035. This needs to be clarified throughout Section 3.6.
119. Section 3.6.5, second paragraph, second sentence: Please provide any information/documentation regarding Harnett County's position on continuing the ILA signed in 2022 for the additional 2 mgd.
120. Section 3.6.5, third paragraph, second sentence: Please consider providing context to this sentence, that this extremely high jump in demand is because the full contract

amounts are used to estimate projected demand and that in actuality this demand is highly unlikely, but obligations exist.

121. Section 3.6.5, third paragraph, third sentence: This appears to be in conflict with the preceding sentence, that the demands will decrease to 42 mgd in 2040 from 43 mgd in 2030. Please consider including a table that details the projected demands in ten-year increments for each purchaser and total system for Harnett County.
122. Section 3.7.1.1, second paragraph, second sentence: Please consider providing context to “water supply storage” to avoid a misinterpretation that the State of North Carolina owns all of the water backed up by Jordan Lake. A diagram or figure might be helpful.
123. Section 3.7.1.1, second paragraph, fourth sentence: Please consider adding “allocation” following “water supply”.
124. Section 3.7.1.1, second paragraph, sixth sentence: Please consider rewording the statement that the minimum release from Jordan Lake is “no less than 40 cfs”, particularly before stating the minimum flow target under normal conditions.
125. Section 3.7.1.1, second paragraph, seventh sentence: Please include that the minimum flow is plus or minus 50 cfs from the published minimum flow target. Please consider providing the minimum release target schedule for drought or low-inflow conditions.
126. Section 3.7.1.1, second paragraph, eighth sentence: Please provide a citation and date range for this statistical calculation.
127. Section 3.7.1.1, third paragraph, first sentence: Please define what is meant by the “conservation storage” and how that relates to the aforementioned water quality pool and water supply storage. A graphic may prove helpful.
128. Section 3.7.1.1, third paragraph, second sentence: Please clarify whether “conservation storage” is intended or “water supply storage”. Please be consistent with this language. Please consider stating that the water supply pool is a percentage-based calculation. For simplicity purposes, it is often discussed as 100 mgd; however, the actual yield is estimated to be higher than that. The Round 4 Allocation document may provide a reasonable explanation to be included and referenced. Please ensure any corrections are made throughout the document for consistency.
129. Section 3.7.1.3, first paragraph, first and second sentences: Please provide a citation for these statements.
130. Section 3.7.1.3, second paragraph, last sentence: Please provide a citation for this statement.
131. Section 3.7.1.3, third paragraph, sixth sentence: To meet the purpose of this document, impacts to recreation, including boating, in Jordan Lake needs to be evaluated quantitatively.
132. Section 3.7.1.3, third paragraph, seventh sentence: Please provide a citation for this statement or state that this evaluation was conducted for the purposes of this project.
133. Section 3.7.1.3, fourth paragraph, first sentence: Please consider replacing “an increase” with “a revised”, as the reallocation process is not necessarily initiated to simply increase the allocations. Please note, the EMC did not entirely support the recommendations from the DWR; therefore, the last statement is misleading.

134. Table 3-13, footnote 1: Please explain what is meant by “OWASA is a supporting partner”.
135. Section 3.7.2, second paragraph, third sentence: Please consider being explicit regarding which town is being discussed. Throughout most the document “The Town” refers to the Town of Fuquay-Varina.
136. Section 3.7.2, third paragraph, second sentence: Please explain why this alternative requires a new raw water intake in Jordan Lake. Please explain why this or another alternative is not considering purchasing the water from the Town of Cary.
137. Table 3-14: For this table to have value to the document, the contract amounts and expiration dates need to be completed, please consider contacting the water systems to determine these values.
138. Table 3-15: Considering that there is only one value presented, the value of this table is questionable.
139. Section 3.7.2.1, first paragraph, fifth sentence: Please consider adding “River Basin” following “Neuse”.
140. Global: For consistency, please consider including the IBT basin codes for all references to IBT river basins or HUC basin codes for hydrologic river basins throughout the document.
141. Section 3.7.2.1, first paragraph, last sentence: Please consider providing an explanation of the formula for required returns to the Cape Fear Basin through the Western Wake WRF, based on the Cary/Apex IBT settlement agreement.
142. Section 3.7.2.2, first paragraph, last sentence: Please explain what is meant by “build-out” in this context.
143. Section 3.7.2.2, second paragraph, second sentence: Since Wake County does not have a LWSP and the table does not contain any information for the eastern half of the Wake County, please explain which County is being discussed.
144. Section 3.7.2.2, second paragraph: Please consider providing data related to 2055, the end of the planning period for this proposed project. The numerous values and dates in the text without context is confusing.
145. Table 3-16, third footnote: This table appears to blend data from LWSP and LRWRP; therefore, please be explicit regarding the source of the data for every value. Please ensure this data is from similar years and projection efforts. Please provide an explanation if the LWSP values are different than what is presented in the LRWRP. Demand projections are provided in the LWSP for 2050 and 2060 demands.
146. Section 3.7.2.3, first paragraph, last sentence: Please provide the projected size of the expanded plant.
147. Section 3.7.2.3, second paragraph: Please provide a citation for the source used.
148. Section 3.7.3, second paragraph, second sentence: It is unlikely a third intake will be granted in Jordan Lake; therefore, please explain why this alternative requires a new raw water intake in Jordan Lake and new WTP, and why this or another alternative is not considering the purchase of water from the Western Intake Partnership. This applied to the Cary/Apex intake alternative as well.

149. Section 3.7.3.1, first paragraph, second sentence: Please clarify or confirm that Chatham County has a separate intake from the Town of Cary's intake for the independent 3 mgd WTP as stated.
150. Section 3.7.3.2, first paragraph, fourth sentence: Please explain how Chatham Park and associated development fits into these growth rates, or not at all.
151. Table 3-18: Please explain how the total raw water supply for OWASA increases by 5 mgd, between 2021 and 2030, while the Jordan Lake portion only increases by 0.5 mgd during the same time period.
152. Section 3.7.4: Please provide projected demand values for the end year of the planning period, 2055, for this proposed project.
153. Section 3.7.4, second paragraph, last sentence: Please provide correspondence or documentation to support this statement.
154. Section 3.7.4, third paragraph, fifth sentence: This seems to be a misleading statement that water systems will be unable to meet their maximum day demands based on the Jordan Lake allocation, without considering that the Partners have other sources of water supply. Please clarify.
155. Section 3.7.4, fourth paragraph, first sentence: Please clarify that "Chatham County North" was included in the 2002 Jordan Lake allocation.
156. Section 3.7.4, sixth paragraph, first sentence: DWR respectfully challenges this statement, considering that Interstate 540 along with other significant develop activities in the southern portion of Wake County have been planned for decades. Additionally, 2030 population projections in the 2002 LWSP are comparable to the 2030 projections in the 2019 LWSP.
157. Section 3.7.4, seventh paragraph, third sentence: Please clarify that the Jordan Lake water supply allocations are based demonstratable projected needs by the neighboring communities. Other than the fact that these communities have been financially paying for allocations based on their long-range planning, the assertion of "higher priority" is questionable.
158. Section 3.7.4, eighth paragraph, fourth sentence: Please provide a citation and explain the details.
159. Section 3.8.2, first paragraph, sixth sentence: Please provide the current use of the property and the capacity/spec limits of the former WWTP throughout the document where appropriate.
160. Section 3.8.2, third paragraph, third sentence: Please consider providing an explanation for "non-tributary flow".
161. Section 3.8.2, third paragraph, last sentence: Please provide a year for "build-out". Please provide a value for 2055, as that is the final year of the planning period for this proposed project.
162. Section 3.8.2.1, second paragraph, first sentence: Please consider including this document from DWR in the appendix.
163. Section 3.8.2.1, second paragraph, sixth sentence: Please include water balance tables based on current, 2035, 2045, and 2055 projections to detail the proposed IBT request.

164. Section 3.8.2.2, first paragraph, third sentence: Please consider including this document from DWR in the appendix and explaining the details of the tiered effluent limits.
165. Section 3.8.2.2, second paragraph, third sentence: Please confirm and provide documentation in the appendix that the Town has secured the sufficient nitrogen credits to support the expanded discharge to 6 mgd.
166. Section 3.8.2.2, second paragraph, third sentence: Please provide an explanation for how the Town will meet 3 mg/L N concentration limit for the proposed 6 mgd expansion, given that under the current WWTP 3.75 mg/L is the best achievable.
167. Section 3.8.2.2, second paragraph, last sentence: Please clarify, the requested IBT value based on 2055 projections. This needs to be stated throughout the document in a consistent fashion. The demonstration mentioned in the preceding sentence may need to occur in concert with or prior to issuance of an IBT Certificate.
168. Section 3.8.2.3, third paragraph, fourth sentence: Please provide a projected year for build-out.
169. Section 3.8.2: There needs to be an evaluation for sending wastewater flows to the Western Wake WRF. The evaluation should include documentation from the owners of the WWTP as to their willingness to cooperate. This appears to be an appropriate section to include this; however, the location of this evaluation in the document is the discretion of the author.
170. Section 3.8.2.4, third paragraph, third sentence: Please identify the approximate location of the proposed outfall in the Cape Fear River.
171. Section 3.8.2.4, second paragraph, first sentence: Please confirm that this section of the Cape Fear River is classified as Nutrient Sensitive Waters (NSW) or consider rephrasing.
172. Section 3.8.2.4, second paragraph, second sentence: Please confirm that this section of the Cape Fear River is classified “impaired” or consider rephrasing. The last sentence in this paragraph states that the Cape Fear River is not listed for any impairments. Please clarify these statements.
173. Section 3.8.2.4, second paragraph, third sentence: Please provide an explanation in this context for what is meant by “frozen”.
174. Section 3.8.2.4, second paragraph, fourth sentence: In order to fully evaluate this alternative and other similar solutions, as compelled by the EIS process, a water quality modeling evaluation needs to be conducted for potential treated wastewater discharges into the Cape Fear River. This should be done before these alternatives can be regarded as infeasible or impractical.
175. Section 3.8.2.4, fourth paragraph, second sentence: Please explain the existing water quality issue at the proposed outfall location, if the standard can not be exceeded more than 10% of the time, as stated in the third paragraph, and is only exceeded 2.5 to 3.3% of the time, as stated in the fourth paragraph. This was described as an “impairment” in the second paragraph of this section.
176. Section 3.8.2.4, fourth paragraph, fourth sentence: Please provide a date/year of the data sample and the concentrations reported.

177. Section 3.8.2.4, fourth paragraph, fifth, sixth, and seventh sentences: Please provide dates/years of the data samples and the concentrations reported.
178. Section 3.8.2.4, sixth paragraph: Please provide the reader with context for this information considering the previous water quality information in this section. Please detail any communication or consultation with the USFWS that has occurred regarding the proposed outfall location.
179. Section 3.8.3, first paragraph, last sentence: Having not fully investigated the potential for this option, this statement seems to be more of an assumption by the author.
180. Section 3.8.3, second paragraph, last sentence: Please ensure the accuracy of this statement is consistent with other statements made throughout this document. Also, confirm this value is based on 2055 (30-year planning period) projections.
181. Section 3.8.3, third paragraph, last sentence: Please explain how this meets the requirements for this proposed IBT EIS that is based on a 30-year planning horizon (2025-2055), not 20-25 years.
182. Section 3.8.3, fourth paragraph, second sentence: That is often the case when conducting alternative analyses for an EIS. Please explain why this EIS is excused from fully evaluating all alternatives presented.
183. Section 3.9, first paragraph, last sentence: Please identify specifically which entity(s) are responsible for each of the various infrastructure projects mentioned.
184. Section 3.9, third paragraph, first sentence: This is not an accurate statement. Though the City does fall under the “cork rule” provision, this does not absolve the City from accounting for the consumptive losses in the portion of their service area that is within the receiving basin (i.e., Deep River). Updated “Surface Water Transfer Worksheets” specifically for the City of Sanford need to be included with this EIS document, detailing the current (2025), 2035, 2045, and 2055 projected transfers.
185. Section 3.9, third paragraph, last sentence: Please provide a brief explanation for why the City’s peaking factor is so high (nearly 2).
186. Table 3-20: Please explain why 3 of the 4 regular sales contracts have expired and if these water sales are still occurring.
187. Section 3.9, fifth paragraph, second sentence: Please provide a citation.
188. Section 3.9, fifth paragraph, third sentence: Please explain the relevance of Chatham County and specifically the Moncure Industrial Park to the City of Sanford.
189. Table 3-21: Please consider providing an explanation regarding the need of additional water resources from the City of Sanford for the Town of Pittsboro and Chatham County beyond the supplies provided by Jordan Lake, as discussed in Section 3.7.
190. Section 3.9.3, second paragraph, fifth sentence: Please clarify, is the reference to “the City’s terminal reservoir” referring to Buckhorn Dam? If not, please describe the role the Buckhorn Dam has on the City of Sanford’s intake.
191. Section 3.9.3, third paragraph, fourth sentence: Please provide a citation.
192. Section 3.9.3, fourth paragraph, fourth sentence: Please consider including a demonstration of effectiveness of the proposed GAC system (appendix) and committing to the installation of the specialized treatment system to avoid the transfer of waters with known concentrations of emerging compounds to waters

within a receiving basin with potentially lower existing concentrations of emerging compounds. A commitment in the mitigation section of the EIS is encouraged.

193. Section 3.9.4, third paragraph, last sentence: Please consider identifying the "separate process" involved with permitting these facilities. Additionally, These infrastructure facilities should be included in the estimated project costs, similar to the other alternatives evaluated.
194. Section 3.10, third paragraph, second sentence: This sentence states that the Cape Fear River is formally impaired, nutrient sensitive waters; however, earlier no formal impairments are listed and the river appears to not be classified as NSW (nutrient sensitive waters). Please clarify.
195. Section 3.11: Please consider adding more information specific to the Fuquay- Varina area than is provided.
196. Section 3.11, first paragraph: Please consider adding clarification between sentences two and four, considering that sentence three states they are "parallel" (i.e., "more than" and "approximately"). Please explain the context between the last two sentences. The document reads as if PWS wells are primarily used for irrigation.
197. Section 3.11, second paragraph, last sentence: Please consider explaining the type of well the "GC" classification is used for and why the EMC is involved.
198. Section 3.11.1, first paragraph, third sentence: Please explain what is meant by "perception" in this context. Perhaps a citation if needed.
199. Section 3.11.1, third paragraph, last sentence: Please explain if every well includes private and/or non-drinking water wells.
200. Section 3.11.1, sixth paragraph: Please consider identifying the systems reviewed to provide context to the relevancy of these selected. Please provide any communication you may have had with these systems, particularly regarding the accuracy of the listed well yields over time and other long-term issues. Please provide any communication with Wake County, who has been conducting a significant, long- range groundwater study, including how their results compare to the results in this document.
201. Section 3.11.1, eighth paragraph, second sentence: Please consider if Alternative 10 was considered as a "minimization" alternative to the IBT, as described in the first sentence of the paragraph, then explain why the full 8.4 mgd average day of the entire service area was evaluated. Please provide any other considerations given, including if the Neuse River basin portion of the service area was supplemented by groundwater to avoid an IBT. The use of "minimization" to describe this alternative is also found in the first sentence of the first paragraph of Section 3.11.
202. Section 3.11.3, third paragraph, sixth sentence: Please identify the location of the study and results presented.
203. Section 3.11.3, third paragraph, sixth sentence: Please identify the location of the study and results presented in context with the Fuquay-Varina area. Please confirm these results and findings from the cited document.
204. Section 3.12, second paragraph, last sentence: Please spell out the acronym, SDWA.
205. Section 3.12.1, third paragraph: A water system withdrawing water from a water body that contains some fraction of treated wastewater produced from an entity upstream is not generally considered "reuse" or "de facto reuse". To present the information in

this context, provide citations, specific to NC. In NC, reuse generally refers to the use of treated wastewater prior to the discharge in a body of water. Many water systems across the state participate in reuse programs for a wide-variety of reasons, to include a reduction in the total discharge to a body of water to meet wastewater discharge (NPDES) permitting requirements. Unless the author is able to present a citation in rule or statute, the "'five-mile' de facto policy" is guidance provided by the PWSS that provides water systems a reasonable opportunity to adjust or cease withdrawals in the event of spills of untreated wastewater from an upstream WWTP.

206. Section 3.12.1, fourth paragraph: Please provide citations.
207. Section 3.12.1, fifth paragraph: Please provide citations.
208. Section 3.12.1, sixth paragraph: Please provide citations.
209. Section 3.12.3, first paragraph: Please explain the context of reuse programs to residential irrigation. Please consider presenting other potential applications of reuse water.
210. Table 3-25: Please explain what the total row represents for each column.
211. Section 3.12.3, second paragraph, last sentence: Are the exceedances and reductions mentioned based on the annual average?
212. Section 3.12.3, third paragraph, seventh sentence: Please explain how irrigation use for any water system offsets the potable water use, as described.
213. Section 3.12.3, fifth paragraph, last sentence: Please explain why agricultural land not being identified in the Town's land use plan excludes developing a reclaimed water program.
214. Section 3.12.3: Please consider evaluating land application of treated wastewater in the source basin, including spray fields and golf courses.
215. Section 3.13.1, third paragraph, last sentence: Please explain how this trend has directly affected the Town of Fuquay-Varina.
216. Section 3.13.1, fourth paragraph: Please provide appropriate citations.
217. Section 3.13.1, fifth paragraph, last sentence: Given that the Town is witnessing significant growth in new construction, please provide the demand range for newer homes.
218. Section 3.13.1, seventh paragraph, first sentence: Please provide the location of the region that was the basis of the study.
219. Section 3.13.1, ninth paragraph, last two sentences: Please consider providing the regional per capita data to support this claim. The selected per capita value (85 gpcd in this example) represents an "average" per capita and should not be intended to ensure full coverage related to "year-to-year fluctuations" for the planning period.
220. Section 3.13.3, first paragraph, first sentence: Please explain how a flat rate pricing structure, instead of the more common increasing block pricing structure, encourages water conservation.
221. Section 3.13.4, first paragraph, third sentence: Please explain how this AMI system will "enhance and promote water conservation."
222. Section 3.13.5: Please provide any data on usage of the website by customers. Also, include any promotion conducted by the Town to make customers aware of the service.

223. Section 3.13.6: Please provide details on the reasons for the decline in non-revenue water over the past 5 years. Please provide a listing of the major water projects the Town has undertaken over the past 5-10 years to improve water efficiency and reduce non-revenue water, include specific financial commitments the Town has made for future projects. Please provide an explanation for why the Town has not conducted a formal water audit, such as the AWWA water audit, and if there are any plans for conducting such a study.
224. Section 3.13.7, third paragraph: Please provide details on any water conservation programs or initiatives by the Town since passing the current water conservation measures in 2008, particularly in advance of the proposed IBT request, to ensure the Town meets or exceeds the strictest water conservation measures and initiatives regionally.
225. Table 3-27: For ease of reading, please state the water conservation stage on every page.
226. Section 3.13.7: Please consider including an ending paragraph for this important section that summarizes the information from Table 3-27 and provides an argument that the Town has a sufficiently strong water conservation plan, measures, and initiatives to meet the statutory requirements for an IBT Certificate.
227. Section 3.14, second paragraph, last sentence: Please detail what is included in the "15 percent of engineering".
228. Section 3.14, third paragraph, fourth sentence: Please ensure that Alternatives 9 A/B/C are treated equally to the other alternatives with regards to assigning costs. Since several of the other alternatives also have partners that will share in the cost of the project or if much of the infrastructure is already in place.
229. Table 3-28: Ensure that all cost estimates provide full breakdowns and itemizations for all projected costs for all alternatives.

Section 4.0

230. Section 4.0, second paragraph, last sentence: Please consider providing an explanation.
231. Section 4.1, first paragraph, first sentence: Section 3.11 (Alternative 10) does not discuss any of the project area as located in the Coastal Plain. Please clarify.
232. Section 4.1: Please consider including maps to illustrate what is described in the first and second paragraphs.
233. Section 4.9, second paragraph, first and last sentences: Throughout Section 3.0, including the cost estimate section, appears to suggest that alternatives 9A/B/C will require a new intake. Please clarify as needed.
234. Section 4.9, third paragraph: Please define and explain the differences between a 100-year floodplain and a floodway.
235. Section 4.9, fourth paragraph, last sentence: Please explain why floodways have not been designated in Lee County.
236. Section 4.14.2, fourth paragraph: Please consider adding a map or depiction.
237. Section 4.14.3, second paragraph, last sentence: Please consider including the findings from the fish community sampling sites in the project area.

238. Table 4-15: Please discuss how Alternative 9 (preferred alternative) will improve or further degrade existing conditions (i.e., Chlorophyll A violation at the Sanford water supply intake and the fair benthic bioclassification at Terrible Creek). Please consider including the proximity of the Terrible Creek WWTP to the Terrible Creek sampling site, perhaps in the discussion adjacent to Table 4-15.
239. Section 4.14.3, eighth paragraph, sixth sentence: The use of the Terrible Creek WWTP is the basis for nearly all of the alternatives, particularly the preferred alternative. Please clarify.
240. Section 4.14.4: Please consider discussing the Coastal Plain if any of the project area is within the Coastal Plain physiographic province.
241. Section 4.15.1.1, second paragraph, second sentence: Please clarify the "minority population percentage that exceeds that of North Carolina."

Section 5.0

242. Section 5.0, fourth paragraph: Measurable values need to be defined for every evaluation, otherwise the technical document (i.e., EIS) will only serve to support the opinions or discretion of the author, which may or may not be the opinions held by the lead agency or reader.
243. Section 5.0, fifth paragraph, second sentence: Please clarify what is meant by "raw water storage facilities" in this context.
244. Section 5.1.1, second paragraph, fourth sentence: Please clarify if this statement is intended to represent the potential indirect and cumulative impacts from all of the alternatives. Please consider providing any available demonstration or evidence.
245. Section 5.3.2: Please consider including information regarding any coordination between the development of the various land use plans. Please consider including the land use plans that most directly affect this project area or provide citations to support the statement in the last sentence.
246. Section 5.4.1, sixth paragraph, second sentence: Please consider providing a similar level of quantitative impact assessment as is done here (i.e., 1.0 acre) for the other sections.
247. Section 5.6.1.1: Please provide the basis for this determination given that the document states no research has been conducted for this subject.
248. Section 5.9, last sentence: Please clarify if this statement is intended to represent the potential indirect and cumulative impacts from all of the alternatives. Please consider providing any available demonstration or evidence.
249. Section 5.9.1, second paragraph, last sentence: It is questionable that impacts that will likely require permitting are minor. Providing a quantifiable basis for the impact determination is needed.
250. Section 5.9.1, sixth paragraph, last sentence: Please provide the basis for the "moderate" determination. Perhaps consider using the quantified values such as those presented in Table 5-4 to make the impact severity determination.
251. Section 5.10, second paragraph: Please consider providing an explanation for the permitting determination (i.e., discussions/coordination with agency staff, permit criteria or other).

252. Section 5.10.1, second paragraph, last sentence: Given that the permanent impacts associated with most alternatives (Table 5-5) are greater than 1 acre, please provide the rationale for why these impacts were all determined to be “minor”.
253. Section 5.11.1, first paragraph, third sentence: Please explain why Alternatives 9A & 9B are not included.
254. Section 5.13.2.2, second paragraph, last sentence: Please consider providing information related to the “current” occurrence.
255. Section 5.13.2.7, first paragraph, second sentence: Need to state that this is the proposed locations for all of the listed infrastructure.
256. Section 5.14.1, fourth paragraph, last sentence: Impacts associated with stream crossings, particularly those that involve open trench installation as described, will require permitting and should therefore be considered significant. Please provide an explanation for the “minor” determination.
257. Section 5.14.1, fifth paragraph, third sentence: Please consider providing a map or depiction to clarify this statement, particularly in regards to Alternatives 4, 5, 8A, and 8B.
258. Section 5.14.1.1, first paragraph: Please provide an explanation for the “minor” determination.
259. Section 5.14.1.1, second paragraph, last sentence: Please explain how all other projects other than the preferred alternative will have permanent, direct, minor, adverse impacts. Please provide the impact analysis for Alternatives 9A/B with an explanation as to how they are different.
260. Section 5.14.1.1, fourth paragraph, first sentence: Please clarify that a raw water intake was considered in the cost estimate for 9A/B.
261. Section 5.14.1.3, first paragraph, third sentence: Please explain “anti-frac out measures”.
262. Section 5.14.1.3, second paragraph: Please consider stating whether permitting will be required.
263. Section 5.14.2.1, first paragraph, last sentence: Please consider including the CWA permit as an attachment.
264. Section 5.14.2.2, first paragraph, first sentence: Please clarify that no wastewater will be sent to the North Harnett WWTP for Alternatives 9A or 9B.
265. Section 5.14.2.3, second paragraph: This paragraph states that the Cape Fear River is impaired, nutrient sensitive waters; however, earlier no formal impairments are listed and the river appears to not be classified as NSW (nutrient sensitive waters). Please clarify.
266. Section 5.14.2.3, fifth paragraph: In order to provide a full evaluation of the alternatives presented, as required by an EIS, and specifically those alternatives that propose to increase the wastewater flows in the Cape Fear, a water quality model evaluation/analysis of these additional inputs in the Cape Fear River at or near the discharge location(s) should be conducted.
267. Section 5.14.3.3, fifth paragraph, last two sentences: Please explain how the impacts can be both “major” and “negligible” for the same alternative on the same resource.

268. Section 5.15, first paragraph: To avoid confusion, please use the language in the statute referenced, and please be explicit as to what DWR is the "steward" of. DWR is not the steward of models owned and managed outside of the agency.
269. Section 5.15, second paragraph, third sentence: DWR does not have hydrologic models for all of the river basins in North Carolina.
270. Section 5.15, third paragraph: Please provide a citation.
271. Section 5.15.1, first paragraph, second sentence: Please provide the year of "current" information.
272. Section 5.15.1, third paragraph, last sentence: Please consider explaining "flow splits".
273. Section 5.15.2: Please provide citations throughout this section.
274. Section 5.15.2, tenth paragraph, third sentence: Please clarify the average that is being discussed (i.e., daily, monthly, annual)
275. Section 5.15.2, tenth paragraph, last sentence: Please provide context that this scenario depends on the current condition/level of the water quality pool and is outside of the management and operations plan of the lake. Therefore, it would be a request to the USACE and not an obligation of the USACE.
276. Section 5.15.2, eleventh paragraph, first sentence: Please consider providing context that downstream users do not have a water supply allocation from Jordan Lake; therefore, the drought plans directly associated with Jordan Lake would not be expected to account for water shortages downstream of Lillington.
277. Section 5.15.2, eleventh paragraph, last sentence: According this sentence, this proposed project is dependent on a policy change or discretionary operations change from the USACE to avoid potential downstream impacts. Please clarify as needed.
278. Section 5.15.4, second paragraph, first sentence: Please explain the relevance of this project to an analysis conducted over 10 years ago.
279. Section 5.15.4, ninth paragraph, second sentence: Not all releases from Jordan Lake are conducted to merely maintain the flow targets. Please explain why high flow releases are made in the context of this sentence. Citation needed.
280. Section 5.15.4, ninth paragraph, third sentence: Please consider including the "drought plans" used in development of the OASIS model as an appendix. Please explain what is meant by "removal of the limitation".
281. Section 5.15.4, ninth paragraph, last sentence: Please explain how the flows from the Deep River maintain flows for the Cape Fear River, not just releases from Jordan Lake.
282. Section 5.15.4, tenth paragraph, fourth sentence: Please provide a citation.
283. Table 5-11, page 5-47: Under Alternatives 9A/B, the water supply for the Town of Dunn appears to be impacted 0.25% of the time. Under the No Action, the water supply for Town of Dunn is impacted 0.12% of the time. Please provide a detailed analysis or drought triggers as provided in the Water Shortage Response Plans (WSRPs) to demonstrate how the Town of Dunn will continue to meet its demands. This level of evaluation also needs to be conducted for water systems such as Fayetteville PWC and the communities supported by Lower Cape Fear Water and Sewer Authority who do not have their water conservation triggers within the OASIS model. Perhaps this evaluation is achievable by use of the OASIS data outside of the model, through a post-process activity.

284. Table 5-12: Please provide the minimum flow values and durations of those flows at the nodes provided.
285. Section 5.15.4, thirteenth paragraph, last sentence: Please consider clarifying that the cost will be the responsibility of the Town of Fuquay-Varina.
286. Section 5.15.5, third paragraph, last sentence: Please explain how impact determinations are made in this situation.
287. Section 5.15.5, fourth paragraph: This paragraph appears to state that the avoidance of potential impacts associated with this proposed project are dependent upon discretionary actions by regulatory agencies during a time of a water supply emergency, likely for all in the basin. The applicant should assume that the regulatory agencies will strictly follow the existing plan. Please explain or revise as needed.
288. Section 5.0: Please provide discussion and analysis for Harnett County's proposed new intake on the Cape Fear River near the Town of Erwin as described in the Harnett Regional Water System 2021 LWSP.

Section 6.0

289. Section 6.0, fifth paragraph, first sentence: Please provide specific quantifiable (i.e., values) metrics for the terms, "negligible, minor, moderate, and major" for each subject presented that uses these terms to define impacts and associated mitigation measures.
290. Table 6-2: Please provide the measures (i.e., actions) the Town has in place or is proposing to implement to mitigate for any potential impacts either defined by the hydrologic model results or potential indirect and cumulative impacts as a result of the preferred alternative. These mitigation actions should be measurable with regard to the projected and potential impacts.
291. Table 6-2, water use: Please provide the specific water conservation and INI projects that have been implemented from recommendations in this plan and specific projects or line items that have received committed funding by the Town Council.
292. Table 6-2, Surface Water Resources: To fully evaluate the alternatives presented, as required by the EIS process, the applicant needs to conduct water quality modeling of the source basin before determining that the impacts are "unknown".

Section 7.0

293. Section 7.0, first paragraph, fourth sentence: Considering that the Town, based on the information provided, has one of the weakest water conservation programs in the region, this document has not demonstrated that there is not significantly more potential for water savings by implementing more stringent water conservation measures and initiatives. Some examples include and not to be taken as all inclusive, Stage 3 is the first stage for the Town that indoor water use reductions are called out. Nearly all other water systems had already implemented this requirement in previous/earlier stages. Stage 3 is also the first noted stage for reductions in commercial and industrial water use, and even that is discretionary. There are no mandatory restrictions on commercial or industrial demand, and customers are still allowed to fill pools even in the worst stages of drought. Not only is water conservation a significant concern related to the viability of Alternative 12 and the demand projections as a basis for the purpose and need of the project, but water

conservation and efficiency are significant concerns consistently held by the Environmental Management Commission and the public for all IBT projects. The Town needs to demonstrate that they are good stewards of the current resource in order to provide confidence to all concerned parties that they will be good stewards of the proposed future resource.

Please contact Harold Brady, Water Supply Planning, 919-707-9005, harold.m.brady@ncdenr.gov, or Linwood Peele, Water Supply Planning, 919-707-9024, linwood.peele@ncdenr.gov, if you have questions regarding these comments.

Response to Agency Comments on Draft EIS, February 2024

Hazen and Sawyer
4011 West Chase Blvd., Suite 500
Raleigh, NC 27607

February 27, 2024

Mr. Harold Brady
Water Planning Section
Division of Water Resources
1611 Mail Service Center
Raleigh, NC 27699-1611

Re: Response to Agency Comments
Interbasin Transfer for Water Supply from Cape Fear to Neuse River Basin
Town of Fuquay-Varina

Dear Mr. Brady,

On behalf of the Town of Fuquay-Varina, Hazen and Sawyer is submitting the revised Draft Environmental Impact Statement (DEIS) to the Division of Water Resources (DWR) for review. Also attached are the responses to agency comments dated March 1, 2023. The response to comments are also included in Appendix G of the revised DEIS. The revised DEIS and associated appendices are located in a OneDrive folder link in the transmittal email.

Please let us know if a meeting is beneficial to discuss the responses to the comments. Hazen and the Town of Fuquay-Varina appreciate the time and consideration of DWR staff to assist with this important project.

Sincerely,

Mary E. Sadler, PE
Associate Vice President

cc: Jim Seymour, Town of Fuquay-Varina
Mike Wagner, Town of Fuquay-Varina
Linwood Peele, Division of Water Resources
Reed Palmer, Hazen and Sawyer

Neela Sarwar (Modeling and Assessment Branch):

- Model Set up:
  - Raleigh Little River Reservoir (LRR):
    - Is Raleigh LRR still an option as a future source? In the model even though it said the connection is turned off, the max flow is set to 20 mgd from LRR to Raleigh. In the set up, the initial storage is set at 1851 AF. Therefore, it's delivering up to 20 mgd as needed and reducing stress on the other Raleigh sources. This might not impact the F-VIBT that much, but it's diverting flow from IR to Neuse River and ultimately flowing through Gayton Gage.

      RESPONSE: Hazen has re-run all of the model scenarios and turned the Raleigh Little River Reservoir option off. Raleigh Water's next supply expansion is not needed to meet the projected 92.4 mgd demand in 2055 (interpolated between the 2050 and 2060 demand); therefore, the model runs were corrected to be consistent with the original DEIS text which indicated the Little River Reservoir is assumed not to be needed in 2055. The Little River Reservoir is one of Raleigh Water's leading alternatives for its next expansion. The timing of the next expansion and selection of the alternative to meet the water demand is currently being evaluated.

    - [from F-VIBT-2055 scenario OASIS NOTE: "And finally...turned off operations and set storage to 0 for little River Reservoir since there is no guarantee this will be built. It was in there to meet the projected 2055 demand of 109 mgd for Raleigh"]

      RESPONSE: Per the prior response, the OASIS model runs have been revised to be consistent with the model documentation and DEIS text. However, in response to the full model note cited above, Raleigh Water has reviewed their demand forecast and determined that the higher projection that resulted in a 109 mgd demand in 2055 was too high to be the primary planning scenario. A lower projection scenario that results in a 2055 demand of 92.4 mgd has been selected. The OASIS model runs are consistent with a 92.4 mgd demand in 2055. The Triangle Water Partnership (TWP) has adopted this lower demand projection scenario at Raleigh's suggestion. It is anticipated that Raleigh Water's 2023 LWSP submittal will reflect a growth rate consistent with a 92.4 mgd demand in the year 2055.

  - Summary Table for Shortage Calculations:
    - The alternatives are simulated with drought plan on. However, the shortages shown in the table are calculated without drought plan. With drought plan, the systems without WSRP would show their regular shortages or no shortages anyway. Valid shortages in few systems [like Cary] shown in Table 3, Appendix C might create more questions.

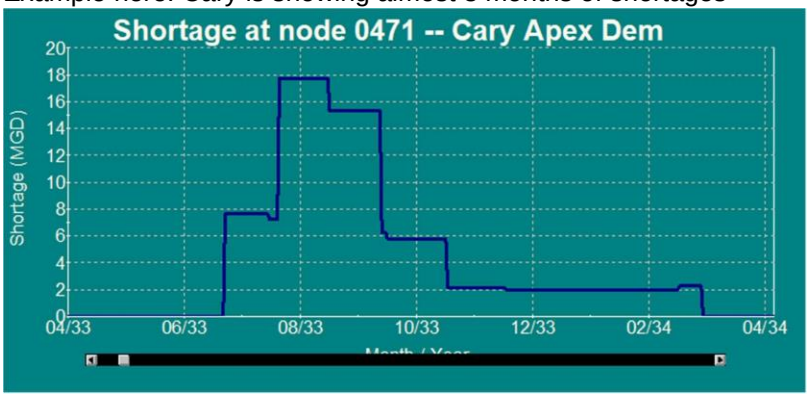
      RESPONSE:
      Hazen has tried to clarify this rather complicated situation by adding Tables 4a and 4b to the Appendix C: Technical Memorandum for OASIS Hydrologic Model of Cape Fear and Neuse River Basins for Interbasin Transfer

    - Adding two more columns might give a different perspective of the shortage periods as is done for the climate change in Appendix C - Table 8
      - Longest duration (in days) of the shortage period.
      - No. of years impacted.

      RESPONSE: Tables 4a and 4b in Appendix C were developed to compliment the shortage information provided in Table 3.

- Frequencies/stages of drought triggered.

  Example here: Cary is showing almost 8 months of shortages



  RESPONSE: The OASIS model output is consistent with Cary being in a WSRP over these 8 months. The native Shortage0471 calculation in OASIS will give a positive value any time the delivery is less than the demand (e.g., Delivery0471 < Demand0471). The value of demand0471 (Cary's demand) is not modified by OASIS during a WSRP trigger event. Rather, the delivery is constrained to less than Demand0471 via code in drought_plans_cf.ocl. Refer to lines 1473-1521 of this file to see how the conservation demand values are set depending on the WSRP stage (which is set earlier in the file). Then the delivery (e.g., the flow through the arc that feeds Cary-Apex demand, or flow0479.0471) is constrained to the conservation program demand value in lines 1527-1529. But since the demand itself isn't modified in the OCL, the standard OneVar output of shortage for node 0471 (or any node with a WSRP demand reduction) will return a positive value for the shortage equal to the WSRP demand reduction. However, Hazen has developed another code to ascertain whether Cary or any other utility has actually run out of water. That code is contained in Shortages.ocl.

- Minor flow differences noticed.
  - Climate yr 7Q10 flows are little different (even though ~1 % difference) as I calculated in the post processor.

    RESPONSE: Yes, the climate 7Q10 flows are slightly different. Segregating the hydrology into climate years (April 1- March 31) is consistent with how the USGS calculates 7Q10 in their semi-official determinations and Hazen has adopted the same policy. The climate 7Q10 flows makes sense given the hydrologic patterns in North Carolina. Hazen is happy to provide the OneVar files for calculating 7Q10s based on climate year. Updated 7Q10 calculations have been provided in the TM using the flow upstream of the intakes for the Fayetteville, Cape Fear PUA, and NR WASA intakes rather than immediately downstream (i.e. after the withdrawals) as they were in the previous draft.

    - Appendix C Table 2.5. Example Alt 1 and 9A-B. [just checked randomly at few key points]. At Fayetteville, my 7Q10 values are 4.56 and 3.62 mgd more than the values in the table.

      RESPONSE: Comment noted. Please refer to aforementioned response. If calendar year annual minimums were used to calculate the 7Q10, then an annual minimum for 2007 and an annual minimum for 2008 would be calculated. In reality, the annual minimum for calendar years 2007 and 2008 derive from the same drought event. This is why climate years are preferred. Additionally, the location of the 7Q10 calculation was changed to be calculated upstream of Fayetteville's withdrawal instead of downstream.

- Fayetteville 7Q10 flow for 2055 is abruptly low from 2025: 351.7cfs down to 294.9 cfs for 2025/2055 where water withdrawals are 34.74 and 62.34 mgd, respectively. Please explain the declines.

  RESPONSE: The decline is primarily due to the cumulative impact of the dramatic growth in demand from Fayetteville. The 7Q10 was being measured downstream of Fayetteville's withdrawals (which average 57 mgd from the CF River at node 0730) and upstream of the wastewater discharges from Cross Creek and Rockfish Creek WRFs, so the magnitude of the impact was maximized. The 7Q10 calculation was updated to be calculated before PWC's intake, reducing the difference between the 2025 and 2055 No Action 7Q10 values significantly. There is now less than 9 cfs difference which is due to increased development and water use upstream rather PWC's water withdrawal.

- Between Lillington gage and Fayetteville intake there are not many major withdrawals like Fort Bragg and Fayetteville; rather, there are few returns from upstream withdrawals plus three local inflow locations with one having a few days of zero flows. Could it be for cut back of flows thru Jordan Lake for higher drought stages?

  RESPONSE: Yes, Jordan Lake operations and the WQ Pool release protocol (Jordan Lake Drought Control Plan) do have an impact on the Fayetteville 7Q10. However, for the reason stated in response to the aforementioned comment, the magnitude of withdrawal at the Hoffer WTP intake would cause the majority of the difference under the prior method of reporting 7Q10s. However, the 9 cfs reduction now reported as the difference in 7Q10 between 2025 and 2055 is due to upstream influences including Greensboro, High Point, Burlington, Jordan Lake users (e.g. Cary and Durham), and at Sanford and Harnett County's intakes along the Cape Fear River upstream of Fayetteville.

Shawn Guyer (Public Water Supply Section – Raleigh Regional Office):

On Page 3-55. Section 3.11.1 Well Yield, The EIS states: “Per the Administrative Code, a minimum of a 100 by 100-foot area is required around every well for well point protection.”

15A NCAC 18C .0203(a)(1) - The well shall be located on a lot so that the area within 100 feet of the well is owned or controlled by the person supplying the water. The supplier of water shall be able to protect the well lot from potential sources of pollution and to construct landscape features for drainage and diversion of pollution.

The rule specifies a 100’ radius, not a 100’ square.

RESPONSE: The EIS text in Section 3.11.1 has been revised.

Fred Tarver (Basin Planning Branch):

1. Does the OASIS model capture the proposed raw-water intake just downstream of the Haw/Deep confluence for the Moncure Megasite? This appears to be a reasonable expectation given the construction of the EV manufacturing facility in the next few years. There may be a cumulative impact on storage in Jordan to offset the combined deficits at the Lillington gage. Also, is a withdrawal from behind Buckhorn Dam of make-up water into Harris Lake included in the OASIS model? This would be a likely occurrence when the nuclear facility is expanded sometime in the future.

   RESPONSE: The OASIS model does not include a separate raw water intake downstream of Moncure. The City of Sanford has committed to providing finished water to the Moncure Megasite (Vinfast) via the expansion of the City's Water Filtration Facility. The demand in the OASIS model for Sanford and partners in 2055 is conservatively high and will cover the need to meet the Moncure Megasite's water supply needs.

   Expansion of the Shearon Harris Nuclear Power Plant would require raising the water level of Harris Lake by 20 feet. Water from the Cape Fear River would be needed to fill and maintain the operating pool for normal operation. Per a 2013 letter from Duke Energy to the U.S. Nuclear Regulatory Commission, Duke Energy requested a suspension of the two proposed reactors, which removes the need to expand Harris Lake. Duke Energy stated that the forecasted operating dates of the two proposed reactors fall outside the fifteen-year planning window of the Integrated Resources Plan. To date, Duke Energy has not proposed a reactivation of an application to expand Shearon Harris. The OASIS model may be modified in the future when Duke Energy announces plans to reconsider further nuclear power capability at Shearon Harris.

2. Pages 3-10, 3-19, 3-20. Table 3-8. Although a reservoir on Middle Creek is a rejected alternative, it is not prudent to be conjecturing on the flow release regime or the safe yield prior to any studies. A comparison to Lakes Benson and Wheeler on Swift Creek is not appropriate because, as mentioned in the document, a new flow regime on an existing reservoir cannot reduce the safe yield by more than 10 percent, according to the Dam Safety Rules. A hypothetical reservoir on Middle Creek would not be under such a restriction.

   RESPONSE: It is understood that a new reservoir would not be subject to a reduction in safe yield of more than 10 percent per NCAC 02K .05. The engineer has to make an assumption with regard to minimum release in order to evaluate supply sufficiency. The Swift Creek minimum flow release was used as a surrogate for sizing a reservoir in Middle Creek to assess the impact of a reservoir footprint, which is appropriate given the proximity of the drainage areas and similar geography.

   As stated in the DEIS, a new reservoir on Middle Creek will have a substantial impact to existing property owners and transportation infrastructure. Per Section 3.2.3.2 of the DEIS:

   > *"Approximately 1,100 acres of private property would need to be acquired to accommodate the reservoir inundation footprint and the 100-foot water supply watershed buffer area. Approximately 140 acres of property are designated for residential development. Fifty households, five farms, and four forestry tracts would be impacted. Approximately 733 feet of state highways, 3,703 feet of secondary roads, and two bridges would be impacted. The construction of one new bridge would be required."*

   In addition to the environmental and community impact, a proposed Middle Creek reservoir was also rejected due to the timeframe required for constructing new reservoirs in North Carolina. The following table provides a summary of the larger reservoirs in North Carolina with the associated construction timeframes and impoundment use. There are 6,662 impoundments and reservoirs in North Carolina per the Dam Inventory List from the Division of Energy, Mineral, and Land Resources. Approximately 480 reservoirs or impoundments in North Carolina are used for flood control, water supply, and recreation. Approximately one-half of the larger reservoirs in North Carolina were constructed in the early 1900s for hydroelectric power. The remaining half of North Carolina's reservoirs were constructed in the mid-1950s and 1960s. The most recent reservoir constructed in

North Carolina is Randleman Lake, which finished construction in 2010. Randleman Lake was originally proposed in 1937 with engineering work continuing through 1987, at which point the U.S. Army Corps of Engineers withdrew support. The current Randleman Lake is a smaller version of the original proposal and is designated for water supply.

Summary of Constructed Reservoirs and Impoundments In North Carolina

Impoundment	Construction Timeframe	Impoundment Use
W. Kerr Scott Dam	1947 to 1952	Hydropower, flood control, water supply
Lake Gaston	1963	Hydropower, water supply
Jordan Lake	1967 to 1982	Flood control, water supply
Santeelah Lake	1928	Hydropower
Lake Norman	1959 to 1964	Hydropower
Randleman Lake	Proposed in 1937 for flood control. Funds authorized in 1968. USACE withdrew support in 1987. Smaller reservoir constructed between 2004-2010 by the Piedmont Triad Regional Water Authority	Water supply
Falls Lake	1978 to 1983	Flood control, water supply
Lake Crabtree	1989	Flood control
Harris Lake	Early 1980s	Nuclear reactor cooling water
High Rock Lake	1926 to 1927	Hydropower
Tuckertown Reservoir	1962	Hydropower, water supply
Falls Reservoir	1919	Hydropower, water supply
Lake Tillery	1928	Hydropower, water supply
Blewett Falls Lake	Early 1900s	Hydropower, water supply
Badin Lake	1917	Hydropower, water supply
Lake Lure	1925 to 1927	Hydropower, water supply
Lake James	1916 to 1923	Hydropower, water supply
Lake Rhodhiss	1925	Hydropower, water supply
Lake Hickory	1927	Hydropower, water supply
Lookout Shoals Lake	1915	Hydropower, water supply
Lake Norman	1959 to 1964	Hydropower, water supply
Mountain Island Lake	1924	Hydropower, water supply
Lake Wylie	1904	Hydropower, water supply
Buckhorn Reservoir	The original dam was constructed in 1974. A new dam 700 feet downstream of the existing dam finished construction in 1999 and expanded the operating level of the reservoir.	Water supply
Lake Michie	1924 to 1926	Water supply reservoir, hydropower until 1960
Little River Reservoir	Completed in 1988	Water supply
Rocky River Lower Reservoir Expansion	Expansion of existing reservoir, 1989-1999	Water supply
West Fork Eno	1993 – 2000	Water supply
Macintosh Reservoir	1971 – 1993	Water supply

Summary of Constructed Reservoirs and Impoundments In North Carolina

Impoundment	Construction Timeframe	Impoundment Use
Back Creek Reservoir	1985 – 1991	Water supply
Lake Howell	1985 – 1993	Water supply
Lakes Benson and Wheeler	Early 1950s; reactivation of reservoirs as water supply 1999-2006	Water supply

3. Page 5-28, Section 5.14.1. "For all stream crossings except the Cape Fear River, stream crossings will be performed by excavating an open trench, installing the transmission line, and backfilling the trench. Instream work will be performed in dry stream conditions, using a pump- around system or diversion as necessary. Transmission line crossings of the Cape Fear River and streams in which federally protected species or designated critical habitats are known to be present, if applicable, will be installed using trenchless technologies." All perennial streams should be crossed perpendicularly and using trenchless boring.

   RESPONSE: Trenchless boring will be used in all areas where feasible. Installation methods will be determined during the design process and permitted accordingly.

4. No mention is made in the document of the designation of the Cape Fear River as being in the Sustainable Rivers Programs (SRP), a cooperative partnership between the US Army Corps of Engineers and The Nature Conservancy. No mention is made of how the various cumulative withdrawals from the Cape Fear River will impact water quality storage and thus flow manipulations from Jordan to benefit downstream water quality and anadromous fish passage by the locks, which are associated with the SRP.

   RESPONSE: The Cape Fear River was included in the U.S. Army Corps of Engineers and the Nature Conservancy Sustainable Rivers Program (SRP) in 2016. The Wilmington District COE and stakeholders participated in a workshop in the Fall of 2019 to develop improved flow regimes for dams on the Cape Fear River. Per the SRP website (https://www.hec.usace.army.mil/sustainablerivers/sites/capefear/), the workshop outlined six environmental flow experimental scenarios for several stretches of the mainstem Cape Fear River below Jordan Dam. The first experimental demonstrations were conducted in the summer of 2020 to assess juvenile fish recruitment and dispersal of algal blooms. Per the SRP website, the demonstration work is currently being assessed in conjunction with river monitoring. Per the SRP website, the USACE has not published any results of the demonstration studies.

   The OASIS model incorporates the current operating protocol from Jordan Lake Dam as established by the USACE. Water releases from Jordan Lake are to maintain a flow target at the Lillington gage, which was established to help meet water quality needs downstream while maintaining water supply storage in the reservoir. Jordan Lake Water Quality Pool statistics are provided in Table 5-12 of the DEIS. The differences in the various storage thresholds (e.g., <80%, <60%, <40%, and <20%) provide a quantitative analysis of the cumulative impacts. For example, the difference in the 2025 and 2055 No Action scenarios effectively describe the cumulative impacts from all other activities in the basin over the 30-year period. Details on the specific impacts are provided in Section 5.15.4.

5. It is unclear whether water demand shortfalls downstream of the Lillington gage would be addressed by the water quality pool, as stated in the document, or by the water supply pool. Is this issue addressed specifically in operations protocols for Jordan?

   RESPONSE: Section 5.15.4 of the DEIS addresses the operational protocol for Jordan Lake Dam. The USACE operates Jordan Lake dam specific to the gage flow target at Lillington and not relative to water supply or water quality pools.

   From the DEIS text: *"It should be noted that for Jordan Lake drought stages 0, 1, and 2, the USACE*

may employ a range of flow targets at Lillington. The range of flows result from collaboration and coordination on a variety of parameters such as stakeholder input, short- and long-term weather outlook, gate status, influences on stream flows downstream, and local inflows to both Jordan Lake and reaches below the dam. The CFNCRB model was set to release water to meet the flow target at Lillington, which includes meeting demand up to this gage when Jordan Lake is in drought levels 3 and 4. The USACE does not specify how far downstream water supply needs should be fulfilled; however, it should be noted that regulation flexibility is limited under existing authority. When Jordan Lake contains water in the conservation pool (as has always been the case), the Lake will be operated to meet water supply requirements and water quality low flow releases."

6. Page 5-40. Typo at ninth bullet?

   RESPONSE: The ninth bullet does not contain an error. The ninth bullet describes the metrics used in the analysis, one of which is the frequency in which the Jordan Lake Water Quality Pool is less than 80 percent, 60 percent, 40 percent, and 20 percent storage.

7. Tables 5-11 and 5-12. An accompanying table should be included in the document to present the number of days of the flow record that the benchmarks could not be attained, as well as the longest duration. Two percent may not seem like a lot but using a flow record of 33,000 days equates to 660 days.

   RESPONSE: Per DEIS Section 5.14, the period of record for the analysis (2040 to 2070) is represented by 11,000 days, so a 0.01 percent result equals approximately 1 day of water supply shortage. The percent of days summarized in Table 5-12 are the total number of days intermittently spread over the period of record. A 1 percent result equals a period of 110 days intermittently spread over a 30-year period of record.

8. Table 5-13 states "flow statistics" but does not indicate what flow statistic is being presented.

   RESPONSE: The table heading for Table 5-13 has been revised to indicate the 7Q10 flow statistic.

9. Although these low flows were pre-2008 they would represent Stage 3 or 4 drought conditions. I think it would be informative to model all the way downstream to L&D1 gage. It's unclear if Jordan has the capacity or will to make up flows in the Lower Cape Fear during these types of conditions. Where does the 600 cfs target come from for Fayetteville mentioned in the document? It would be interesting to see in the model whether the water systems could meet their demand during these flow events, whether or not they had WSRP in place. Perhaps the Annual 7-day minimum would be a good statistic to examine, in addition to the longest duration low flow value.

   02102500 CAPE FEAR RIVER AT LILLINGTON, NC -
   Water Years 1982 - 2021

Lowest daily mean	155.0	Aug 06, 2002
Annual 7-day minimum	206.3	Oct 09, 2007

   02105769 CAPE FEAR RIVER AT LOCK 1 NEAR KELLY, NC
   Water Years 1982 – 2021

Lowest daily mean	179.0	Aug 10, 2002
Annual 7-day minimum	322.7	Oct 13, 2007

   RESPONSE: The OASIS model extends downstream to Lock and Dam #1. The drought level 0 flow target at Lillington is 600 +/- 50 cfs. Section 5.14 of the DEIS provides a summary of the modeling results for the Cape Fear and Neuse River basin nodes, including CFPUA.

Nora Deamer (Basin Planning Branch):

Section 3.8: Section 3.8 of this report captures many of the issues in both the Neuse and Cape Fear River Basins accurately. The Neuse River basin is NSW and Fuquay-Varina has a nitrogen allocation which they must meet in order to discharge their waste into any stream in the Neuse River Basin.

RESPONSE: Comment noted.

The Cape Fear River basin is not officially classified as NSW, but it has been recognized as being nutrient over enriched. A model is required before additional nutrients can be allowed into the segment of the river basin. The information provided about the latest water quality data is likely accurate but what was missing is that during periods of extended low flow, water quality conditions decline which results in high chlorophyll a concentrations. The latest water quality data doesn't include extended low flow conditions. It is also important to note that due to the water quality concerns in the central portion of the Cape Fear River basin, the Division is participating in a nutrient criteria development plan with the goal of understanding and potentially developing nutrient criteria for flowing streams. This could result in instream nitrogen and/or phosphorus concentration criteria as well as development of a different chlorophyll a criterion for flowing streams. It is recognized that the current chlorophyll a standard is not likely appropriate for flowing streams (would likely be less than 40 µg/L).

RESPONSE: Comment noted.

Communities in NC need to evaluate their resources prior to developing their long-term growth plans. At some point these resources can no longer support continued development. The location of certain communities make growth more challenging. It needs to be recognized that in order to grow they will need to have in place the best available technologies to support their water supply and wastewater management needs.

RESPONSE: Comment noted.

Section 5.14.2 [and] 5.14.2.3. I believe this was also referenced in section 3.8.

RESPONSE: Comment noted.

On page 5-33 "Utilities seeking a new discharge are required to conduct independent water quality modeling to support the discharge request."

It should be noted that the Division completed data collection in 2020 and is currently working directly with the USEPA on a modeling effort of the central portion of the Cape Fear River Basin.

RESPONSE: Comment noted. The DEIS text in Section 5.14 has been revised to reflect the EPA modeling.

This work is scheduled to be completed at the end of 2023. At that point the Nutrient Criteria Development Plan (NCDP) process can use this model to establish if there is a need for instream criterion for N and P or other response variables (like Chl A). This information is needed prior to understanding what nutrient loading can be supported in the central Cape Fear River basin and allow for nutrient allocations, reductions, or other possible steps to address over enrichment in the Cape Fear River. This could lead to refinement of the permitting strategy, a specific watershed strategy to address all sources of nutrients to the basin, a TMDL or other voluntary and/or required measures.

Note: I did not verify the actual water quality findings. I don't think this is necessary. My comments indicate that during low flow periods there are serious water quality concerns and this is why we need to address nutrients in this section of the Cape Fear.

RESPONSE: The DEIS has been updated to reflect this latest information.

Forest Shepherd (Basin Planning Branch):

Comment #1:

The following statements are from the Environmental Impact Statement for Interbasin Transfer for Water Supply from Cape Fear River to Neuse River: "The ILA with Harnett County is for the purchase of up to 2 mgd. The contract expires in 2040; however, the Town anticipates a contract renewal with Harnett County in 2040. Additionally, the Town has negotiated with Harnett County for an additional 2 mgd increase until 2035." (pdf page 35; document page 1-3). Table 1-1 stating: "The Town has negotiated an additional 2 mgd until 2035 (2022)." (Table 1-1 image below).

This "additional 2 mgd increase until 2035" was not included in Tables 2-5, Table 2-6, and Table 3-1 (table images below). Specifically, this "additional 2 mgd increase until 2035" does not appear to be included in the "Water Supply Source By Seller, mgd" column of data under the "Harnett County (Cape Fear)" data column, any other columns of data, calculated values. Please consider including the "additional 2 mgd increase until 2035" comment throughout the document when discussing the water supply available to the Town of Fuquay-Varina and including it in any calculations and tables.

Additionally, if an additional 2 mgd contract for water supply is available until 2035 from Harnett County, please consider obtaining that additional water supply and/or explaining why the Town of Fuquay-Varina is not pursuing it. It appears that additional 2 mgd would improve the Town of Fuquay-Varina's projected water supply deficit (Table 2-4). An additional 2 mgd from Harnett County would provide the Town of Fuquay-Varina with a total water supply of 4 mgd from Harnett County until 2035, instead of the 2 mgd as stated in the tables. If this additional 2 mgd can be obtain it will afford the Town of Fuquay-Varina a total water supply of 7.25 mgd instead of the current 5.25 mgd. This would provide the Town of Fuquay-Varina with a water supply that could potentially meet the Maximum Day Water Demand (Table 3-1) until at least 2030 and possibly into 2035; depending on future growth.

RESPONSE: Table 1-1 was updated to reflect the temporary lease agreement for an additional 2 mgd with Harnett County until 2032. This additional 2 mgd was not explicitly included in the IBT calculations. The Town of Fuquay-Varina agreement with Harnett County is a temporary measure to provide water to the Town to mitigate the anticipated extended timing of construction of the City of Sanford's Water Filtration Facility and the associated finished water transmission main. The Town of Fuquay-Varina will not utilize the temporary lease agreement for the additional 2 mgd from Harnett County once the City of Sanford's Water Filtration Facility expansion project is completed.

Section 3.6.5 of the DEIS outlines the reasons for the Harnett County alternative to not be viable for the Town of Fuquay-Varina: *"Alternative 5 does not meet the Town of Fuquay-Varina's project purpose and need. The Town of Fuquay-Varina has been unable to secure permanent water supply capacity from Harnett County in lieu of the continuation of the temporary interlocal lease agreement. The Town of Fuquay-Varina's current interlocal agreement for 2 mgd expires in 2040. Harnett County has not committed to providing the Town of Fuquay-Varina additional water supply greater than the interlocal agreement amount as stated in County's approved 2021 LWSP. Therefore, Alternative 5 does not provide water supply capacity in a timeframe needed for the Town to address their water supply shortfall by 2030."*

Comment #2:

Could you please provide a citation for the sentence: "The Round 4 allocation increased the total Jordan Lake allocation to 95.9 percent. Raleigh Water rescinded their 4.7 mgd allocation from Jordan Lake in March 2019 as a result of the Falls Lake Reallocation Process for additional storage in the Falls Lake reservoir. The revised Jordan Lake allocation is 91.2 mgd."

RESPONSE: The Raleigh Water reference was provided.

Comment #3:
Related to these two statements:
"The Jordan Lake water quality storage never drops less than 20 percent in any alternative using either historic or climate change inflows. The water quality storage declines to less than 40 percent infrequently (e.g., less than 2 percent of the time)." "The two most concerning climate scenarios, there is a significant increase in the number of days with little or no additional runoff from the watershed area below the Lillington gage (e.g., no downstream flow gain). So, the combination of increased downstream demand, more severe drought scenarios, and cutbacks in the Jordan Lake release protocol under Stage 3 and 4 drought conditions combine to allow these brief shortages to materialize. It seems likely that with a significant volume of water left in the Jordan Lake Water Quality Pool, a change in policy and/or discretionary action by the USACE, in consultation with other stakeholders, would allow for additional releases to be made to meet these needs."

Could you please elaborate on what change in policy is expected and the timeline needed to fulfill that change in policy based on the statements above. Also, how would the discretionary action by the USACE, in consultation with other stakeholders, allow for additional releases and how long would that process take.

RESPONSE: The OASIS model simulations do suggest the potential benefit of establishing flow targets further downstream of Lillington, such as at Fayetteville or Lock and Dam #1 to mitigate extreme drought impacts on top of severe climate change. However, historically this has not been necessary. Per Table 5-9, the median unit runoff is the highest in the lower Cape Fear. No change in USACE policy is expected at present and none is warranted. The climate scenarios used, especially the two relying on RCP 8.5, as indicated in the second paragraph on page 5-37. The best available science at present indicates these scenarios represent greenhouse gas concentrations that are unlikely to occur based on the recent (e.g., past 5 years) shift toward renewable energy sources. Nevertheless, when water shortages arise, the USACE can quickly take discretionary action to mitigate those conditions. Once the Water Quality Pool drops less than 80 percent, the USACE will set up weekly calls with stakeholder groups. These stakeholder group discussions factor into the Jordan Lake dam release schedule for the upcoming week. Longer term changes to institute permanent flow targets further downstream would require more regulatory oversight and possibly an environmental assessment led by the USACE.

Comment #4:
In Table 3-21, Please explain why other municipalities (i.e., Chatham, Pittsboro, Siler City, and Holly Springs) will not be seeking water supplies from the City of Sanford.

RESPONSE: Pittsboro and Holly Springs are partners in the City of Sanford's Water Filtration Facility. Chatham County was partnering with Sanford only to provide water for the Moncure Industrial Park. The City of Sanford is now supplying water directly to Moncure, so Chatham County no longer needs to partner with Sanford. The City of Sanford has recently merged utilities with Siler City; however, Siler City is not a partner in the Sanford WTP expansion.

Adrienne Weaver (Classifications and Standards Branch):

The information in Subsection 1.5.6 (Surface water reclassification) is correct.

RESPONSE: Comment noted.

The critical area and protected area definitions in that same subsection are correct.

RESPONSE: Comment noted.

Paul Clark (Water Supply Watershed Protection Coordinator, Stormwater Branch, Division of Energy, Mineral, and Land Resources):

Recommended edits to the fifth paragraph in Subsection 3.4.1 (Proposed Middle Creek Reservoir) to make it clearer and more accurate:

"A surface water reclassification process per 15A NCAC 2B .0100 and .0200 would be required to reclassify the Middle Creek watershed as a WS-IV water supply watershed. Similar to Alternative 1 (Purchase of Finished Water from Raleigh Water), a proposed reservoir would have a significant impact on the development potential of the Middle Creek basin. The critical area is a one-half mile buffer area as measured from the normal pool elevation. The protected area is 5 miles as measured from normal pool elevation. In the protected area, the low-density option limits impervious surface to 24 percent (or 20,000 square foot lot excluding roadway ROW or one dwelling unit per half acre for single family residential development. Only the 24 percent impervious cover measurement is allowed for non-residential and all other residential development. The low-density option allows for higher density (e.g., 70 percent) in 10 percent of a jurisdiction's service area. The WS-IV high-density option limits built upon area to 24 to 70 percent in the protected area; however, the jurisdiction must assume responsibility for operation and maintenance for engineered stormwater controls to handle the additional stormwater flow generated from greater impervious cover."

RESPONSE: Edits to the DEIS have been made per the above recommendation.

Recommend using "area" instead of "buffer" because buffer implies little to no development in this region. One can develop in the critical area associated with a water supply, but there are restrictions associated with the development.

RESPONSE: Comment note. Edits were made to the DEIS per the above recommendation.

Mark Durway (Groundwater Management Branch):

In summary, Hazen & Sawyer concludes that Fuquay-Varina would need a 9100 acre well field and 388 wells to meet its 2055 water demand of 8.4 mgd. The study is based on 1000-ft well spacing and average well yield of 30 gpm. Hazen & Sawyer notes that groundwater within the area is vulnerable to contamination and that a full-scale water treatment plant would be required for blending, softening, iron and manganese removal, chlorination, potential contaminant treatment and removal, etc.

If further evaluation of groundwater as an IBT alternative is warranted, the following is recommended:

1. Identify one or more potential wellfield locations. The well system and wellfield should meet DWR Public Water Supply siting requirements including Wellhead Protection Area standards. Discuss site suitability and projected well yield with the Wake County hydrogeologist and DWR Groundwater Management Branch staff.
2. Conduct a Phase I Environmental Site Assessment to identify areas of known or potential groundwater contamination which could affect water quality and availability and result in additional treatment requirements and operating costs. Identify how potential water system issues will be overcome, such as reduced well yields during drought.
3. Modify the proposed wellfield plan to include a DWR-approved Wellhead Protection Area and a wellfield expansion area should additional wells be required because of unforeseen water quantity and water quality issues.

RESPONSE: The groundwater alternative was eliminated in the DEIS due to the feasibility of large groundwater systems for public water supply in the Piedmont Region. The 2022 USGS groundwater study in Wake County supports the conclusion in the DEIS that limited well yield is available for large water supply systems.

Renee Kramer (NCDEQ Title VI and Environmental Justice Coordinator):

I think overall the EJ portion is well done, and I commend them for including such a section in the report. I have reviewed the EJ portion and have the following comments:

1. In the section 4.15.2, 50% threshold for low-income is the highest I have ever seen, and I think is too high to use. For example, we use 10% greater than the state or county levels to flag as the potential for impact. I believe they also use that comparison for other metrics, so it is unclear why they don't use that for low-income.

   RESPONSE: The 50 percent threshold was based on *Promising Practices for EJ Methodologies in NEPA Reviews* (March 2016), a document issued by the federal Interagency Working Group on Environmental Justice and NEPA Committee. The analysis threshold has been revised to reflect the +10 percent metric for all population analyses. The +10 percent metric is based on the definition of potentially underserved block groups in the NC Department of Environmental Quality's *Community Mapping System Glossary of Terms and Definitions* (updated January 2022).

2. I want to make sure they are aware of the DEQ Community Mapping System and our potentially underserved community layer-that can be a great way to conduct maps and visually demonstrate potential EJ impacts of projects.

   RESPONSE: Comment noted.

3. I also didn't see any portion about community outreach and if they plan to conduct any engagement in their identified underserved communities-they should outline some outreach plan to connect with those communities if there is opportunity for public input to shape or change the project outcome.

   RESPONSE: The Town of Fuquay-Varina has engaged in public outreach for the proposed IBT project via the public meetings that were held in the fall of 2020. The Town will continue to engage in public outreach as part of the State Environmental Policy Act (SEPA) process and IBT Petition phase.

Vann Stancil (Research Coordinator, NCWRC Habitat Conservation Division):

In general, does this project present any cause for concern regarding the cumulative transfer of water from the Cape Fear to the Neuse or to any other river basin?

RESPONSE: No, the proposed project will not result in a concern over cumulative impacts of the proposed transfer. Section 5.15 describes the minimal direct impact that the proposed transfer will have on the Cape Fear and Neuse River basins.

There is increased discussion about possibly removing Buckhorn Dam on the Cape Fear River. Some of the biggest concerns are the intake(s) within the impoundment above Buckhorn Dam. This might be a great opportunity to reconfigure Sanford's intake to ensure it is sustainable even if the dam is removed. The DEIS alludes to that somewhat, saying that they want to move it lower in the river, but the DEIS should be clearer that the intake is in the impoundment formed by Buckhorn Dam and future plans should not assume that the dam will always be there.

RESPONSE: The City of Sanford's raw water intake was conservatively modeled as a run-of-river intake and does not include storage from the Buckhorn Dam impoundment. Buckhorn Dam is a low head dam, so the buffering capacity of storage behind the dam is minimal. Dam removal would be a concern for the operational considerations at the City of Sanford's raw water intake. The raw water intake design approach includes locating the screens at a favorable location in the river under present conditions. The design includes a removable spool piece that will allow the screens to be dropped down to a minimum operable level.

SPECIFICALLY ABOUT RARE SPECIES:

The list of species on page 4-26 is somewhat misleading. First of all, while NCWRC does do some stream surveys for fish, we are usually targeting certain rare species, not doing a fish community assessment. The community assessment of stream fish is more similar to the work of the Biological Assessment Branch of DEQ. Biological Assessment Branch | NC DEQ. In addition, some of those species are only found much farther southeast, in the lower Coastal Plain of the Neuse or Cape Fear River basins. So, the list is somewhat misleading, not necessarily comprehensive, and not representative of the species found near the project.

RESPONSE: Language relative to fish community sampling was acquired from a WRC report, as sited in Section 4.11, paragraph 2, of the DEIS. The 95 fish species and priority aquatic species referenced in Section 4.11 of the DEIS were reported by WRC in 2017. The DEIS states that the species listed are reported by WRC to be within the Cape Fear and Neuse River basins and does not state that they are not in proximity to the project areas. Information provided for final permitting efforts will be narrowed down following selection of a final alternative utilizing most recent publicly available location specific information provided by WRC.

It would be useful to include the type of taxa for species listed in Table 4-13 starting on page 4- 33/173. It's confusing when the lists jumps around from fishes to birds, to mammals since they are alphabetical and separated only by vertebrates and invertebrates and vascular and non-vascular plants. I'd prefer headings for fish, mussels, crayfish, bats, mammals, etc., otherwise it is difficult to determine what some species are. In addition, it would be helpful to identify if aquatic species are found only in the Cape Fear or Neuse basin or both.

RESPONSE: Since NEPA guidance does not specify the categorization of listed species in NEPA documents, reorganization of Table 4-13 is not necessary.

The list of state listed species includes some species that can be removed. While I do not know the background behind the record(s), the American alligator is not typically found in Harnett Co. so that record deserves further investigation. Robust redhorse should be removed, in NC they are only found in the Pee Dee River below Blewett Falls Dam. Therefore, I am not sure why Chatham Co. is included. The

list should be checked again for any other anomalies or errors.

RESPONSE: Table 4-13 has been updated per the rereview of the USFWS Information for Planning and Consulting tool as of August 11, 2023.

The descriptions of listed species starting on pages 4-45/185 are very generic. The descriptions would be much more useful if they focused on habitat and occurrence within NC and within the counties of concern here. For instance, Atlantic sturgeon is limited to our large coastal rivers below dams. They can move upstream to Falls Lake Dam, at least theoretically, but won't pass all 3 locks and dams or Buckhorn Dam on the Cape Fear River and won't be in tributaries to the Neuse or Cape Fear River. American alligators are coastal, a Harnett Co. record is anomalous. Neuse River waterdog and Carolina madtom are also endemic to the Tar River basin (not just the Neuse). There's little discussion about the distribution and habitat of the Atlantic Pigtoe, which is what is most useful to include. The Tar spiny description is more comprehensive and would be a good template to follow for other species.

RESPONSE: Species, such as the American alligator, provided in the DEIS are listed by USFWS based on their status by County. A statement related to the distribution of the Neuse River waterdog and Carolina madtom has been updated in Section 4.13.2.1 of the DEIS. Specific descriptions of habitat and occurrence has not been provided due to the extensive geographic area covered by the project corridors and the numerous types of communities present within the project areas.

On page 4-60/200 the authors talk about Significant Aquatic Endangered Species Habitats (SAESH) designated by the WRC. That is an old designation that we no longer use, therefore all references to SAESH should be removed. This would be a good place to include Critical Habitat (designated by the FWS) as applicable, instead. For instance, Middle Creek is Critical Habitat for Neuse River waterdog for approximately 7 miles as it flows from Wake to Johnston County.

RESPONSE: Discussion related to areas of SAESH has been removed from the DEIS as appropriate. Section 4.13.2 has been updated to include information related to USFWS designated critical habitat for federally listed species.

The NHP's lists of rare plants and rare animals have been updated in their 2022 publication. The state status of some species has changed since the DEIS was written. 2022 Rare Animal List | NHP (ncnhp.org)

RESPONSE: Updates will continuously occur throughout the review process and publication of the DEIS.

If there are records for Federally listed species near the project, the US Fish & Wildlife Service will need to be consulted. If they believe a Federally listed species may be impacted by the project, they will issue a Biological Opinion and address take. That is not discussed or listed in the permitting section.

RESPONSE: Potential need for consultation with USFWS is addressed in Section 5.13.2.

Shelton Sullivan (401 & Buffer Permitting Branch):

For any of the proposed options, an environmental assessment of the jurisdictional and non-jurisdictional streams, wetlands, waters, and riparian buffers is required to accurately depict the environmental features along with the proposed temporary and permanent impacts for DWR review and evaluation. These impacts from any of the proposed alternatives will require the coverage of a 401 Water Quality Certification, as per 15A NCAC 02H Section .0500, an Isolated Wetlands and Waters (non-404) Permit, as per 15A NCAC 02H Section .1300, and/or a Federally Non-jurisdictional Wetlands or Waters permit, as per 15A NCAC 02H Section 01400. In addition, if there are proposed temporary or permanent impacts within the regulated Neuse River Riparian Buffers, as per 15A NCAC 02B .0714, then these should be evaluated to determine if a Buffer Authorization should be sought and submitted to DWR for review and approval, as per 15A NCAC 02B .0611. Please note that the applicant must also obtain and comply with all applicable federal, other state, and local regulations regarding the construction and development of this project.

RESPONSE: Delineation of jurisdictional waters and riparian buffers will be conducted upon selection of an alternative. Permits will be acquired, as applicable, prior to construction commencement of the final alternative.

David Wainwright (Water Supply Planning Branch):

- In Table ES-4, and in other places in the document, the term "politically unacceptable" is used to describe a negative aspect of some alternatives considered, primarily those associated with Johnston County. After reviewing the document, the term is understood, but is probably not a good term to use, as without context it could be taken out of context and appear that the project is politically motivated. Perhaps something like "May not be acceptable to local government" or something similar would be a better way to phrase the argument.

  RESPONSE: The DEIS has been revised with the suggested text. Additionally, the DEIS Alternative 2 text has been revised to reflect that Johnston County is moving forward with a preliminary design for a raw water intake at Richardson Bridge Road as the next water supply solution. When the DEIS was originally drafted, Johnston County had not made the decision to move forward with the Richardson Bridge raw water intake.

- At the top of page 1-2, 01 North Carolina Administrative Code (NCAC) 25 .0100 is referenced as a SEPA rule. I can see why the reference to these rules was chosen. However, it may be more appropriate to reference G.S. 143-215 .22L(d), which specifically references the requirement of an EA or EIS for a proposed IBT project and the requirements of the document.

  RESPONSE: The DEIS page 1-2 has been revised to reflect General Statute §143-215 .22L(d).

- The very last bullet item at the bottom of page 1-4 states "Interbasin transfers are explicitly exempt from Session Law 215-90. All interbasin transfers are required to submit environmental documentation for SEPA review." This statement is a little confusing, stating in the first sentence that IBT projects are exempt from SEPA then saying that they are required. Session Law 215-90 does not exempt IBT projects from SEPA; quite to the contrary. Section 7 of 215-90 (G.S. 143-215 .22L(d)) explicitly states that an EA or EIS for IBT projects is required.

  RESPONSE: This bullet point has been deleted from the DEIS text. Session Law 2015-90 does require environmental documentation per GS 143-215 .22L. The bullet was meant to state that interbasin transfers are not subject to the list of project exclusions in Session Law 2015-90 Section 5 modifying G.S. 113A-12.

- The purpose and need statement does not clearly define those aspects of the project. The purpose and need for any project needs to be explicitly and clearly stated as they define the project and are used to determine whether the alternatives should be carried forward for additional analysis as well as to what extent the alternative does (or does not) satisfy the purpose and need. For example, and simply stated, the purpose could be to provide additional drinking water to the Town of Fuquay-Varina; the need could be to address the anticipated growth, and hence water demands, within the Town's water service limits. By defining the purpose in such a manner, it allows each alternative to be compared to these – does the alternative provide additional drinking water to the Town? Will the alternative provide enough water to supply future needs? These are yes/no questions that can easily compare each alternative and whether it meets the purpose and need of the project. The degree to which each alternative meets the purpose and need can further be used to discount alternatives – if an alternative does supply water but doesn't supply enough to meet the need then it can perhaps be discounted based on this. Part of the need could be to supply the Town with an additional 4.2 MGD by 2025 (and explain why this is necessary – the P&N section does not explain why 2025 is critical to having the water supply in place) and then discount certain alternatives because they cannot meet the stated need.

  RESPONSE: Section 2.4 (Purpose and Need Summary) of the DEIS has been revised to clarify the purpose and need. A new Table 2-6 has been added to support the purpose and need. Table 2-6 summarizes the Town of Fuquay-Varina's average day in a maximum month water demand projections, the interbasin transfer projections from the Cape Fear River basin to the Neuse River basin, the Town's total current water supply contract amount, and the projected water supply shortfall.

The water supply shortfall assumes that the Town's current contract amounts expire as planned and additional water supply is not available. Without provisions for additional water supply capacity, the Town is projected to have a water supply shortfall beginning in 2031, which supports the need for additional (and permanent) water supply to satisfy the Town's projected water demand in the service area.

Additionally, the text in Section 3 (Alternatives Analysis) of the DEIS has been modified to compare each alternative against the purpose and need, as suggested by this comment.

- In Section 5.14.2, with respect to wastewater discharges, it is stated that, "Direct and indirect permanent and temporary impacts as a result of the discharge of treated effluent will be negligible, as these impacts are addressed in an existing CWA permit." The additional wastewater discharge created because of the transfer of water is a direct impact resulting from this project and will likely not be a negligible impact; the increased discharge is being generated due to additional water supply being made available. The effects of the additional wastewater discharge to surface waters, water quality, wild and aquatic life, etc. needs to be taken into consideration and addressed and not just stating that it will be addressed through the NPDES permit, which will likely need to be amended to account for the additional discharge as a result of this project.

  RESPONSE: Sections 5.14.4 and 5.15.2 have been revised to clarify the modeling results with respect to water quality.

- On page 1-2 in Section 1.4.1, second paragraph, line five, "Ten Road" I think should be "Ten-Ten Road." Also, page 3-38, Section 3.7.3, paragraph 4, line 2, "Har" should probably be "Haw".

  RESPONSE: The DEIS text in Section 1.4.1 and Section 3.7.3 was updated with these edits.

Louis Murray (Water Supply Planning Branch):

I have reviewed Sections 2 and 3 based on evaluating consistency with Fuquay's LWSPs.

Section 2. Purpose and Need

1. Section 2. Purpose and Need/Population – historic population numbers in Table 2-1 are consistent with those referenced in the LWSPs. However, the reported 5-yr moving average growth rates should be checked, as most look a little off; for example, annualized 5-yr ma growth rates for:

   2004 to 2009 = (8.53+7.86+0.95+0.94+0.93)/5 = 3.84% (not 3.78%);
   2012 to 2017 = (0.66+9.34+5.85+13.90+5.73)/5 = 7.10% (not 7.00%);
   2015 to 2020 = (13.90+5.73+6.70+4.00+7.74)/5 = 7.61% (not 7.56%)

   RESPONSE: The 5-year moving average for population was calculated using an exponential moving average based on the population data. The calculation was changed to a simple moving average based on the annual growth rate increase per this comment.

2. 2.1.2 Population Projections – the fourth paragraph states, "The percent of population served in the Neuse and Cape Fear River basins at build-out is approximately 62 percent and 38 percent, respectively. The ratio of anticipated growth in the Cape Fear and Neuse River basins is fairly consistent throughout the planning period." Just a comment here - the 2021 LWSP indicates a 50/50 service-area split between the Neuse and Cape Fear Basins, different than the 62/28 shown above. It is something to keep in mind when we assume a system's demand is proportional to the areal distribution in our Basin Water Quantity plans. Table 2-2. Population Projections – projected populations in Table 2-2 are consistent with those reported in the 2021 LWSP.

   RESPONSE: The Town of Fuquay-Varina has updated the 2022 LWSP with a 60%/40% distribution in the Neuse and Cape Fear River basins, respectively.

3. 2.2 Water Demand Analysis – the first paragraph reads, "Residential accounts contributed approximately 72 percent of the water use in the service area between 2015 and 2021." However, I get 66% if referring to the percentage of residential use to the total service-area demand.

   "The number of residential accounts has increased an average of 5.5 percent per year since 2015." However, I get 6.6% per year if accounts are equated to metered connections. "Residential use contributes 73 percent of the total water demand." Assuming reference to the most recent (2021) LWSP, I get 61% (1.714 mgd/2.791 mgd). If averaged over the six years from 2015-2021, I get 66%.

   RESPONSE: The water demand analysis section has been updated with the 2022 data. Additionally, the calculation did not consider the unaccounted for water in the total percentage, which was adjusted in Section 2 per this comment.

   "Commercial use contributes 17 percent of the total water demand." Assuming reference to the most recent (2021) LWSP, I get 15% (o.407 mgd/2.791 mgd). If averaged over the six years from 2015-2021, I get 16%.

   RESPONSE: The water demand analysis section has been updated with the 2022 data. Additionally, the calculation did not consider the unaccounted for water in the total percentage, which was adjusted in Section 2 per this comment.

4. 2.2.1 Per Capita Demand – the first paragraph reads, “Since 2016, the residential per capita use is less than 54 gpcd.” However, per capita demand averaged 56 gpcd in 2019.

   RESPONSE: In 2019, the residential per capita demand was 53.2 gpcd (e.g., 1.629 mgd residential use * 1,000,000 gal/MG / 30,628 people = 53.2 gpcd).

   “The sum of industrial and institutional per capita use has averaged approximately 4 gpcd over the last few years.” However, I get 6.5 gpcd over the past four years.

   RESPONSE: This statement was made as a general characterization of the industrial and institutional water use. Including the new 2022 data, the average industrial and institutional per capita use averages 3.8 and 3.3, respectively. The data is summarized in the following table and the DEIS text was updated.

Year	Industrial Water Demand, mgd	Industrial Per Capita Demand, gpcd	Institutional Water Demand, mgd	Institutional Per Capita Demand, gpcd
2018	0.0250	0.8	0.1020	3.5
2019	0.0970	3.2	0.1070	3.5
2020	0.0250	0.8	0.0390	1.2
2021	0.2430	7.1	0.2160	6.3
2022	0.2800	7.1	0.0840	2.1
Average (2018 – 2021)		3.0		3.6
Average (2018 – 2022)		**3.8**		**3.3**

   3rd para – “The Town’s percentage of non-revenue water has declined since 2016 at 13.8 percent to 7.6 percent in 2021.” However, assuming non-revenue water includes system process use as indicated in this paragraph, I get 12.7% in 2016 and 7.6% in 2021 (Non-revenue water equals unaccounted-for-water plus process water).

   RESPONSE: The percentage of revenue water has been updated to include process water. The percentage of unaccounted for water in 2021 was 7.6 percent.

5. Table 2-3. Summary of total Water Billed and Purchased Water Per Capita Demand – the footnote 2 at the bottom of this table defines ‘non-revenue’ water as “unaccounted- for water in Local Water Supply Plans (Section 5. Planning).” However, non-revenue water was earlier defined in this document to also include process water use.

   I reviewed the data for years 2015 to 2021. If Total Billed water = Total Water Purchased - (process water + unaccounted for water), then the following corrections are needed:
   2020: total water billed and purchased should be 2.173 mgd and 2.517 mgd, respectively.
   2019: total water billed and purchased should be 2.253 mgd and 2.478 mgd, respectively.
   2018: total water billed and purchased should be 2.067 mgd and 2.306 mgd, respectively.
   2017: total water billed and purchased should be 1.949 mgd and 2.186 mgd, respectively.
   2016: total water billed and purchased should be 1.864 mgd and 2.136 mgd, respectively.
   2015: total water billed and purchased should be 1.822 mgd and 2.008 mgd, respectively.

   I would suggest also reviewing years 2002-2014. Changes likely needed here also.

   RESPONSE: Edits have been made to Table 2-3 to reflect these changes.

6. Table 2-4 Summary of Annual Average, Max Month, and Max Day Water Demand Projections – Correction needed – 2050 max monthly demand should be 8.9 mgd. All other values are correct and consistent with 2021 LWSP.

   RESPONSE: The text in Table 2-4 has been corrected to reflect this edit.

   Suggest revising footnote 1 to indicate that the projected populations are consistent with those in the 2021 LWSP. For example, "[1] Population projections from linear best fit regression method used for the 2021 Local Water Supply Plan."

   RESPONSE: Edits were made to Table 2-4 to reflect this change.

7. 2.3 Interbasin Transfer Projections – first paragraph indicates that "Post 2049, all of the Town's water supply will originate from the Cape Fear River basin (2-3). The maximum month transfer in 2055 is anticipated to be 6.13 mgd. The maximum day transfer amount is anticipated to be 7.8 mgd. By 2055, approximately 12.6 mgd of water supply will be required to support peak day needs." However, the 2021 LWSP indicates future purchases from Sanford at 11.0 mgd (avg. day) by 2055 which, using the previously referenced max month and max day peaking factors of 1.18 and 1.5, would equate to a max month supply of 13.0 mgd and a max day supply of 16.5 mgd, amounts greater than those referenced here. Please explain.

   RESPONSE: The maximum day is calculated using a 1.5 peaking factor from the average day. The 2055 maximum day is calculated as an average day of 8.37 mgd multiplied by the peaking factor of 1.5 to equal 12.5 mgd. The Town of Fuquay-Varina will maintain the 2 mgd from Harnett County for a total water supply from the Cape Fear River basin of 13 mgd.

8. 2.4 Summary of Purpose and Need – revise first paragraph to indicate the current population is now over 34,000 people.

   RESPONSE: Section 2.5 (formerly Section 2.4) has been updated. This sentence is no longer included in the first paragraph.

Section 3. Alternative Analysis

9. 3.1 No Action – Fuquay's 2021 LWSP does not show an additional supply of 2.0 mgd coming from Harnett County until 2035 as mentioned in the first paragraph (maybe I am misreading this?).

   RESPONSE: The temporary agreement for an additional 2 mgd from Harnett County was in progress as the Draft EIS was being finalized and submitted for review. This leased capacity is included in the 2022 Local Water Supply Plan. This ILA was added to Section 1.4.3 Table 1-1 and in Appendix A.

10. Table 3-2. Sale agreement with Franklin County is not shown in Raleigh's 2021 LWSP (maybe it was not finalized in time to include it).

    RESPONSE: Raleigh Water's wholesale water agreement with Franklin County was in progress as the Draft EIS was being finalized. The agreement is included in Raleigh Water's 2022 Local Water Supply Plan. Table 3-2 was updated to reflect this revision.

11. 3.2.1 Existing Water Supply and Treatment Infrastructure – the third paragraph indicates a safe yield of 84 mgd for Falls Lake but Raleigh's 2021 LWSP shows a 50-yr safe yield of 88.2 mgd. The 5th paragraph indicates a capacity of 20 mgd for the Dempsey Benton WTP but the LWSP shows 16 mgd.

    RESPONSE: Attributing yields to individual supply source is complicated when multiple sources used conjunctively are considered. The total yield for Raleigh Water's system (99.4 mgd) exceeds the sum

of the yield from either Falls Lake or Wheeler/Benson independently. Raleigh Water's 2022 Local Water Supply Plan indicates a 50-year safe yield of 11.2 mgd in Lake Benson, which is consistent with the DEIS text. In the Local Water Supply Plan yield of 88.2 mgd, Raleigh Water is reporting the conjunctive benefit of two water supply sources with different droughts of record (e.g., 1980s for Lakes Wheeler and Benson and 2000s for Falls Lake). The Falls Lake yield stated as 84 mgd is the "stand-alone" yield of this source. The difference of approximately 4 mgd is the benefit of operating two sources which have different droughts of record. A statement has been added to Section 3.2.1 of the DEIS to clarify this point.

12. 3.3.4 Summary -- first paragraph reads "Johnston County is unlikely to accept a new wholesale customer or water supply partner. The County's continued long range water supply planning effort has identified a potentially feasible alternative that will satisfy the 2050 water supply deficit in the County's service area. The identified alternative will not yield sufficient water supply capacity for additional wholesale customers or water supply partners, including the Town of Fuquay-Varina. However, this alternative was carried forward in the EIS for an environmental impact analysis". Agree. Johnston County's 2021 Plan, still unapproved, shows a demand-to-supply ratio of 82% by 2030 and 86% by 2040.

    RESPONSE: Comment noted.

13. 3.5.1. Population and Water Demand Projections for City of Dunn – the first paragraph states that the average day water demand in 2050 is 5.9 mgd. However, Table 3-10 below (as well as the LWSP) indicate 4.85 mgd.

    RESPONSE: The DEIS text has been modified to reflect an average day water demand of 4.85 mgd in 2050.

14. 3.5.3 Cape Fear River Instream Flow Characterization at Dunn – first paragraph reads "A 7Q10 value near Dunn is not documented in the 1998 USGS report. However, DWR published a Cape Fear River Basin Water Supply Plan (2002) that estimated the available water withdrawal at Dunn to be 69.8 mgd." What does 'available' water withdrawal mean? Wondering how this was defined in DWRs report. It is much greater than the 12.0 mgd shown in the LWSP as the 20-yr safe yield.

    RESPONSE: Per the Cape Fear River Basin Water Supply Plan (2002), DWR assumed that the maximum capacity of a run of river intake is 20% of the 7Q10 flow at that location unless other limits on withdrawals were reported.

15. Table 3-20 Summary of City of Sanford Wholesale Water Sales Contracts – the City sold approximately 0.87 mgd (not 0.83 mgd) of bulk finished water out of a total contract amount of 2.3 mgd in 2021, excluding emergency use contracts. Also, the avg. day sale to Chatham County (Asbury) in 2021 was 0.445 mgd, not 0.401 mgd.

    RESPONSE: Due to the timing of the DEIS with respect to the City of Sanford's Local Water Supply Plan, the provisional 2021 LWSP data was used. The DEIS has been updated with provisional 2022 Local Water Supply data.

16. I briefly reviewed the twelve alternatives and, based on my very limited knowledge of the specifics, feel comfortable with the rationale used to accept some while rejecting others. Other than no action, the GW alternative is one of the more obvious rejections.

    RESPONSE: Comment noted.

Vardry Austin (Water Supply Planning Branch):

EIS Page 2-4 and Appendix A – Page 13: In the first bullet, commercial accounts should be 7.4 percent.

RESPONSE: The DEIS text has been updated to reflect this change. Data from the approved 2022 Local Water Supply Plan has been added. The average commercial demand between 2015 and 2022 is 7.1 percent.

EIS Page 2-5: In the third paragraph, correct the percent of commercial accounts to 7.4 percent of total accounts.

RESPONSE: The DEIS text has been updated to reflect this change. Data from the approved 2022 Local Water Supply Plan has been added. The average commercial demand between 2015 and 2022 is 7.1 percent.

EIS Page 3-69: Fifth paragraph, commercial accounts should be 7.4 percent.

RESPONSE: The DEIS text has been updated to reflect this change.

Appendix A – Table 4: Correct the LWSP population for 2019.

RESPONSE: Table 4 in Appendix A has been updated.

Appendix A – Table 8: Correct UAFW per capita demand as noted in the LWSP.

RESPONSE: Table 8 in Appendix A has been updated.

Appendix A – Table 9 and EIS Table 2-3 (as appropriate): Revise total water billed and total water purchased to calculate non-revenue water (unaccounted-for water) as shown in the LWSP.

RESPONSE: Table 9 in Appendix A and Table 2-3 of the DEIS have been updated.

Appendix A – Table 9 and EIS Table 2-3 (as appropriate): Complete table for non-revenue water for 2021.

RESPONSE: Non-revenue water for 2021 is included in Table 9 of Appendix A and DEIS Table 2-3.

Appendix A – Table 9 and EIS Table 2-3 (as appropriate): Change heading for non-revenue water to read MGD.

RESPONSE: Appendix A Table 9 and DEIS Table 2-3 have been revised to delete this column. This column was replaced with “Unaccounted for Water, %.”

Appendix A – Table 11: Correct the maximum month water demand for 2050.

RESPONSE: The correction to Appendix A Table 11 has been made.

EIS Page 3-27: Section 3.6.1 states the county’s average day withdrawal in 2020 was 19.93 mgd with a maximum day of 27.85 mgd. Confirm the source of these numbers since they are not in the 2020 LWSP.

RESPONSE: The values stated in the DEIS may have been provisional LWSP data. The DEIS text has been updated to reflect the annual average and maximum day per the approved 2021 Local Water Supply Plan.

EIS Page 3-49: The third paragraph states the average day water demand in 2021 for Sanford was 6.4 mgd with a maximum day demand approaching 12 mgd. Confirm the source of these numbers since they are not in the 2021 LWSP.

RESPONSE: The DEIS has been updated with 2022 Local Water Supply Plan data for annual average and maximum day.

Harold Brady (Water Supply Planning Branch):

Executive Summary

1. Cover Page: Need to state that this Draft EIS document has been written for NCDEQ – Division of Water Resources. "Completeness review" language should be removed before issuance of the draft for public review.

   RESPONSE: The text on the inside cover page has been replaced with the following:

Past Submittals:	DEIS State Agency Review (July 2022)
Current Submittal:	DEIS for State Environmental Policy Act Review (March 2023)

2. Back Cover Page: Replace "River Basin Management" with "Water Supply Planning"

   RESPONSE: This text edit has been made to the inside cover page.

3. Executive Summary, ES.1, second paragraph, second sentence: Consider opening with, "Per GS 215-143.22G."

   RESPONSE: The second sentence of the second paragraph in ES.1 has been revised.

4. Executive Summary, ES.1, second paragraph, last sentence: Consider referencing this location on a map, as well as identifying the HUC number.

   RESPONSE: The second paragraph of ES.1 has been revised to match the second paragraph in Section 1.1. A reference to Figure 1-1 was added.

5. Executive Summary, ES.2, second paragraph, first sentence: Consider adding that Harnett County is the Town's current primary water supplier. The use of "temporary" is questionable, considering nearly all water supply purchase agreements are time-limited, including the ILA with Harnett County. Perhaps provide an explanation that these will not be renewed. Please include any documentation from the sellers regarding this issue. Please revise accordingly throughout the document.

   RESPONSE: The first and second paragraphs in Section ES.3 (formerly Section ES.2) were revised as follows:

   "The Town of Fuquay-Varina needs to secure a permanent water supply source in lieu of a continuation of temporary interlocal lease agreements with wholesale suppliers to meet the projected growth and water demand. The Town of Fuquay-Varina is pursuing this water supply project to secure a permanent water supply source to meet the water supply needs in the Town's service area. The preferred water supply source results in a requirement for an interbasin transfer (IBT) certificate to transfer water from the Cape Fear River basin to the Neuse River basin. Per General Statute §143-215.22L, an interbasin transfer certificate is required if a daily average water demand of 2 mgd in a calendar month (e.g., maximum month) or 3 mgd in one day (e.g., maximum day) is exceeded.

   Per the contractual language in interlocal agreements, the Town of Fuquay-Varina does not have the right of ownership of treatment capacity in neighboring purveyor's treatment facilities. Therefore, the Town of Fuquay-Varina cannot control the production of water or guarantee a reliable water supply. All three of the Town of Fuquay-Varina's interlocal agreements (e.g., Raleigh Water, Johnston County, and Harnett County) have the right to interrupt finished water service on an as-needed basis or in an emergency. The Town of Fuquay-Varina receives approximately 50 percent of finished water from Harnett County."

6. Executive Summary, ES.2, second paragraph, third sentence: Need to describe the proposed project or preferred alternative before stating that an IBT is necessary.

   RESPONSE: A new Section ES.2 was edit to better describe the proposed project.

7. Executive Summary, ES.2, third paragraph, third sentence: Include, “met or” between “is” and “exceeded”.

   RESPONSE: The third paragraph of Section ES.3 (formerly ES.2) was edited.

8. Executive Summary, ES.2, third paragraph, fifth sentence: Change “amount” to “amounts”, as there are multiple contract amounts.

   RESPONSE: The fifth sentence of the third paragraph in Section ES.3 (formerly Section ES.2) has been edited.

9. Executive Summary, ES.3, second paragraph, first sentence: Replace “will support the” to “has been prepared for”. Add, “as part of the” between “(DEQ)” and “decision- making”.

   RESPONSE: The first sentence of the second paragraph in Section ES.2 (formerly Section ES.3) has been edited.

10. Executive Summary, ES.3, second paragraph, last sentence: Please double-check the Administrative Code SEPA citation. Please also reference, GS 113-A, making specific note of its various subsections depending upon the subject throughout the draft document.

    RESPONSE: The reference to the Administrative Code in the text has been corrected. The reference to General Statute §113A has been added to several sections.

11. Executive Summary, Table ES-2: Include the definitions of footnotes on every page that they are used. This should be done throughout the document. The portion of table with no information on page vi should be deleted.

    RESPONSE: Each table has “header row repeat” programming to maintain the table title and table column headers with the applicable footnotes if a table has to break pages. Many of the tables in the EIS contain a significant amount of data, so table breaks across pages are occasionally necessary. The document format does not allow footnotes in the page footer. The additional page has been deleted. This page was added for front and back printing.

12. Executive Summary, ES.5, first paragraph, last sentence: These qualifiers will need to be quantitatively defined for each impact type throughout the document.

    RESPONSE: The EIS has been written using standards set forth by the North Carolina Department of Administration in the Environmental Assessment Guidelines. Per the guidelines in Section E (Predicted Environmental Effects of Projects), quantifiable impacts are necessary in all categories, where quantifiable impacts are feasible based on available published mapping and data. Where impacts cannot be quantified, impact intensity (e.g., negligible, minor, moderate, and major) were developed based on National Environmental Policy Act definitions for context and intensity per 40 CFR §1508 and impact threshold guidelines from federal agencies.

13. Executive Summary, ES.6, second paragraph, fifth bullet: Need to note specifically what the noted impacts are for downstream water users. Please ensure that the 99.9% value is not misleading. Furthermore, the four downstream water users noted are following the statutory requirements for Water Shortage Response Plans (WSRP). The document should contain an analysis (i.e., post-process) of potential impacts to those water systems whose WSRP triggers are not in the model to

fully evaluate all potential impacts.

RESPONSE: The 99.9% reliability statement has been removed. Between revisions to Sections 3 and 4 of Appendix C and revisions to ES.6, the document contains the analysis DWR requested. Demand reductions would mitigate shortages to some extent, but may not completely eliminate shortages. In combination with the storage above Lock and Dam 1 (now described in Section 4 of Appendix C) and modest increases in Jordan Lake operations, the shortages can be eliminated. Simply changing the Jordan Lake Drought Stage 3 releases back to Stage 2 operations also eliminates shortages even without implementing demand reductions. This is described in Section 4 of Appendix C.

14. Executive Summary, ES.6, second paragraph, eighth bullet: Please provide the value or a quantifiable definition for “nominal”.

    RESPONSE: Discussion of time spent below 80% the Water Quality Pool storage has been relegated to discussion in Section 3.2 of Appendix C. There is a 40% reduction between 2025 and 2055 of time below 80% of water quality storage (25% versus 15%). The range across all 12 alternatives in 2055 spans just 15.0% to 15.7% under the historical hydrology. We have removed use of the term “nominal.”

15. Executive Summary, ES.6, second paragraph, ninth bullet: Please explain the context and importance of this statement.

    RESPONSE: The 550 cfs flow target at Lillington is met over 85% of the time in 2055 (85.3% to 85.8%), which is a slight increase from an 81% result in the 2025 scenario. The frequency of meeting the flow target matches fairly closely with the frequency of time Jordan Lake is not in Drought Stage 1 through 4. The flow target is met slightly more often (than times in Drought Stage 0) since there are periods when a Drought Stage 1 through 4 is in effect and the flow target at Lillington will be met from runoff in the unregulated contributing drainage area. The EIS has been updated to note that the variability across all alternatives is quite low.

16. Executive Summary, ES.6, second paragraph, tenth bullet: Please cite the source for the 600 cfs flow target at Fayetteville.

    RESPONSE: The 600 cfs is is derived from metrics reported in the 2014 Cary-Apex IBT (page 90 of the pdf file, or page 5-4). The 600 cfs threshold exceedance at Fayetteville is also described in Table 9 of the Modeling Evaluation for the Cary/Apex IBT (page 243 of the pdf). In a footnote on that page, the authors indicate the following: “*600 cfs was selected for presentation to provide an indication of the frequency of low flow events in the Cape Fear River near Fayetteville*.” There updated CFNCRB model does not include a minimum flow target at the Fayetteville gage. We have reworded the statement in the updated ES.6 to describe the 600 cfs metric as a flow threshold.

17. Executive Summary, ES.6, fourth paragraph: Need to note the specific withdrawal amounts from the City of Sanford intake that are used in the model runs.

    RESPONSE: The total amount withdrawn at the Sanford intake averages 26.9 mgd of raw water in the 2055 Alternative 9 model runs. 2.2 mgd is returned as process water at the same location, for a net withdrawal of 24.7 mgd.

18. Table ES-3: All qualifiers need to be defined, quantitatively, if possible, otherwise the determinations are entirely the author’s discretion. All footnotes used on the page should defined on each page throughout the document.

    RESPONSE: Please refer to response to comment #12 and response to comment #97.

19. Executive Summary, ES.6, first paragraph, fourth sentence: Limiting the available alternatives to only those that can fully achieve the 2055 (study period) project goals by 2025 is an overly restrictive consideration to the other alternatives. Due to this proposal coming to the DEQ so close to this "deadline", the applicant may need to resolve the short-term maximum day demand issues outside of the proposed long- term IBT project.

    RESPONSE: The DEIS text has been updated to reflect that the Town of Fuquay-Varina has negotiated a short term emergency water contract with Harnett County. None of the alternatives were eliminated in the DEIS, even alternatives that do not meet the purpose and need. Table ES-2 has been revised.

20. Executive Summary, ES-6, Table ES-4, Alternative 5: Explain why there is no alternative that proposes expansion the Harnett County WWTP beyond the 6.0 mgd under the current long-term ILA.

    RESPONSE: The detailed discussion for the expansion of the Harnett County North Regional WWTP is provided in Alternative 8A/B in Section 3.8 of the EIS.

21. Executive Summary, Table ES-4, Alternative 8A/B: This would have been a regional solution had the City of Raleigh been considered a partner in developing this alternative as originally discussed in Feb. 2020 with the applicant. This alternative was initially discussed with the applicant in terms of the proposal that the City of Raleigh provided to the DEQ during the Round 4 Jordan Lake Allocation process, in which the City of Raleigh proposed withdrawing water, from their proposed Jordan Lake allocation, from the Cape Fear River and returning all but 2 mgd; thereby avoiding issuance of an IBT Certificate.

    RESPONSE: The Town of Fuquay-Varina has conducted many conversations with Raleigh Water over the last several years. Raleigh Water has communicated to the Town that the Interlocal Agreements will not be renewed. However, Raleigh Water did agree to a temporary ILA until 2035 after initially denying the Town a renewal. The Interlocal Agreement between the Town and Raleigh Water is provided in an Appendix

22. Executive Summary, Table ES-4, Alternative 12: Consider clarifying that the Town's water conservation measures/plan must meet or exceed those by other water systems in the Cape Fear River (source) basin. The document states that the IBT projections account for water conservation; however, these measures need to meet or exceed the most stringent measures by other water systems in the Cape Fear (source) basin to fully account for this alternative to not be viable.

    RESPONSE: The EIS Section 3.14 (formerly Section 3.13) has been updated to clarify and expand on the Town of Fuquay-Varina's water conservation program. A new Table ES.2 has been developed to clarify the Town's water conservation programs.

23. Global: Consider embedding all maps and figures where the discussion of the topic first occurs, instead of in the back of the document.

    RESPONSE: All of the figures in the DEIS are 11x17. The figures were located in a separate section so that the rest of the document could be printed double-sided to save paper. Per DWR's request, the applicable figures have been relocated at the end of each section. Printed hard copies, if necessary, will be single-sided.

Section 1.0

24. Section 1.4: The document needs to address the practicality and logistics of avoiding an IBT Certificate request, by utilizing the existing collection system to route flows toward the North Harnett WWTP instead of Terrible Creek WWTP. Consider providing information related to any improvements to the collection system that routed greater flows toward Terrible Creek WWTP, particularly those

activities that occurred after issuance of the NOI. Where this information is presented in the document is left to the authors discretion.

RESPONSE: Section 1.4 of the DEIS has been revised to clarify a few nuances regarding the Town's Interlocal Agreements with neighboring communities. The Town signed an ILA with Harnett County for the purchase of wastewater allocation in the North Harnett Regional WWTP. Per the ILA, the Town does not have any right of ownership (e.g., capacity) in the North Harnett Regional WWTP. However, the wastewater ILA with Harnett County expires in 2040 but automatically renews for an additional 40 years. Section 1.4 was also edited to clarify that the Town only owns the 36-inch diameter segment of the 15-mile interceptor to the Wake-Harnett County line. Additionally, a third paragraph in a new Section 1.4.3.1 has been added to state that the capacity of the 36-inch diameter interceptor was designed to meet the project needs in 2000, which was a 6 mgd average day flow with a hydraulic peak flow of 12 mgd as stated in the Interlocal Agreement. This capacity was confirmed with a hydraulic model.

A sentence to the first paragraph in Section 1.4.2 has been revised to state that the Town has not ever had the ability to transfer flow between river basins.

Alternatives Analysis Section 3.8 addresses a discharge to the Cape Fear River. Please refer to response to comment #167.

25. Section 1.4.2, second paragraph, last sentence: Need documentation from Harnett County as to their interest in a cooperative expansion of the North Harnett WWTP. Also, the document needs to define the constrictive element to the 6 mgd "carrying capacity" of the interceptor line and what would be entailed in expanding that line. Perhaps this would best be addressed as an additional alternative.

RESPONSE: The Town of Fuquay-Varina sent a Letter of Intent to Harnett County in May 2021 requesting an additional 3.4 mgd of treatment capacity in the North Harnett Regional WWTP per the 2000 Interlocal Agreement. Per conversations between the Town of Fuquay-Varina and Harnett County staff, Harnett County's wastewater capacity obligations to other member partners (e.g., Angier, Lillington, and Harnett County) does enable Harnett County to provide wastewater capacity to the Town of Fuquay-Varina greater than the Interlocal Agreement capacity of 6 mgd. However, in the May 2021 Letter of Intent, the Town expressed interest in purchasing additional capacity when available. The Town's May 2021 Letter of Intent to Harnett County is provided in an Appendix. Additionally, the Town's 2023 amendment to the ILA with Harnett County for the additional 3.4 mgd is in an Appendix.

Section 1.4 of the EIS has been revised to clarify the Town of Fuquay-Varina's Interlocal Agreements with neighboring communities and provide more information on the Town's infrastructure. Regarding the carrying capacity of the 36-inch interceptor to Harnett County, a third paragraph in a new Section 1.4.3.1 has been added, as follows: "*The Town of Fuquay-Varina and Harnett County interceptor was designed and constructed in accordance with applicable design criteria in the 1996 version of the Minimum Design Criteria for the Permitting of Gravity Sewers (DWR) to meet the capacity needs of the proposed project in 2000. The hydraulic capacity of the Town of Fuquay-Varina's allocation in the interceptor is 6 mgd average day flow with a hydraulic peak flow of 12 mgd. The capacity of the 36-inch interceptor was confirmed with a hydraulic model.*"

An additional alternative does not need to be added to the EIS. Alternative 8 provides a discussion of the use of the Town of Fuquay-Varina's existing wastewater allocation in the North Harnett County Regional WWTP. Per the May 2021 Letter of Intent, Harnett County will sell the Town of Fuquay-Varina the remaining 3.4 mgd of wastewater allocation in the North Harnett Regional WWTP. The Harnett County North Harnett Regional WWTP expansion to 16.5 mgd is anticipated to meet wastewater capacity needs for the County's regional partners over the next 20-year planning period. Harnett County received the modified NPDES permit NC0021636 in July 2023.

26. Section 1.5.1, second paragraph: Please review this entire paragraph for accuracy avoiding misconstruing the statute. 1) The Session Law is 2015-90. 2) This session law does not modify the Administrative Rules 15A NCAC 01C, rather it added specific thresholds in statute, needed to be met before a SEPA document would be required for specific projects. 3) The statute includes more context and requirements to the third bullet than provided in the document. 4) The Session Law includes considerable language regarding IBTs; therefore, the subject and associated projects should not be characterized as "exempt."

    RESPONSE: 1) The DEIS text has been revised to correct the typographical error for the session law identifier as 2015-90. 2) The sentence of the DEIS text has been reworded. 3) The third bullet has been deleted and replaced with a new paragraph. 4) This bullet point has been deleted from the DEIS text. Session Law 2015-90 does require environmental documentation per GS 143-215 .22L. This bullet was meant to state that interbasin transfers are not subject to the list of project exclusions in Session Law 2015-90 Section 5 modifying G.S. 113A-12.

27. Section 1.5.4, second paragraph: Please explain the relevance of this subject to the proposed project.

    RESPONSE: The DEIS text in Section 1.5.4 has been revised.

28. Section 1.5.8, first paragraph, first sentence: The statute referenced compels the Department to develop hydrologic models with approval and modification responsibilities granted to the Commission. Please correct accordingly.

    RESPONSE: The DEIS text in Section 1.5.8 has been revised.

Section 2.0

29. Section 2, second paragraph, second sentence: Based on the most recent data presented the population growth rate based on the previous 5-year average is 5.5%, not 7%. Please correct accordingly. This change appears to be consistent with the 1st paragraph in Section 2.2.

    RESPONSE: The DEIS text has been revised and updated with 2022 data.

30. Section 2.1.2, second paragraph, last sentence: Please explain the population of 17,500 that are unserved in the service area. How the value was determined and generally why they are currently not served.

    RESPONSE: The DEIS text and the Technical Memorandum in Appendix A have been revised to state that the unserved population is on private well systems. The location of the private well systems is provided on Exhibit 2 of the Technical Memorandum in Appendix A.

31. Section 2.1.2, fourth paragraph, third sentence: Please provide details/estimates for the service population growth over the next 5-7 years, describing both the population currently unserved in the service area and the anticipated new residential growth in the service area.

    RESPONSE: The fourth paragraph, second sentence in Section 2.1.2 provides an explanation of the population growth in the next 5-7 years. The DEIS text (and Appendix A) has been revised for clarity, as follows: *The Town's near-term development data was compared to the 2025 TAZ projection data as a cross-check for reasonableness. The Town maintains proposed, approved, or under construction development data in GIS for single and multi-family lots. The Town's GIS development layer results in an additional 25,750 people that are estimated to be served by the Town in the next 5 to 7 years, which closely correlates to the anticipated 2025 TAZ population estimate.*

32. Section 2.1.2, fifth paragraph, eighth sentence: Please consider providing a demonstration for how the linear best fit method is consistent with the TAZ build-out projections, particularly considering that the population is projected to nearly double in this relatively short time period.

    RESPONSE: The TAZ build-out projections were used as an estimate of the build-out in the service area. TAZ projections are very conservative and tend to overestimate population growth and were not used for timing of growth. The Town does not anticipate reaching the TAZ population projection of 134,800 people by 2045 based on the current growth rates. The linear growth fit was the best fit to the Town's historical population growth.

33. Section 2.1.2, fifth paragraph, sentences 10 and 11: It appears that these sentences saying the same thing. Please explain the differences between these two sentences.

    RESPONSE: Sentence 11 of the fifth paragraph in Section 2.1.2 was deleted.

34. Section 2.2.1, last paragraph, last sentence: Please explain why the Town expects no reductions in the per capita demand over the planning period. Considering that the past 5-year per capita average (2017-2021) is 79.5 gpcd, please explain why 80 gpcd isn't a more reasonable, yet still conservative, per capita value when estimating long- term demand growth. NCGS 143-355(l) compels water systems to provides plans for reductions in per capita water demand. The historic record provided by LWSPs are our most commonly used method to provide a check on demand projections; however, over the past 15 years the Town has consistently not provided the necessary information to approve their LWSPs or not provided the maximum daily values in the monthly table, critical for IBT calculation of average day maximum month statistic. Therefore, the DWR is left with limited means to adequately validate the historic demands presented in this document. Below is an account of the status of the Town's LWSPs since 2007.
    - 2007: not submitted
    - 2008: not submitted
    - 2009: incomplete
    - 2010: incomplete
    - 2011: incomplete
    - 2012: approved
    - 2013: incomplete
    - 2014: incomplete
    - 2015: approved (no max day values)
    - 2016: incomplete
    - 2017: approved
    - 2018: approved
    - 2019: incomplete
    - 2020: approved
    - 2021: approved (no max day values)

    RESPONSE: The Town of Fuquay-Varina has sixteen years of Local Water Supply Plan data submitted to DWR. The Town conducted a review of the record of incomplete plans. The incomplete plan status appears to be a result of demand exceeding supply or an issue with providing a maximum day water demand. The service area demand exceeding supply is indicative of the Town's need to secure a permanent water supply versus continuing to rely on temporary purchase agreements, a point which is documented in the DEIS. The maximum day demand values have been extremely difficult for the Town to extract from multiple utility SCADA systems. The Town has historically purchased the majority of finished water from Harnett County, so the maximum day and month demand statistics for Harnett were used as a surrogate in the DEIS. The Technical Memorandum in Appendix B provides maximum day data from other utilities for comparison. Additionally, technology updates have allowed recent data to be extracted. The Technical Memorandum in Appendix B was updated with the Town's maximum month and maximum day data from 2019 through 2022.

The Town of Fuquay-Varina's average annual purchased water use was 82.3 gpcd between 2012 and 2022. The 75th percentile of the total purchased annual water use was 86.3 gpcd over this same time period. In 2022, the Town's total per capita use declined to an historic low of 75.1 gpcd. As a comparison, the following table provides a summary of per capita use for utilities in the Cape Fear and Neuse River basins based on the most recently approved Local Water Supply Plans. For comparison, the per capita use for Raleigh Water and Cary-Apex is 90.44 and 95.3 gpcd, respectively. Other utilities in the state range from 72 to 125.6 gpcd. The Town's selection of an 85 gpcd use is based on recent data and will account for year-to-year fluctuations in water use. An 85 gpcd is a reasonable per capita assessment for a reliable water supply need over a 30-year period. As documented in the DEIS, data collected in a 2016 national survey by the Water Research Foundation (2016c) published an average total per capita use of 96 gpcd. Per a USGS study published in 2017, domestic 2015 water use by state ranged from 35 to 184 gpcd, with the national average at 82 gpcd (USGS, 2017). The Town of Fuquay-Varina's total per capita use is comparable to utilities in the region and around the country.

Utility	River Basin [1]	Data of Approved Local Water Supply Plan	Residential Per Capital Use, gpcd [2, 3]	Total Per Capita Use, gpcd [2, 4]
Raleigh Water	Neuse	2022 LWSP	51.3	90.4
Cary-Apex	Neuse and Cape Fear	2022 LWSP	49.1	95.3
Holly Springs	Neuse and Cape Fear	2022 LWSP	45.5	72.2
Harnett County	Cape Fear	2022 LWSP	49.1	96.1
Johnston County	Neuse	2021 LWSP	53.5	90.1
City of Durham	Cape Fear	2022 LWSP	42.5	93.9
City of Sanford	Cape Fear	2022 LWSP	41.6	135.7
Fayetteville PWC	Cape Fear	2021 LSWP	53.2	125.1
City of Greensboro	Cape Fear	2022 LWSP	52.3	108.5
City of Burlington	Cape Fear	2022 LWSP	50.2	154.1
City of High Point	Cape Fear	2022 LWSP	48.9	114.6
Town of Fuquay-Varina	Neuse and Cape Fear	2022 LWSP	48.1	75.4
Cape Fear Utility Authority	Cape Fear	2022 LWSP	58.7	101.8

[1] Hydrologic river basin boundaries as defined in 1991 by Session Law 712 (General Statute §143-215 22G).
[2] Data extracted from the most recently approved Local Water Supply Plans.
[3] The residential per capita use is the residential service area demand divided by the year-round service area population.
[4] The total per capita use is the total service area demand (e.g., includes un-accounted for water) divided by the year round service area population.

35. Section 2.2.2, first paragraph, sixth sentence: Please explain why Harnett County's peaking factor was used instead of data from the Town of Fuquay-Varina.

RESPONSE: Maximum day water data was obtained from the Town of Fuquay-Varina's SCADA system for the years 2019 to 2022. The DEIS and Appendix B have been revised to clarify that the Town's water meter data was used to calculate the maximum month and day peaking factors. The Town's data matches the assumptions made using the Harnett County data. However, the Harnett County data has been removed from the text.

36. Section 2.2.2, first paragraph, seventh sentence: Please present the data with the names of the communities used to make this maximum day calculation.

    RESPONSE: This data was removed from the DEIS and Appendix B.

37. Table 2-4: Please double-check the 2050 Maximum Month Water Demand value.

    RESPONSE: The DEIS was corrected to fix the typographical error in Table 2-4.

38. Section 2.3, first paragraph, eighth sentence: Throughout the document, please ensure that the language is clear regarding the statistic, average day over the maximum month, instead of simply maximum month.

    RESPONSE: The DEIS and Appendix A have been revised to clarify this statistic.

39. Section 2.3, first paragraph, last sentence: Consider providing clarity that this is for system-wide demand.

    RESPONSE: DEIS Section 2.4 (formerly Section 2.3), first paragraph, last sentence has been revised to state: "*By 2055, approximately 12.5 mgd of water supply will be required to support peak day needs in the Town of Fuquay-Varina's service area*."

40. Section 2.3.1, first paragraph: Please provide a citation for this definition for consumptive use. The DWR water supply planning branch uses the term "consumptive" demand as the portion of the demand that is not collected into a centralized wastewater system, primarily lost to the ground in various ways. Based on this, please clarify what the 17.5% represents.

    RESPONSE: A citation from USGS was added to Section 2.4.1 (formerly Section 2.3.1). A definition has also been provided with several examples of water that is not returned to the source (e.g., septic systems, firefighting, lawn-watering, etc.). Section 2.4.1 of the DEIS has been further edited. The 17.5% represents the percent of water supplied to the Town of Fuquay-Varina's service area that is not returned to a centralized wastewater treatment plant.

41. Section 2.3.1, second paragraph, third and fourth sentences: Please clarify, is the author referencing HUC boundaries and state IBT boundaries? A map embedded with the discussion would be very helpful.

    RESPONSE: Clarification was provided in the second paragraph in Section 2.4.1 (formerly Section 2.3.1). Figure 1-1 provides an illustration of the Town of Fuquay-Varina's service area to include the hydrologic and legislated IBT boundary.

42. Section 2.3.1, second paragraph, fifth sentence: Please explain where the Town directly discharges to the Neuse River.

    RESPONSE: The second paragraph in Section 2.4 (formerly Section 2.3) was edited for clarity.

Section 3.0

43. Section 3.1, first paragraph, first sentence: For ease of reading, please consider spelling out acronyms that haven't been used in several sections throughout the document. Also, ensure that all acronyms are appropriately defined throughout the document.

    RESPONSE: According to the APA Formatting Style Guide (7th Edition), once an acronym is defined, the acronym may continue to be used for the remainder of the document. A list of acronyms for the DEIS is located in the Table of Contents section. Another round of quality control for acronym use was conducted in the revised DEIS.

44. Section 3.1, first paragraph, third sentence: Please consider including correspondence with Harnett County to avoid expectations or assumptions when discussing alternative selections.

    RESPONSE: The Town of Fuquay-Varina has conducted many conversations with Harnett County over the last several years. Harnett County has communicated to the Town that additional water supply would not be provided beyond the current Interlocal Agreement. However, Harnett County did agree to a second temporary Interlocal Agreement with the Town for a temporary capacity of 2 mgd. The new temporary Interlocal Agreement is provided in an Appendix. The DEIS text in Section 1.4.3 has been updated to describe the temporary ILA with Harnett County.

45. Section 3.1, first paragraph, last sentence: Please consider including correspondence with Raleigh to avoid expectations or assumptions when discussing alternative selections.

    RESPONSE: The Town of Fuquay-Varina has conducted many conversations with Raleigh Water over the last several years. Raleigh Water has communicated to the Town that the Interlocal Agreements will not be renewed. However, Raleigh Water did agree to a temporary ILA until 2035 after initially denying the Town a renewal. The Interlocal Agreement between the Town and Raleigh Water is provided in an Appendix.

46. Table 3-1: Consider including the current year or 2020 to provide context for the starting point of the projections. Please clarify what the positive or negative values represent. As presented, it appears there is a 1.02 deficit in 2025.

    RESPONSE: Table 3-1 was updated to provide the year 2022 as the starting point. The column headers were updated to clarify the data in the table. For example, water supply “deficit” was replaced with water supply “shortfall,” the header of the last column in the table was updated to indicated that a “( )” noted a water supply shortfall, and alphabet letters were used to describe the calculation for the shortfall amount.

47. Table 3-2: Consider including totals.

    RESPONSE: The DEIS text in Table 3-2 was updated to provide total amounts for bulk finished water sales contracts.

48. Section 3.2.1, fourth paragraph, fourth sentence: Consider including “targets” following “instream flow”, as these are targeted flows, that can be reduced or not met, as needed.

    RESPONSE: Section 3.2.1 of the DEIS was updated to add the word “target” following “instream flow.”

49. Section 3.2.1, fifth paragraph, first sentence: Please explain the “source” or the “storage” that is located at the intersection of the two roads.

    RESPONSE: The first sentence of the fifth paragraph in Section 3.2.1 has been revised for clarity. The word “combined” has been deleted in the first sentence.

50. Section 3.2.1, fifth paragraph, fifth sentence: Please provide a citation and the lead agency involved in the Biological Opinion.

    RESPONSE: The fifth sentence of the fifth paragraph in Section 3.2.1 was revised to state the lead agency. A citation was also provided.

51. Section 3.2.1, fifth paragraph, last sentence: Please provide the year of the drought of record for this site.

    RESPONSE: The last sentence of the fifth paragraph in Section 3.2.1 was revised to provide the year of the drought of record.

52. Section 3.2.2, first paragraph, fourth sentence: Consider replacing, "will" with "is projected", as these are values projected into the future that lack certainty. Likewise, consider adding "projected" between "combined" and "2050".

    RESPONSE: The fourth sentence of the first paragraph in Section 3.2.2 has been revised for this text revision.

53. Section 3.2.2, first paragraph, fifth sentence: Please explain further.

    RESPONSE: The DEIS has been edited to total the independent yields of Lakes Benson/Wheeler and Falls Lake compared to the combined yield of both water systems at 99.7 mgd.

54. Section 3.2.2, first paragraph, last sentence: Please state if this is based on current demand.

    RESPONSE: The last sentence of the first paragraph in Section 3.2.2 has been edited to clarify that recent water demand projections assume further reductions in total per capita use for Raleigh Water.

55. Section 3.2.2, second paragraph, last sentence: Please explain why the 25th percentile is used.

    RESPONSE: Raleigh Water's water demand projections in the 2021 and 2022 Local Water Supply Plan are based on the analysis from the Integrated Water Master Plan as stated in the EIS. The 25th percentile was selected as the basis for planning, as this projection curve better characterized Raleigh Water's service area historic demands. The last sentence in the second paragraph has been deleted to avoid confusion.

56. Table 3-3: Please explain why the total average day demand is less than the average day service area demand in 2021 and then again in 2060.

    RESPONSE: The data in Table 3-3 has been corrected.

57. Section 3.2.3, first paragraph, last sentence: Consider replacing "suggested that" with "compelled", as it was the environmental review process that necessitated an alternative analysis.

    RESPONSE: This word change edit has been made to the last sentence of the first paragraph in Section 3.2.3.

58. Section 3.2.3, second paragraph, second sentence: Please provide a citation for this statement.

    RESPONSE: A citation has been provided in the second sentence of the second paragraph in Section 3.2.3.

59. Section 3.2.3, fourth paragraph, third sentence: Please provide the value and citation for Raleigh Water's referenced current allocation in Jordan Lake.

    RESPONSE: The third sentence of the fourth paragraph in Section 3.2.3 has been revised to "*Future water supply expansion alternatives include raising the Lake Benson and Lake Wheeler water supply pool by 2 feet, a new intake along the Neuse River between Falls dam and the Johnston County line, building of the Little River Reservoir in northeastern Wake County, and a reallocation of the Falls Lake Sediment Storage Pool*." Raleigh Water rescinded their Jordan Lake Allocation in March 2019, which is discussed in Section 3.7 of the DEIS. A Jordan Lake alternative is no longer among Raleigh

Water's top water supply options.

60. Section 3.2.3.2, first paragraph, third sentence: The second paragraph in Section 3.2.3 states that the reallocation of Falls Lake would satisfy the City's demands for 30 years; however, this sentence states that demands will exceed supply in 25 to 30 years. Please clarify.

    RESPONSE: The "30-year" phrase in the second paragraph and second sentence of Section 3.2.3 has been deleted. Section 3.2.3.2 was updated to clarify that Raleigh Water anticipates that service area demands will exceed water supply capacity in the next 20 years based on the projected water demand per Raleigh Water's 2022 LWSP and the current supply system safe yield. The DEIS text was updated with Raleigh Water's 2022 approved Local Water Supply Plan data.

61. Section 3.2.3.2, second paragraph, first sentence: Consider adding "The Town of" at the start of the sentence.

    RESPONSE: This edit has been made to the first sentence of the second paragraph in Section 3.2.3.2.

62. Section 3.2.3.2, sixth paragraph, last sentence: Consider stating the county where the dam will be located as well as the county(s) where the impounded waters would be in.

    RESPONSE: The seventh paragraph in Section 3.2.3.2 has been revised to state the location of the proposed dam and area of inundation.

63. Section 3.2.3.2, seventh paragraph, first sentence: Without maps embedded in the document where the discussion occurs it is difficult for the reader to visualize these types of topics.

    RESPONSE: Refer to the response to Question #23.

64. Section 3.2.3.2, eighth paragraph, fourth sentence: Please consider stating that the minimum release was assumed for the purposes of estimating yield, and please provide a source or methodology for these proposed minimum flow rates.

    RESPONSE: The tenth paragraph in Section 3.2.3.2 provided the basis for the proposed minimum release. The tenth paragraph was moved to the ninth paragraph position.

65. Section 3.2.3.2, eighth paragraph, fifth sentence: Please replace "developed" with "revised".

    RESPONSE: This edit has been made to the fifth sentence in the eighth paragraph in Section 3.2.3.2.

66. Section 3.2.3.2, ninth paragraph, fifth sentence: Please consider replacing "defacto reuse" with "guidance", as this common situation is not generally viewed as "reuse" water since the treated waters have been discharged into a flowing body of water.

    RESPONSE: This revision has been made to the fifth sentence of the ninth paragraph in Section 3.2.3.2.

67. Section 3.2.3.2, ninth paragraph, sixth sentence: Likewise, from the previous comment, please consider changing the statement "recycle loop" as it suggests that the treated waters are not being discharged into a body of water, but directly "recycled" by another water system. "Inputs" seems like an acceptable replacement.

    RESPONSE: The sixth sentence of the ninth paragraph in Section 3.2.3.2 has been revised.

68. Section 3.2.3.2, ninth paragraph, last sentence: Consider avoiding the term “returned” as most of this treated wastewater originated in the Cape Fear River Basin, not the Neuse River Basin.

    RESPONSE: The last sentence of the ninth paragraph in Section 3.2.3.2 has been revised to state, “*Under prevailing summer and fall conditions in 2055, the majority of the stored water in the reservoir contents would consist of wastewater discharged from the three aforementioned wastewater treatment facilities upstream of the proposed reservoir*.”

69. Section 3.2.4, second paragraph: Consider acknowledging that the alternative does satisfies the long-term demands for the Town. The Town’s lack of long-term planning years ago should not be the burden of the lead agency to select a preferred alternative solely because it will take too long to fully meet the defined long-term purpose and need. If this is the situation, then a short-term solution may need to be initiated while the long-term solution is evaluated, permitted and instituted.

    RESPONSE: Per Section 1-1 of the DEIS, the Town initiated the planning process for water supply in 2016 with a Request for Proposals for a Water Capacity Study. Scoping for the proposed IBT project started in January 2019 after several years of the Town attempting to negotiate Interlocal Agreements for additional water with neighboring communities. The several years of unsuccessful negotiation resulted in a redirection to secure (e.g., purchase) permanent water supply capacity in lieu of continued negotiation of Interlocal Agreements.

    A proposed Middle Creek reservoir was rejected due to the timeframe required for constructing new reservoirs in North Carolina, particularly reservoirs with state and federally threatened and endangered species. There are 6,662 impoundments and reservoirs in North Carolina per the Dam Inventory List from the Division of Energy, Mineral, and Land Resources (DEMLR). Approximately 480 publicly owned (federal, state, or local government) reservoirs or impoundments are used for flood control, water supply, and recreation. Approximately one-half of the largest reservoirs in North Carolina were constructed in the early 1900s for hydroelectric power (refer to the Summary of Constructed Reservoirs table in response to Fred Tarver’s comment #2). The remaining half of North Carolina’s largest reservoirs were constructed in the mid-1950s and 1960s. The most recent reservoir constructed in North Carolina is Randleman Lake, which finished construction in 2010. Randleman Lake was originally proposed in 1937 with engineering work continuing through 1987, at which point the U.S. Army Corps of Engineers withdrew support. The current Randleman Lake is a smaller version of the original proposal and is designated for water supply.

    In 2011, the Division of Water Resources (Tom Reeder) presented to the Senate Environmental Review Commission a list of North Carolina reservoirs that had been constructed within 20 years of 2011. The reservoir examples provided by DWR included the Rocky River Lower Reservoir expansion (Charles L. Turner Reservoir) in 2009, Horse Creek Reservoir (off-line storage) in 2008, the Nicks Creek Reservoir modifications in 2002, the West Fork Eno Reservoir in 2000, the Macintosh Reservoir in 1993, Lake Howell in 1993, Stewarts Creek Reservoir expansion in 1992, and Back Creek Reservoir in 1991. The most recent 2009 Rocky River Lower Reservoir expansion project for Siler City started in 1989 with construction finished in 2009. The presentation by DWR highlighted the complexities and long timeframes typically associated with constructing new reservoirs in North Carolina.

70. Section 3.3, second paragraph, first sentence: Please state if this is based on average day demand or other statistic or time scale.

    RESPONSE: The first sentence of the second paragraph in Section 3.3 has been revised to clarify the text.

71. Table 3-5: Considering that 4 water systems are regular purchasers of water without a contract amount, please explain the accuracy of 8.5 mgd.

    RESPONSE: Johnston County's contract with the Town of Selma is for emergency only. A contract amount is not specified. The other four communities without a contract amount are community water systems (CWS). A footnote was added to Table 3-6 (formerly Table 3-5) to clarify that Johnston County does not have a contract with Community Water Systems in the County's water service area. However, the water sold is tracked in the Local Water Supply Plan.

72. Section 3.3, third paragraph, last sentence: Consider including a tabular breakdown of the 7.0 mgd in 2050 in Table 3-6.

    RESPONSE: Table 3-7 (formerly Table 3-6) has been revised to sum the total contract amounts, excluding emergency use contracts. Section 3.3 has also been updated to reflect Johnston County's 2022 approved LWSP.

73. Section 3.3.1, first paragraph, fourth sentence: Please consider avoiding the term "allocated" in this context. DWR has not allocated a specific amount of guaranteed water supply to Johnston County.

    RESPONSE: The fourth sentence of first paragraph in Section 3.3.1 was revised.

74. Section 3.3.1, first paragraph, last sentence: This sentence could be confusing to a reader as it lacks context that the projected plant discharges have been effectively subtracted from the 20% of the 7Q10 withdrawal limitation.

    RESPONSE: The last sentence of the first paragraph in Section 3.3.1 was revised to indicate a maximum raw water withdrawal of 17 mgd. Additionally, Section 3.3.1 was revised to state that Johnston County is expanding the Timothy G. Broome WTP to 18 mgd by managing the on-site raw water storage system.

75. Section 3.3.2, second paragraph, fourth sentence: Please explain why the use of groundwater presents correlation issues.

    RESPONSE: A sentence was added to the second paragraph of Section 3.3.2 as follows: "*Private groundwater use is not included in the County's total water use projections.*"

76. Section 3.3.2, third paragraph, last sentence: Please consider including the projected demands of the ECIA developed by the Town and County.

    RESPONSE: The third paragraph in Section 3.3.2 has been revised to clarify that the Town of Clayton's LWSP includes the anticipated water purchase from Johnston County.

77. Section 3.3.2, fourth paragraph, fourth sentence: Please consider including the projected growth rate between 2040 and 2050.

    RESPONSE: The fourth paragraph in Section 3.3.2 was revised.

78. Section 3.3.2, fourth paragraph, last sentence: Recommend ending with "demands."

    RESPONSE: The fourth paragraph in Section 3.3.2 was revised.

79. Section 3.3.3, first paragraph, third & last sentence: These sentences appear to say the same thing, please explain any differences.

    RESPONSE: The last sentence of the first paragraph in Section 3.3.3 was deleted.

80. Section 3.3.3.1, second paragraph, last sentence: Please include the entire citation for the second general statute referenced.

    RESPONSE: Section 3.3.2 has been updated to reflect recent updates to Johnston County's Long Range Water Supply Plan. Section 3.3.3.1 has been deleted.

81. Section 3.3.3.2.2, second paragraph, first sentence: Please consider adding, "option" or a similar word following "Richardson Bridge Road".

    RESPONSE: Section 3.3.3 has been updated to reflect recent updates to Johnston County's Long Range Water Supply Plan. Section 3.3.3.2 has been deleted.

82. Section 3.3.4, second paragraph, last sentence: Please double-check this statement to ensure accuracy.

    RESPONSE: The last sentence in the second paragraph in Section 3.3.4 was deleted as the WS-IV classification is already in place for this location.

83. Section 3.4.1, second paragraph: Please refer to comments #66, 67, & 68 and make appropriate corrections.

    RESPONSE: These corrections were made to Section 3.4.1 of the DEIS.

84. Section 3.4.2: Consider acknowledging that the alternative does satisfies the long-term demands for the Town.

    RESPONSE: The text in Section 3.4.2 has been revised.

85. Section 3.5, first paragraph: Please ensure clarity throughout the document that the subbasins mentioned referred to IBT defined basins to avoid confusion with HUC unit basins.

    RESPONSE: To avoid repetition in the document, a new paragraph in Section 1.5.2 has been added as follows: "*The hydrologic river basin boundaries were defined in 1991 by Session Law 712 (General Statute §143-215 22G). The Cape Fear River is designated as basin 2-3. The Neuse River basin is designated as 10-1. The river basin designations used in Section 3 (Alternatives Analysis) and elsewhere in this EIS refer to the hydrologic river basin as defined by General Statute §143-215 22G*."

86. Section 3.5.1, first paragraph, fifth sentence: Please consider explaining the relevance of this statement.

    RESPONSE: The fifth sentence in the first paragraph of Section 3.5.1 was deleted.

87. Section 3.5.1, first paragraph, sixth & seventh sentences: Please ensure that the values presented are consistent with the values presented in Table 3-10. Please provide explanations for any differences in calculation.

    RESPONSE: The first paragraph in Section 3.5.1 has been revised.

88. Table 3-10: Please explain the fluctuating projected sales values (i.e., increasing, decreasing, and increasing again). The total demand in 2060 appears to be different based on the other values presented. Please ensure that the methodology for calculating peaking factors (i.e., previous 5-year average) are consistent throughout the document.

    RESPONSE: The data in Table 3-10 was as per reported on the City of Dunn's 2021 Local Water Supply Plan. Table 3-10 has been updated with data from the approved 2022 LWSP. The

methodology for calculating peaking factors is consistent throughout the DEIS.

89. Section 3.5.3, first paragraph, first sentence: Please explain which portion of the Administrative Rule requirements are being referenced.

    RESPONSE: The first sentence of the first paragraph in Section 3.5.3 was revised to clarify that 15A NCAC 01C .0408(2)(b)(1) is being referenced.

90. Section 3.5.3, fourth sentence: It is advisable that alternative analysis decisions should not be made based on environmental field data over 20 years old, particularly when more recent data is readily available or could be calculated.

    RESPONSE: The 7Q10 data for this analysis is from the Division of Cape Fear Water Resources Report dated 2002. There have been no stream flow metric updates from the USGS or DWR since that time. The statement was made in the DEIS that sufficient allowable water withdrawal is available to the City of Dunn.

91. Section 3.5.3, first paragraph, fifth sentence: Please use caution with use of the term “allowable”, as there is no specific water withdrawal permitting in this portion of North Carolina, and the referenced Administrative Rule allows for withdrawals greater than the referenced statistic (not mentioned in this discussion) through site-specific investigations.

    RESPONSE: The term “allowable” was replaced with “available.”

92. Section 3.5.3, first paragraph, last sentence: When mentioning “water withdrawal” is this a reference to available capacity?

    RESPONSE: The last sentence of the first paragraph in Section 3.5.3 was revised as follows: “*Regardless of the anticipated decline in the 7Q10, sufficient water supply is available to the City of Dunn for future water supply expansions over the next planning period*.”

93. Section 3.5.4, first paragraph, third sentence: Please define “re-rate” in this context.

    RESPONSE: A new sentence was added to the first paragraph of Section 3.5.4 to define the re-rating of a facility.

94. Section 3.5.4, third paragraph, first sentence: Please explain what is meant by “re-rate for capacity recovery”.

    RESPONSE: The first sentence of the third paragraph in Section 3.5.4 has been revised.

95. Section 3.5.4, sixth paragraph: Please state if construction of a terminal raw water reservoir part of the proposed package for this alternative.

    RESPONSE: The sixth paragraph is Section 3.5.4 has been revised to clarify that a terminal reservoir is included. Additionally, the table in Section 3.15 includes a terminal reservoir in the summary infrastructure for this alternative.

96. Section 3.6, second paragraph, second sentence: Please state if this breakdown represents the “service” population. If so, please consider also providing the demand percentages.

    RESPONSE: The second paragraph in Section 3.6 has been revised to clarify that the percentage breakdown is for the service area population. A statement has also been added that this data is from Harnett County’s LWSP. The LWSP does not provide a breakdown of water demand by County.

97. Global: Ensure that footnotes from tables presented have the referenced footnotes on every page they are used.

    RESPONSE: Each table has "header row repeat" programming to maintain the table title and table column headers with the applicable footnotes if a table has to break pages. Many of the tables in the EIS contain a significant amount of data, so table breaks across pages are occasionally necessary. The document format does not allow footnotes in the page footer.

98. Section 3.6.1, first paragraph, fourth sentence: Please consider stating that the discharges are allowed through the issuance of an NPDES permit, instead of "via".

    RESPONSE: The fourth sentence of the first paragraph in Section 3.6.1 has been revised.

99. Section 3.6.1, first paragraph, fifth sentence: Please explain the relevancy of this information.

    RESPONSE: The first paragraph in Section 3.6.1 has been revised as follows: "*Per the Harnett County 2022 LWSP, the County has purchased land for a new water treatment plant and intake on the Cape Fear River near the Town of Erwin. Harnett County has not initiated any studies to permit water infrastructure at this site*." This sentence is a description of the data provided in the approved 2022 LWSP.

100. Section 3.6.1, first paragraph, sixth sentence: Please state by type, name and number which permit is referenced. There are no specific water withdrawal permits in this part of the state. Please consider including a copy of the "permit" in the Appendix.

    RESPONSE: The first paragraph in Section 3.6.1 has been revised as follows: "*Per the Harnett County 2022 LWSP, the County has purchased land for a new water treatment plant and intake on the Cape Fear River near the Town of Erwin. Harnett County has not initiated any studies to permit water infrastructure at this site*."

101. Section 3.6.2, first paragraph: Comments #89, 90, & 91 are also applicable to this paragraph. Please correct accordingly.

    RESPONSE: The text in Section 3.6.3 has been revised per DWR comments #89 and #91. To address comment #90, Hazen calculated a revised 7Q10 at the Lillington gage (sixth sentence in the second paragraph).

102. Section 3.6.2, second paragraph: Please consider providing documentation from the USGS if this revised 7Q10 calculation has been verified. Please provide relevant information from the EA and associated FONSI prepared for the Harnett County 42 mgd WTP expansion.

    RESPONSE: Per the response to comment #100, the first paragraph in Section 3.6.1 has been revised as follows: "*Per the Harnett County 2021 LWSP, the County has purchased land for a new water treatment plant and intake on the Cape Fear River near the Town of Erwin. Harnett County has not initiated any studies to permit water infrastructure at this site*."

    Section 3.6.2 has been revised to reflect the 7Q10 determination from USGS in September 2023.

103. Section 3.6.3, first paragraph, last sentence: Provide an explanation for the 1.5% annual growth factor.

    RESPONSE: The annual growth rate was calculated from the data provided in Harnett County's Local Water Supply Plan using a slope and intercept specific to the ten year time period.

104. Global: Ensure the document is consistent when referring to Towns and Cities, that these entities should be referred to as the Town of… or the City of…

RESPONSE: The DEIS was revised to refer to communities as “City of” or “Town of.”

105. Section 3.6.3, second paragraph, fifth sentence: Please explain why this analysis is being conducted with TAZ data instead of using the full contract amounts as presented in the LWSP, as was done for all other similar analyses.

RESPONSE: The LWSP was used in the analysis. Section 3.6.3 has been edited to remove the extraneous information.

106. Section 3.6.3, fourth paragraph, third sentence: Table 3-12 appears to suggest that the annual growth rate between current and 2030 is 1.48%, not 1.34%. Please explain or correct.

RESPONSE: The third sentence in the fourth paragraph in Section 3.6.3 has been revised.

107. Global: Ensure the document is consistent with use of significant digits.

RESPONSE: The data in the tables from Local Water Supply Plans are reported in the DEIS with the number of significant digits as published on the DWR website. Otherwise, standard practices for reported data with significant digits were used.

108. Section 3.6.3, fourth paragraph, sixth sentence: It is important to note if the EA and associated FONSI from the Harnett County WTP expansion provide any details to future expansion.

RESPONSE: The DEIS text in Section 3.6.1 has been revised to state that per the Harnett County 2022 LWSP, Harnett County has purchased land for a new water treatment plant and intake on the Cape Fear River near the Town of Erwin. Harnett County has not initiated any studies to permit water infrastructure at this site.

109. Section 3.6.3, fourth paragraph, sixth sentence: Please explain if the “planning numbers” referenced related to the values presented in Table 3-12 or are they from the “Master Plan”. If they are from the “Master Plan”, please provide these values and provide explanations if they are significantly different to the values presented in Table 3-12.

RESPONSE: Section 3.6.3 has been revised to clarify that the data provided in Table 3-12 is from the County’s Local Water Supply Plan. The water sales projections are supported by the 2017 Master Plan (Hazen, 2017).

110. Table 3-12: Please provide an explanation for the large jump in demand between 2021 and 2030 as compared to the other years.

RESPONSE: The data in Table 3-14 (formerly Table 3-12) was updated to reflect Harnett County’s approved 2022 Local Water Supply Plan. Section 3.6.3 has been revised to include a new second paragraph stating that the Town of Holly Springs, the Town of Fuquay-Varina, and Johnston County are anticipated to purchase finished water from Harnett County up to these community’s entire contract amounts by 2030.

111. Section 3.6.4, second paragraph, first sentence: Please explain the contracted amount of 23.9 mgd, in context with the reported contract amounts of 10 mgd for the Town of Holly Springs and 2 mgd to the Town of Fuquay-Varina in 2040. Please provide details and what is meant by the “Northwest and East Central Pressure Zones”, as this is the reference in the document.

RESPONSE: The first sentence of second paragraph of Section 3.6.4 has been revised as follows: “*The firm pumping capacity needed to supply projected 2040 demands via the 36 inch transmission*

main (Harnett County's Northwest and East Central pressure zones) is 23.9 mgd, which is the sum of the contract amount for the Town of Holly Springs at 10 mgd, the Town of Fuquay-Varina at 2 mgd, and the anticipated Harnett County demand of 11.9 mgd."

112. Section 3.6.4, second paragraph, second sentence: Is this a "firm pumping" capacity as stated in the proceeding sentence, or is this the capacity to meet the contractual amounts?

RESPONSE: Firm pumping capacity is defined as the largest pump unit out of service. The word "firm" has been deleted to avoid confusion, as this term is more applicable for use in a preliminary engineering report.

113. Section 3.6.4, third paragraph, first sentence: Please provide a date or state if this demand is through the planning period.

RESPONSE: The first sentence of the third paragraph in Section 3.6.4 has been revised as follows: "*Harnett County would need to provide an additional 11 mgd by 2050 to meet the projected maximum day water demand from the Town of Fuquay-Varina*."

114. Section 3.6.4, fourth paragraph, second sentence: Table 3-12 references 2021 LWSP projection data; however, this sentence references 2020 LWSP projections. Please explain the differences and why both years are used in the analysis. The 2021 LWSP shows that Harnett County can meet projected demands and contractual operations well beyond 2040, without an expansion of the existing WTP. This is achievable through development of a proposed 10 mgd WTP near the Town of Erwin. This document should discuss the proposed WTP and how that might provide additional capacity in the existing Harnett County WTP.

RESPONSE: The DEIS was updated with Harnett County's 2021 LWSP prior to submittal to DWR in July 2022. A few references to the Harnett County 2020 LWSP were inadvertently missed in the July 2022 DEIS. The DEIS has been updated to reflect the approved 2022 LWSP data.

Regarding Harnett County's new raw water intake and 10 mgd water treatment plant site near the Town of Erwin, the first sentence in the fourth paragraph of Section 3.6.4 states the following: "*Harnett County will require an expansion of the Regional WTP or the construction of a new 10 mgd WTP in the next 20-year planning period to meet Harnett County's current service area demands and wholesale contract obligations*." A new sentence has been added as follows: "*Harnett County's wholesale obligations do not extend additional water supply to the Town of Fuquay-Varina.*"

The first paragraph of Section 3.6.1 has also been revised to add the following: "*Per the Harnett County 2022 LWSP, the County has purchased land for a new 10 mgd water treatment plant and raw water intake on the Cape Fear River near the Town of Erwin. The new raw water intake site became available when Harnett County purchased the Town of Erwin's water system. Per Harnett County's 2022 LWSP, a new intake and water treatment facility near the Town of Erwin is anticipated to supply the eastern portion of Harnett County and Johnston County at the intersection of Highway 210 and 50 and Highway 27 at the Johnston County Line. Harnett County has not initiated any studies to permit water infrastructure at this site*."

115. Section 3.6.4, fourth paragraph, last sentence: Please provide details regarding the required improvements to the distribution system and raw water intake and how these would differ from other alternatives presented.

RESPONSE: The last sentence in the fourth paragraph in Section 3.6.4 has been deleted. Section 3.6.4 has been extensively edited to clarify the proposed improvements for Alternative 5.

116. Section 3.6: Please include any correspondence from Harnett County detailing their position to provide additional water supply capacity to the Town of Fuquay-Varina. Similarly, the document needs to include any correspondence with Harnett County regarding their position regarding an

expansion of the North Harnett WWTP beyond the 6 mgd expansion in an existing ILA. The best location for this information is left to the authors discretion (i.e., Sections: 3.6, 3.8.2.1, 3.10).

RESPONSE: The Town has conducted many conversations with Harnett County over the last several years. Harnett County has communicated to the Town that additional water supply would not be provided beyond the current Interlocal Agreement. However, the Town of Fuquay-Varina negotiated with Harnett County in 2022 for an additional 2 mgd increase in water allocation until 2032. The 2022 ILA with Harnett County is a temporary measure to provide water to the Town to mitigate the anticipated extended timing of construction of the City of Sanford's Water Treatment Plant and the associated finished water transmission main. Section 1.4.3.2 of the DEIS has been revised to include the 2022 ILA.

117. Section 3.6.5, first paragraph, first sentence: It has not been demonstrated that merely continuing the purchase of water from Harnett County would necessitate an IBT. Please consider rewording or strike from the document.

RESPONSE: Section 3.6.5 of the DEIS has been revised. The third paragraph provides a statement that a purchase of water from the Town of Fuquay-Varina from Harnett County will result in an interbasin transfer from the Cape Fear to the Neuse River basin. A sentence has been added to the third paragraph as follows: "*The Town of Fuquay-Varina's water demand in 2055 will exceed the average day in a maximum month threshold threshold per General Statute §143-215.22L as stated in Section 2 of this EIS*."

118. Section 3.6.5, second paragraph, first sentence: Table 3-11 only depicts a contractual amount for the Town of 2 mgd ending in 2040; however, this sentence suggests there is a new ILA that provides an additional 2 mgd (total of 4 mgd) that ends in 2035. This needs to be clarified throughout Section 3.6.

RESPONSE: Section 1.4.3 and Table 1-1 of the DEIS has been revised to describe the additional 2 mgd from Harnett County until 2032. This additional 2 mgd was not explicitly included in the IBT calculations. The Town of Fuquay-Varina agreement with Harnett County is a temporary measure to provide water to the Town to mitigate the anticipated extended timing of construction of the City of Sanford's Water Treatment Plant and the associated finished water transmission main. The Town of Fuquay-Varina will not utilize the temporary lease agreement for the additional 2 mgd from Harnett County once the City of Sanford's Water Treatment Plant expansion project is completed. The reference to the temporary ILA was deleted from Section 3.6.5 as this information does not provide value to the analysis.

119. Section 3.6.5, second paragraph, second sentence: Please provide any information/documentation regarding Harnett County's position on continuing the ILA signed in 2022 for the additional 2 mgd.

RESPONSE: Please see response to comment #118.

120. Section 3.6.5, third paragraph, second sentence: Please consider providing context to this sentence, that this extremely high jump in demand is because the full contract amounts are used to estimate projected demand and that in actuality this demand is highly unlikely, but obligations exist.

RESPONSE: Section 3.6.5 has been extensively edited to respond to the preceding comments. The original referenced third paragraph has been edited as follows: "*Harnett County's water supply capacity is fully allocated to the growth and development needs of Harnett County's service area over the next 20-year planning period. Harnett County's water supply capacity also fulfills the existing obligations to the County's wholesale communities to provide bulk finished water. By 2040, Harnett County is anticipated to maximize the 42 mgd Regional WTP capacity (refer Harnett County's water demand projections in Table 3-14). Based on the updated 7Q10 estimate at the Lillington gage, Harnett County may be required to conduct an instream flow study to further increase withdrawals per 15A NCAC 01C .0408(2)(b)(1)*."

121. Section 3.6.5, third paragraph, third sentence: This appears to be in conflict with the preceding sentence, that the demands will decrease to 42 mgd in 2040 from 43 mgd in 2030. Please consider including a table that details the projected demands in ten-year increments for each purchaser and total system for Harnett County.

    RESPONSE: The original DEIS text stated that the Harnett County was anticipated to have an average day water demand of 43 mgd by 2030 and the Harnett County Regional WTP will be maximized on capacity by 2040. Per response to comment #112, Section 3.6.5 of the DEIS has been revised extensively to address the preceding comments.

122. Section 3.7.1.1, second paragraph, second sentence: Please consider providing context to "water supply storage" to avoid a misinterpretation that the State of North Carolina owns all of the water backed up by Jordan Lake. A diagram or figure might be helpful.

    RESPONSE: The second and third sentences of the second paragraph in Section 3.7.1.1 were revised as follows: "*The State of North Carolina requested that the USACE include water supply in the total lake storage volume. The State of North Carolina subsequently purchased the water supply fraction of the total storage in Jordan Lake*."

123. Section 3.7.1.1, second paragraph, fourth sentence: Please consider adding "allocation" following "water supply".

    RESPONSE: This edit has been made to Section 3.7.1.1 of the DEIS.

124. Section 3.7.1.1, second paragraph, sixth sentence: Please consider rewording the statement that the minimum release from Jordan Lake is "no less than 40 cfs", particularly before stating the minimum flow target under normal conditions.

    RESPONSE: The second paragraph in Section 3.7.1.1 has been edited to state that the minimum release from Jordan Lake is no less than 40 cfs and not in the same context as the flow target at the Lillington gage.

125. Section 3.7.1.1, second paragraph, seventh sentence: Please include that the minimum flow is plus or minus 50 cfs from the published minimum flow target. Please consider providing the minimum release target schedule for drought or low-inflow conditions.

    RESPONSE: The second paragraph of Section 3.7.1.1 has been revised to add the +/- 50 cfs tolerance to the Lillington flow target. The DEIS text was also edited to reference Appendix C for the drought stage flow targets in lieu of listing the entire drought stage flow targets in the DEIS to avoid lengthy detail in the main DEIS text.

126. Section 3.7.1.1, second paragraph, eighth sentence: Please provide a citation and date range for this statistical calculation.

    RESPONSE: The 1998 USGS citation has been added to the second paragraph in Section 3.7.1.1.

127. Section 3.7.1.1, third paragraph, first sentence: Please define what is meant by the "conservation storage" and how that relates to the aforementioned water quality pool and water supply storage. A graphic may prove helpful.

    RESPONSE: A sentence has been added to the third paragraph in Section 3.7.1.1 as follows: "*Conservation storage is defined as the sum of water supply volume and low flow augmentation volume.*"

128. Section 3.7.1.1, third paragraph, second sentence: Please clarify whether “conservation storage” is intended or “water supply storage”. Please be consistent with this language. Please consider stating that the water supply pool is a percentage-based calculation. For simplicity purposes, it is often discussed as 100 mgd; however, the actual yield is estimated to be higher than that. The Round 4 Allocation document may provide a reasonable explanation to be included and referenced. Please ensure any corrections are made throughout the document for consistency.

    RESPONSE: The second sentence of the third paragraph in Section 3.7.1.1 has been revised to clarify that “water supply storage” is being referenced. A citation has been provided. A DWR presentation from August 2014 to Round 4 Jordan Lake Applicants describes modeling that indicated a yield greater than 100 mgd; however, on slide 10 of this presentation, DWR stated the safe yield estimate of 100 mgd will be maintained. In paragraph 1 of Section 3.7.1.3 it is clearly stated that allocations are on a percentage basis.

129. Section 3.7.1.3, first paragraph, first and second sentences: Please provide a citation for these statements.

    RESPONSE: A citation has been provided for the first and second sentences of the first paragraph in Section 3.7.1.3.

130. Section 3.7.1.3, second paragraph, last sentence: Please provide a citation for this statement.

    RESPONSE: A citation has been added for the last sentence of the second paragraph in Section 3.7.1.3.

131. Section 3.7.1.3, third paragraph, sixth sentence: To meet the purpose of this document, impacts to recreation, including boating, in Jordan Lake needs to be evaluated quantitatively.

    RESPONSE: The sixth sentence of the third paragraph in Section 3.7.1.3 is referencing the DWR Round 4 modeling results with respect to recreation. A sentence was added (with a citation) as follows: “*For the 2060 demand scenario, the Round 4 modeling results anticipated the minimum water surface elevations approximately 2.4 feet lower than the minimum water levels projected with the 2010 baseline scenario and amount of time the water surface elevation drops below 214 MSL increases from 10 to 15 percent of the time (DWR, 2016a).*”

132. Section 3.7.1.3, third paragraph, seventh sentence: Please provide a citation for this statement or state that this evaluation was conducted for the purposes of this project.

    RESPONSE: The seventh sentence of the third paragraph in Section 3.7.1.3 was edited to clarify that the statement is referencing the Round 4 modeling by DWR. A citation has been provided.

133. Section 3.7.1.3, fourth paragraph, first sentence: Please consider replacing “an increase” with “a revised”, as the reallocation process is not necessarily initiated to simply increase the allocations. Please note, the EMC did not entirely support the recommendations from the DWR; therefore, the last statement is misleading.

    RESPONSE: The first sentence of the fourth paragraph in Section 3.7.1.3 was revised to replace “an increase” with “a revised.” The last sentence in the fourth paragraph has been deleted. The new last sentence in the fourth paragraph has been revised to state: “*The revised Jordan Lake allocation is 91.2 mgd out of the total 100 mgd safe yield*.”

134. Table 3-13, footnote 1: Please explain what is meant by “OWASA is a supporting partner”.

    RESPONSE: As of late 2023, OWASA is financially participating in the Western Intake Partnership. This statement was deleted from the DEIS.

135. Section 3.7.2, second paragraph, third sentence: Please consider being explicit regarding which town is being discussed. Throughout most the document “The Town” refers to the Town of Fuquay-Varina.

RESPONSE: The third sentence of the second paragraph in Section 3.7.2 has been revised to clarify the reference to the Town of Apex. The entire DEIS has been reviewed to clarify the specific Town/City/County being referenced in a specific section.

136. Section 3.7.2, third paragraph, second sentence: Please explain why this alternative requires a new raw water intake in Jordan Lake. Please explain why this or another alternative is not considering purchasing the water from the Town of Cary.

RESPONSE: The text in Section 3.7 of the DEIS has been reorganized. In lieu of a combined summary in Section 3.7.4, a summary for Alternative 6 has been added to Section 3.7.2 and a summary for Alternative 7 has been added to Section 3.7.3. The summary text in the new Section 3.7.2.4 (Alternative 6) provides an explanation for the Towns of Cary and Apex requiring additional water supply until 2045. A new raw water intake was assumed for the purposes of comparison in the environmental impact analysis.

137. Table 3-14: For this table to have value to the document, the contract amounts and expiration dates need to be completed, please consider contacting the water systems to determine these values.

RESPONSE: Contract amounts are not listed in the approved Local Water Supply Plans for emergency non-recurring contracts. The data in table 3-16 (formerly Table 3-14) references the information from the approved Local Water Supply Plans.

138. Table 3-15: Considering that there is only one value presented, the value of this table is questionable.

RESPONSE Table 3-17 (formerly Table 3-15) was included to match all of the other tables in the DEIS summarizing water supply purchase contracts. The value of Table 3-17 is to demonstrate that the Towns of Cary and Apex do not have regular water supply purchase contracts with other utilities. All of the water supply purchase contracts for the Towns of Cary and Apex are for emergency use only. A sentence was added to the end of the third paragraph in Section 3.7.2: “*The Town of Apex and the Town of Cary do not have contracts to purchase a regular supply of water from a neighboring utility.*”

139. Section 3.7.2.1, first paragraph, fifth sentence: Please consider adding “River Basin” following “Neuse”.

RESPONSE This edit was made to the fifth sentence of the first paragraph in Section 3.7.2.1.

140. Global: For consistency, please consider including the IBT basin codes for all references to IBT river basins or HUC basin codes for hydrologic river basins throughout the document.

RESPONSE Please refer to the response to comment #85. To avoid repetition in the document, a new paragraph in Section 1.5.2 has been added as follows: “*The hydrologic river basin boundaries were defined in 1991 by Session Law 712 (General Statute §143-215 22G). The Cape Fear River is designated as basin 2-3. The Neuse River basin is designated as 10-1. The river basin designations used in Section 3 (Alternatives Analysis) and elsewhere in this EIS refer to the hydrologic river basin as defined by General Statute §143-215 22G*.”

141. Section 3.7.2.1, first paragraph, last sentence: Please consider providing an explanation of the formula for required returns to the Cape Fear Basin through the Western Wake WRF, based on the Cary/Apex IBT settlement agreement.

RESPONSE A paragraph was added to Section 3.7.2.1 that provides an explanation of the 2018 Consent Judgement for the required returns to the Cape Fear and Haw River basins.

142. Section 3.7.2.2, first paragraph, last sentence: Please explain what is meant by "build-out" in this context.

RESPONSE The last sentence of the first paragraph in Section 3.7.2.2 has been revised as follows: *"The LRWRP identified the year 2065 for the Towns of Cary and Apex to reach the limit of potential development in the service area (e.g., build-out)."*

143. Section 3.7.2.2, second paragraph, second sentence: Since Wake County does not have a LWSP and the table does not contain any information for the eastern half of the Wake County, please explain which County is being discussed.

RESPONSE The second sentence in the second paragraph in Section 3.7.2.2 has been revised as follows: "*The summarized data is based on the Town of Cary's approved 2022 LWSP and LRWRP*."

144. Section 3.7.2.2, second paragraph: Please consider providing data related to 2055, the end of the planning period for this proposed project. The numerous values and dates in the text without context is confusing.

RESPONSE The year 2055 was added to Table 3-18 (formerly Table 3-16). The second paragraph in Section 3.7.2.2 was updated to report the 2055 water metrics (e.g., maximum day, maximum day withdrawal).

145. Table 3-16, third footnote: This table appears to blend data from LWSP and LRWRP; therefore, please be explicit regarding the source of the data for every value. Please ensure this data is from similar years and projection efforts. Please provide an explanation if the LWSP values are different than what is presented in the LRWRP. Demand projections are provided in the LWSP for 2050 and 2060 demands.

RESPONSE The footnotes in Table 3-18 (formerly Table 3-16) have been revised to indicate that the Town of Cary's water use projection data are from the Town's 2022 approved LWSP. The Town of Cary's approved 2022 LWSP references the Town of Cary's Long Range Water Resources Plan Update (Jacobs, 2018). Per the note in Section 5 of the approved 2022 LWSP (and footnoted in Table 3-18), the Town of Cary's projections represent the 75th percentile forecast per Appendix B Section 3.12 and 3.13 of the Long Range Water Resources Plan Update.

146. Section 3.7.2.3, first paragraph, last sentence: Please provide the projected size of the expanded plant.

RESPONSE The Town of Cary's Long Range Water Resources Plan does not provide a planned incremental expansion of the Towns of Cary/Apex Water Treatment Plant. Therefore, the DEIS text was not revised.

147. Section 3.7.2.3, second paragraph: Please provide a citation for the source used.

RESPONSE The second paragraph in Section 3.7.2.3 was revised to reference, with citation, the Town of Cary's Long Range Water Resources Plan.

148. Section 3.7.3, second paragraph, second sentence: It is unlikely a third intake will be granted in Jordan Lake; therefore, please explain why this alternative requires a new raw water intake in Jordan Lake and new WTP, and why this or another alternative is not considering the purchase of water from the Western Intake Partnership. This applied to the Cary/Apex intake alternative as well.

RESPONSE A new Section 3.7.2.4 (Summary for Alternative 6, Raw Water Supply from Towns of Cary, Apex, and Morrisville) was added to the DEIS. The following sentences have been added to the second paragraph of Section 3.7.2.4: "*This alternative was carried forward in the EIS for an environmental impact analysis as a comparison to other alternatives. To assess the environmental impact of this alternative, it was assumed that a new raw water intake could be located adjacent to the raw water intake for the Towns of Cary and Apex*." Similar reorganization and text was added to Section 3.7.3.

149. Section 3.7.3.1, first paragraph, second sentence: Please clarify or confirm that Chatham County has a separate intake from the Town of Cary's intake for the independent 3 mgd WTP as stated.

RESPONSE The second sentence of the first paragraph in Section 3.7.3.1 was revised to clarify that Chatham County uses the Cary/Apex raw water intake as the raw water supply for the County's 3 mgd water Jordan Lake Water Treatment Plant.

150. Section 3.7.3.2, first paragraph, fourth sentence: Please explain how Chatham Park and associated development fits into these growth rates, or not at all.

RESPONSE Chatham Park and associated growth is included in the Town of Pittsboro projections. A footnote has been added to Table 3-19 (formerly Table 3-17) and the first paragraph of Section 3.7.3.2 has been edited to include this statement.

151. Table 3-18: Please explain how the total raw water supply for OWASA increases by 5 mgd, between 2021 and 2030, while the Jordan Lake portion only increases by 0.5 mgd during the same time period.

RESPONSE Table 3-20 (formerly Table 3-18) reflects current water supply planning for OWASA.

152. Section 3.7.4: Please provide projected demand values for the end year of the planning period, 2055, for this proposed project.

RESPONSE The text in Section 3.7.4 has been edited and re-organized. A new Section 3.7.3.4 (Summary for Alternative 7, Raw Water Supply from Western Intake Partners) was added. The projected 2055 water demand was added for the Western Intake Partners, as follows: "*In 2055, the total average day water demand is anticipated to be 61.6 mgd for all four Partners*."

153. Section 3.7.4, second paragraph, last sentence: Please provide correspondence or documentation to support this statement.

RESPONSE This statement was deleted from the DEIS text as a result of the reorganization and edits to Section 3.7.2 and 3.7.3.

154. Section 3.7.4, third paragraph, fifth sentence: This seems to be a misleading statement that water systems will be unable to meet their maximum day demands based on the Jordan Lake allocation, without considering that the Partners have other sources of water supply. Please clarify.

RESPONSE This statement was deleted from the DEIS text as a result of the reorganization and edits to Section 3.7.2 and 3.7.3.

155. Section 3.7.4, fourth paragraph, first sentence: Please clarify that "Chatham County North" was included in the 2002 Jordan Lake allocation.

RESPONSE The fourth paragraph in Section 3.7.4 has been deleted from the DEIS text as a result of the reorganization and edits to Sections 3.7.2, 3.7.3, and 3.7.4. The current third paragraph in Section 3.7.4 has been revised as follows: "*Approximately 8.8 mgd of additional allocation is available out of the 100 mgd safe yield in Jordan Lake. It is unknown at this time when a Round 5 application process might be initiated. However, the communities with a long-term investment in the Jordan Lake allocation process for water resources planning and infrastructure may receive higher priority in a future allocation process. The Towns of Cary/Apex and the Western Intake Partnership (e.g., City of Durham, Chatham County North, OWASA, and the Town of Pittsboro) have demonstrated a clear purpose and need to be granted a water supply allocation in Jordan Lake. The remaining communities with water allocation have also demonstrated a purpose and need for the water supply.*"

156. Section 3.7.4, sixth paragraph, first sentence: DWR respectfully challenges this statement, considering that Interstate 540 along with other significant develop activities in the southern portion of Wake County have been planned for decades. Additionally, 2030 population projections in the 2002 LWSP are comparable to the 2030 projections in the 2019 LWSP.

RESPONSE This statement was deleted from the DEIS text as a result of the reorganization and edits to Section 3.7.2 and 3.7.3. However, the text edits have been made to Section 2.2 and Section 3.7.4.

In Section 2.2, the following paragraphs were added with a new Table 2-2: "*Growth in Wake County and the Piedmont region has been significant due to several factors. The I-540 interchange has been in the planning process since the mid-1990s. The first stretch of I-540 opened in 1999 and the Triangle Expressway Southeast Extension (e.g., between the Town of Holly Springs and the Town of Garner) is under construction after approximately 15 years of delay. More significantly to the growth pressure is the recent economic development drive by the North Carolina Department of Commerce and the Economic Development Partnership of North Carolina (EDPNC) to attract industry to North Carolina. Founded as a non-profit in 2014, EDPNC is funded both by a contract with the North Carolina Department of Commerce and by private investment to provide economic development services. EPDNC, in partnership with the North Carolina Department of Commerce, has been highly successful in attracting new industry to the Piedmont region*."

"*The population projections documented in the Town of Fuquay Varina's LWSPs reflect the activity in the region given the uncertainties with the timing of NCDOT road projects and other economic development activities. The Town of Fuquay-Varina has adjusted population projections in the annual LWSPs as warranted by activity in the region. Table 2-2 provides a summary of the population projections as reported in the Town of Fuquay-Varina's LWSPs compared to the historic population. The following are observations with respect to the historic population compared to the population projections in the LWSPs:*

- *The 2010 population projection as reported in the 1989 Diehl and Phillips study, the 2006 LWSP, and the 2009 LWSP was 19,184 people compared to the 2010 historic population of 17,937 people.*
- *The 2020 population projection as reported in the 2010 LWSP was 27,662 people compared to the historic 2020 population of 33,000 people.*
- *The 2020 population projection as reported in the 2016 LWSP was 31,105 people compared to the historic 2020 population of 33,000 people*.
- *The 2030 population projection as reported in the 2002 LWPS was 43,724 people as compared to a population projection of 51,530 people as reported in the 2022 LWSP.*

Hazen and Sawyer updated the Town of Fuquay-Varina's population projections to support the proposed request for an interbasin transfer. The Town commissioned Hazen in early 2019 to begin the planning process. The population projections as reported in the Town of Fuquay-Varina's 2020,

2021, and 2022 LWSPs reflect the updated planning estimates for the proposed project."

Table 2-2: Population Projections as Reported in Town of Fuquay-Varina's Local Water Supply Plans Compared to Historic Population

Local Water Supply Plan Year	Historic Population	Population Projection As Reported for a Local Water Supply Plan Planning Year						
		2010	2020	2030	2040	2050	2060	2070
1989 Study [1]		19,148	21,405					
1997 LWSP	6,249	18,268	38,942					
2002 LWSP	10,335	14,510	25,188	43,724				
2006 LWSP	14,584	19,184	30,684	42,184	53,684	65,184		
2009 LWSP	15,000	19,184	30,684	42,184	53,684	65,184		
2010 LWSP	17,937	17,937	27,662	42,162	59,662	77,162	94,662	
2011 LWSP	18,600		27,662	42,162	59,662	77,162	94,662	
2012 LWSP	19,674		27,662	42,162	59,662	77,162	94,662	
2013 LWSP	19,804		27,662	42,162	59,662	77,162	94,662	
2014 LWSP	21,653		27,662	42,162	59,662	77,162	94,662	
2015 LWSP	22,920		27,662	42,162	59,662	77,162	94,662	
2016 LWSP	26,105		31,105	43,605	56,105	68,605	73,733	
2017 LWSP	27,600		31,105	43,605	56,105	68,605	73,733	
2018 LWSP	29,450		32,395	45,350	58,960	70,750	77,830	
2019 LWSP	29,200		32,395	45,350	58,960	70,750	77,830	
2020 LWSP [2]	33,000		33,000	51,530	70,290	89,050	108,000	126,000
2021 LWSP [2]	34,152			51,530	70,290	89,050	108,000	126,000
2022 LWSP [2]	39,468			51,530	70,290	89,050	108,000	126,000

[1] Diehl and Philips (1989).
[2] The Town of Fuquay-Varina's LWSP reflects IBT planning projections.

Significant revisions were also made to Section 3.7.4, as follows:
"*The application process for a water supply allocation in Jordan Lake is a lengthy and complicated process. The Round 2 application process started in 2000 with an EMC decision in 2002. The process for Round 4 allocations was initiated in 2009, applications were submitted in 2014, and a final decision from the EMC was in 2017 (e.g., 8 years). The majority of communities that were granted water allocation in Jordan Lake are located proximate to the Lake, have historically been using Jordan Lake as water supply, or have identified Jordan Lake as a future water supply source in water resources planning efforts.*

In 2009 when the Jordan Lake Round 4 application process started, the Town of Fuquay-Varina population was 15,000 people with an associated water demand of 1.8 mgd. A prior planning study by Diehl and Phillips (1989) estimated a 2010 population of approximately 19,000 people and a 2020 population of 21,400 people. During the Round 4 Jordan Lake Allocation process, the Town of Fuquay-Varina had sufficient water supply as a wholesale customer to Raleigh Water, Johnston County, and Harnett County.

The growth in Wake County has been significant due to several factors. The I-540 interchange has

been in the planning process since the mid-1990s with the initial stretch opening in 1999. The Triangle Expressway Southeast Extension connecting the Towns of Holly Springs and Garner is under construction after approximately 15 years of delay. More significantly is the recent economic development activity by the North Carolina Department of Commerce and the EDPNC. Founded as a non-profit in 2014, EDPNC is funded both by a contract with the North Carolina Department of Commerce and by private investment to provide economic development services to attract industry to North Carolina. EPDNC, in partnership with the North Carolina Department of Commerce, has been highly successful in attracting new industry to the Piedmont region.

The Town of Fuquay-Varina is a secondary recipient of the growth in the Piedmont region. The Town has not gained new industry but is instead planning around the effects of residential and commercial growth to support surrounding communities' industrial growth. The Town of Fuquay-Varina's growth started to accelerate in 2016, at which point the Town commissioned the Water Capacity Study (WithersRavenel|Freese and Nichols, 2017).

Approximately 8.8 mgd of additional allocation is available out of the 100 mgd safe yield in Jordan Lake. It is unknown at this time when a Round 5 application process might be initiated. However, the communities with a long-term investment in the Jordan Lake allocation process for water resources planning and infrastructure may receive higher priority in a future allocation process. The Towns of Cary/Apex and the Western Intake Partnership (e.g., City of Durham, Chatham County North, OWASA, and the Town of Pittsboro) have demonstrated a clear purpose and need to be granted a water supply allocation in Jordan Lake. The remaining communities with water allocation have also demonstrated a purpose and need for the water supply."

157. Section 3.7.4, seventh paragraph, third sentence: Please clarify that the Jordan Lake water supply allocations are based demonstratable projected needs by the neighboring communities. Other than the fact that these communities have been financially paying for allocations based on their long-range planning, the assertion of "higher priority" is questionable.

RESPONSE The text in Section 3.74 has been edited significantly. Please refer to the fifth paragraph in the response to comment #156.

158. Section 3.7.4, eighth paragraph, fourth sentence: Please provide a citation and explain the details.

RESPONSE A citation has been added to the now sixth paragraph in Section 3.7.4 (post revisions).

159. Section 3.8.2, first paragraph, sixth sentence: Please provide the current use of the property and the capacity/spec limits of the former WWTP throughout the document where appropriate.

RESPONSE A new paragraph has been added to Section 3.8.2, as follows: "*The proposed infrastructure for Alternative 8 includes a return of water to the Cape Fear River. The Town of Fuquay-Varina previously owned and operated a 1.2 mgd Kenneth Branch WWTP in the Town's portion of the service area in the Cape Fear River basin. However, the Town decommissioned the Kenneth Branch WWTP in 2006 and rescinded the NPDES permit NC0028118 (NCDENR, 2008). The effluent outfall for the Kenneth Branch WWTP was located in the headwaters of Kenneth Creek. Kenneth Creek is a tributary to Neals Creek, which is tributary to the Cape Fear River upstream of the Town of Lillington. The Town of Fuquay-Varina deeded the property to the Wake County Public School System in 2022. The Wake County Public School System is currently constructing middle and elementary schools on this property. Monthly average effluent NPDES permit limits for the Kenneth Creek WWTP included 16 mg/L biochemical oxygen demand (BOD), 30 mg/L total suspended solids (TSS), 5 mg/L of ammonia in summer (April 1 to October 31), and 13 mg/L of ammonia in winter (November 1 to March 31).*"

A discussion of the capacity of the Town of Fuquay-Varina's 36-inch interceptor was also included in Section 3.8.2. Please reference response to comment #24.

160. Section 3.8.2, third paragraph, third sentence: Please consider providing an explanation for "non-tributary flow."

RESPONSE A discussion of the Town of Fuquay-Varina's wastewater flow projections has been moved to a new Section 2.3 of the DEIS. A definition for "non-tributary flow" has been provided in a new Table in Section 3.8.2.1.

161. Section 3.8.2, third paragraph, last sentence: Please provide a year for "build-out". Please provide a value for 2055, as that is the final year of the planning period for this proposed project.

RESPONSE A wastewater flow projection for the year 2055 has been provided in Section 2.3 in a new Table 2-7.

162. Section 3.8.2.1, second paragraph, first sentence: Please consider including this document from DWR in the appendix.

RESPONSE Due to the amount of time that has passed since the submittal of the DEIS for completeness review, Harnett County has received an NPDES permit for the proposed expansion of the North Harnett Regional WWTP. The inclusion of a speculative limits request letter is no longer necessary. A new Table 3-23 has been added to Section 3.8.2.1 summarizing the North Harnett Regional WWTP effluent limits at 7.5 and 16.5 mgd.

163. Section 3.8.2.1, second paragraph, sixth sentence: Please include water balance tables based on current, 2035, 2045, and 2055 projections to detail the proposed IBT request.

RESPONSE The water balance tables were already included in Section 2 of the DEIS. All of the finished water delivered to the Neuse River basin is discharged to the Neuse River basin and all of the finished water delivered to the Cape Fear River basin is discharged to the Cape Fear River basin. Per Section 2.4 of the DEIS, the only consumptive loss is the 512 homes located geographically in the Cape Fear River basin but in the Neuse River basin per G.S. §143-215 22G. The water balance for the Town of Fuquay-Varina is included in Appendix C of the DEIS.

164. Section 3.8.2.2, first paragraph, third sentence: Please consider including this document from DWR in the appendix and explaining the details of the tiered effluent limits.

RESPONSE The NPDES permit for the Terrible Creek WWTP is included in an Appendix.

165. Section 3.8.2.2, second paragraph, third sentence: Please confirm and provide documentation in the appendix that the Town has secured the sufficient nitrogen credits to support the expanded discharge to 6 mgd.

RESPONSE The NPDES permit for the Terrible Creek WWTP is included in an Appendix. A new paragraph has been added to Section 3.8.2.2 as follows: *"The Town of Fuquay-Varina's Terrible Creek WWTP expansion to 6 mgd will satisfy the Town's wastewater capacity needs in the Neuse service area over the next 20-year planning period per DWR guidance (2019). The wastewater flow projection in the Neuse service area is anticipated to be between 3.3 and 6.3 mgd by 2045. The Town of Fuquay-Varina may not require an expansion of the Terrible Creek WWTP post 2045, as a range of wastewater flow projections is predicted to be between 4.0 and 7.6 mgd by 2055 depending on the rate of growth. If an expansion of the Terrible Creek WWTP is necessary post 2045, the Town of Fuquay-Varina will be able to meet the annual mass load of 68,065 pound per year (lb/yr) total nitrogen per the NPDES permit with conventional activated sludge treatment technology."*

166. Section 3.8.2.2, second paragraph, third sentence: Please provide an explanation for how the Town will meet 3 mg/L N concentration limit for the proposed 6 mgd expansion, given that under the current WWTP 3.75 mg/L is the best achievable.

RESPONSE The second paragraph in Section 3.8.2.2 has been rewritten to state the following: "*The Town of Fuquay-Varina's Terrible Creek WWTP expansion to 6 mgd will satisfy the Town's wastewater capacity needs in the Neuse service area over the next 20-year planning period per DWR guidance (2019). The wastewater flow projection in the Neuse service area is anticipated to be between 3.3 and 6.3 mgd by 2045. The Town of Fuquay-Varina may not require an expansion of the Terrible Creek WWTP expansion post 2045, as a range of wastewater flow projections is predicted to be between 4.0 and 7.6 mgd by 2055 depending on the rate of growth. If an expansion of the Terrible Creek WWTP is necessary post 2045, the Town of Fuquay-Varina will be able to meet the annual mass load of 68,065 pound per year (lb/yr) total nitrogen per the NPDES permit with conventional activated sludge treatment technology.*"

Conventional activated sludge plants have successfully achieved effluent total nitrogen concentrations at approximately 2 mg/L.

167. Section 3.8.2.2, second paragraph, last sentence: Please clarify the requested IBT value based on 2055 projections. This needs to be stated throughout the document in a consistent fashion. The demonstration mentioned in the preceding sentence may need to occur in concert with or prior to issuance of an IBT Certificate.

RESPONSE Section 3.8.2 has been significantly revised to clarify technical points. A new introductory paragraph in Section 3.8.2 has been added to define the 2055 wastewater flow projections, as follows:

The proposed infrastructure for Alternative 8 includes a return of water to the Cape Fear River. Per the DWR Guidance Document for facilities requesting a new or expanding NPDES discharge permit, utilities must document the associated population growth over a 20-year planning period (DWR, 2019). In this analysis, the 20-year planning period for a potential wastewater capacity project would be before the year 2045. Per Section 2.3, wastewater flow projections in the Cape Fear service area are anticipated to be between 3.4 and 6.3 mgd by 2045 and between 4.1 and 7.6 mgd by 2055 depending on the rate of growth in the service area. The wastewater flow projection in the Neuse service area is anticipated to be between 3.3 and 6.3 mgd by 2045 and between 4.0 and 7.6 mgd by 2055.

For Alternative 8, the following effluent disposal options were evaluated:

- *Use of Town of Fuquay-Varina's existing 36-inch interceptor and ILA with Harnett County*
- *Use of Town of Fuquay-Varina's Existing Wastewater Treatment Facilities in the Neuse River Basin*
- *Use of Capacity in the Town of Holly Springs Utley Creek WRF*
- *A new outfall to the Cape Fear River*

Per the response to comments #165 and #166, if an expansion of the Terrible Creek WWTP is necessary, the Town will be able to meet the annual mass load of 68,065 pound per year (lb/yr) total nitrogen per the NPDES permit with conventional activated sludge treatment technology.

168. Section 3.8.2.3, third paragraph, fourth sentence: Please provide a projected year for build-out.

RESPONSE The projected year for the Town of Holly Springs build-out was not provided in the Master Plan. However, a sentence was added to the third paragraph in Section 3.8.2.3 that build-out will likely occur post 2055.

169. Section 3.8.2: There needs to be an evaluation for sending wastewater flows to the Western Wake WRF. The evaluation should include documentation from the owners of the WWTP as to their willingness to cooperate. This appears to be an appropriate section to include this; however, the location of this evaluation in the document is the discretion of the author.

RESPONSE Email correspondence from the Town of Cary has been provided in an Appendix. Alternative 9D has been added to the DEIS to discuss a return of flow to the Cape Fear River basin via the Western Wake WRF.

170. Section 3.8.2.4, third paragraph, third sentence: Please identify the approximate location of the proposed outfall in the Cape Fear River.

RESPONSE The third paragraph in Section 3.8.2.4 has been deleted. However, a sentence has been added to the second paragraph, as follows: "*Figure 3-10 provides the location of the proposed effluent outfall across the river from the North Harnett Regional WWTP downstream of Highway 210.*"

171. Section 3.8.2.4, second paragraph, first sentence: Please confirm that this section of the Cape Fear River is classified as Nutrient Sensitive Waters (NSW) or consider rephrasing.

RESPONSE All water quality discussions have been relocated to Sections 4.14 and 5.15. The DEIS text has been revised to state that the Cape Fear River basin is not nutrient impaired and not classified as Nutrient Sensitive.

172. Section 3.8.2.4, second paragraph, second sentence: Please confirm that this section of the Cape Fear River is classified "impaired" or consider rephrasing. The last sentence in this paragraph states that the Cape Fear River is not listed for any impairments. Please clarify these statements.

RESPONSE All water quality discussions have been relocated to Sections 4.14 and 5.15. The DEIS text has been revised to state that the Cape Fear River basin is not nutrient impaired and not classified as Nutrient Sensitive.

173. Section 3.8.2.4, second paragraph, third sentence: Please provide an explanation in this context for what is meant by "frozen".

RESPONSE All water quality discussions have been relocated to Sections 4.14 and 5.15. The DEIS text has been revised to state that the Cape Fear River basin is not nutrient impaired and not classified as Nutrient Sensitive.

174. Section 3.8.2.4, second paragraph, fourth sentence: In order to fully evaluate this alternative and other similar solutions, as compelled by the EIS process, a water quality modeling evaluation needs to be conducted for potential treated wastewater discharges into the Cape Fear River. This should be done before these alternatives can be regarded as infeasible or impractical.

RESPONSE The DEIS has been revised to add a new Section 2.3 to discuss the Town of Fuquay-Varina's wastewater flow projections. The DEIS Section 3.8.2 has been heavily revised for clarification. Text has been added to the third paragraph of Section 3.8.3 (Summary) as follows: "*The Town of Fuquay-Varina has sufficient wastewater capacity in the Town's Neuse River service to support future wastewater capacity needs over the 20-year planning period for wastewater. It is also likely that the Town of Fuquay-Varina will have sufficient wastewater capacity in the Cape Fear service area over the 20-year planning period for wastewater depending on the rate of growth. Refer to Sections 5.14 and 5.15 for a discussion of water quantity and quality of a return of water to the Cape Fear River basin, respectively."*

175. Section 3.8.2.4, fourth paragraph, second sentence: Please explain the existing water quality issue at the proposed outfall location, if the standard cannot be exceeded more than 10% of the time, as stated in the third paragraph, and is only exceeded 2.5 to 3.3% of the time, as stated in the fourth paragraph. This was described as an "impairment" in the second paragraph of this section.

RESPONSE This sentence has been deleted from the DEIS as the data is older compared to newer data collected by DWR. In lieu of specific water quality data, Nora Deemer's discussion (second comment) has been added to the DEIS in Section 4.14 and 5.15.

176. Section 3.8.2.4, fourth paragraph, fourth sentence: Please provide a date/year of the data sample and the concentrations reported.

RESPONSE This sentence has been deleted from the DEIS as the data is older compared to newer data collected by DWR. In lieu of specific water quality data, Nora Deemer's discussion per her second comment has been added to the DEIS in Section 4.14 and 5.15.

177. Section 3.8.2.4, fourth paragraph, fifth, sixth, and seventh sentences: Please provide dates/years of the data samples and the concentrations reported.

RESPONSE Please see the response to comment #176.

178. Section 3.8.2.4, sixth paragraph: Please provide the reader with context for this information considering the previous water quality information in this section. Please detail any communication or consultation with the USFWS that has occurred regarding the proposed outfall location.

RESPONSE The information in the paragraph has been moved to the appropriate section (5.13.2). The introductory paragraphs for this section specify the sources of information used. Coordination with USFWS will occur if a population of a federally protected species is found to be present in a project area associated with the selected alternative.

179. Section 3.8.3, first paragraph, last sentence: Having not fully investigated the potential for this option, this statement seems to be more of an assumption by the author.

RESPONSE Instream flow studies are very time consuming and expensive. The following table has been added to the DEIS as Table 1-2 in Section 1.5.4 and referenced in Section 3.8.3:

Instream Flow Study Project	Fee	Fee Date	Timeframe	Fee in 2023$ [1]
Tar River	$1,180,000	2009	8 years	$1,780,000
Swift Creek	$1,400,000	2006	7 years	$2,310,000
Savannah River	$673,000	2007	5 years	$1,080,000
James River	$780,000	2007	5 years	$1,250,000
Russian River	$923,000	2007	> 6 years	$1,480,000

[1] *Fees updated to 2023 dollars using an annual 3% per year inflation.*

180. Section 3.8.3, second paragraph, last sentence: Please ensure the accuracy of this statement is consistent with other statements made throughout this document. Also, confirm this value is based on 2055 (30-year planning period) projections.

RESPONSE Section 3.8.3 of the DEIS has been revised. The last sentence of the second paragraph has been deleted. The second paragraph of Section 3.8.3 has been revised for clarification, as follows: *"A return of treated effluent to the Cape Fear River may offset the impact of the proposed withdrawal. A total maximum withdrawal of 13 mgd is required to meet the projected maximum day water demand for the Town of Fuquay-Varona, which is equivalent to an annual average withdrawal*

of 8.4 mgd. A proposed 11 mgd withdrawal would be supplemented by the Town's contractual amount to purchase 2 mgd from Harnett County. A wastewater return of 6 mgd would be required per the interbasin transfer calculations in Table 2-8 in 2055."

181. Section 3.8.3, third paragraph, last sentence: Please explain how this meets the requirements for this proposed IBT EIS that is based on a 30-year planning horizon (2025-2055), not 20-25 years.

RESPONSE The last sentence in the now second paragraph of Section 3.8.3 has been revised as follows: "*A wastewater return of 6 mgd would be required per the interbasin transfer calculations in Table 2-8 in 2055.*" The last sentence in the third paragraph was deleted.

182. Section 3.8.3, fourth paragraph, second sentence: That is often the case when conducting alternative analyses for an EIS. Please explain why this EIS is excused from fully evaluating all alternatives presented.

RESPONSE The fourth paragraph of Section 3.8.3 has been deleted for clarity. Section 3.8.3 has been revised for clarity.

For all alternatives, revisions to the purpose and need statements have been made per the suggestion of David Wainwright in these comments. Not all of the alternatives fully meet the purpose and need of the proposed project. The Town of Fuquay-Varina has signed an interlocal agreement with the City of Sanford to implement a regional solution to water supply in the Cape Fear River.

183. Section 3.9, first paragraph, last sentence: Please identify specifically which entity(s) are responsible for each of the various infrastructure projects mentioned.

RESPONSE A sentence has been added to the first paragraph of Section 3.9, as follows: *"The City of Sanford is the lead agency for the design of the entire project with the Partners participating in the process."*

184. Section 3.9, third paragraph, first sentence: This is not an accurate statement. Though the City does fall under the "cork rule" provision, this does not absolve the City from accounting for the consumptive losses in the portion of their service area that is within the receiving basin (i.e., Deep River). Updated "Surface Water Transfer Worksheets" specifically for the City of Sanford need to be included with this EIS document, detailing the current (2025), 2035, 2045, and 2055 projected transfers.

RESPONSE A water balance table for the City of Sanford has been provided in an Appendix.

185. Section 3.9, third paragraph, last sentence: Please provide a brief explanation for why the City's peaking factor is so high (nearly 2).

RESPONSE The 2021 data as documented in the DEIS was as reported on the City of Sanford's approved 2021 LWSP. The DEIS text has been updated to include the provisional 2022 LWSP data. Annual average to maximum day demand peaking factors will vary from year to year. The third sentence in the third paragraph has been revised to reflect the 2022 annual average water demand of 7.87 mgd and a maximum day demand of 10.4 mgd.

186. Table 3-20: Please explain why 3 of the 4 regular sales contracts have expired and if these water sales are still occurring.

RESPONSE The data in Table 3-24 (Formerly Table 3-20) has been updated with 2022 values from the approved 2022 LWSP.

187. Section 3.9, fifth paragraph, second sentence: Please provide a citation.

RESPONSE A citation has been provided for the second sentence of the fifth paragraph.

188. Section 3.9, fifth paragraph, third sentence: Please explain the relevance of Chatham County and specifically the Moncure Industrial Park to the City of Sanford.

RESPONSE A sentence has been added to the fifth paragraph in Section 3.9, as follows: *"Water and wastewater services for industry in Moncure Park will be provided by the City of Sanford*."

189. Table 3-21: Please consider providing an explanation regarding the need of additional water resources from the City of Sanford for the Town of Pittsboro and Chatham County beyond the supplies provided by Jordan Lake, as discussed in Section 3.7.

RESPONSE The sixth paragraph in Section 3.9 has been revised to clarify other water supply sources used by the City of Sanford's regional partners.

190. Section 3.9.3, second paragraph, fifth sentence: Please clarify, is the reference to "the City's terminal reservoir" referring to Buckhorn Dam? If not, please describe the role the Buckhorn Dam has on the City of Sanford's intake.

RESPONSE The second paragraph has been revised to clarify that the terminal reservoir is a raw water storage reservoir. Additionally, the second paragraph of Section 3.9.3 has been revised to add the following sentences: "*The PER did not recommend an expansion of the City's terminal (e.g., raw water storage reservoir), for which the DWR Public Water Supply Section concurred in March 2021. The City pumps raw water from the Cape Fear River into the terminal reservoir to allow a few days of raw water storage prior to treatment*."

The second paragraph of Section 3.9.3 has also been revised to add the following sentences: "*For the 30 mgd expansion, the existing raw water intake structure will be replaced with a pair of new cylindrical wedge-wire intake screens installed farther out in the river to accommodate low river flow. The new screens will include a removable spool piece that will allow the screens to be dropped down to a minimum operable level. This design consideration is in anticipation of the future possibility that Buckhorn dam could be lowered or removed. The existing intake screens will be demolished."*

191. Section 3.9.3, third paragraph, fourth sentence: Please provide a citation.

RESPONSE A citation has been provided for the fourth sentence of the third paragraph in Section 3.9.3.

192. Section 3.9.3, fourth paragraph, fourth sentence: Please consider including a demonstration of effectiveness of the proposed GAC system (appendix) and committing to the installation of the specialized treatment system to avoid the transfer of waters with known concentrations of emerging compounds to waters within a receiving basin with potentially lower existing concentrations of emerging compounds. A commitment in the mitigation section of the EIS is encouraged.

RESPONSE A sentence has been added to the fourth paragraph of Section 3.9.3 to clarify that granular activated carbon (GAC) treatment for PFAS compounds is included in the design of the City of Sanford's WFF expansion. GAC is a proven technology for PFAS removal. A Technical Memorandum outlining rapid small scale carbon tests (RSSCTs) for carbon and PFAS for the City of Sanford has been provided in an Appendix of the DEIS.

193. Section 3.9.4, third paragraph, last sentence: Please consider identifying the "separate process" involved with permitting these facilities. Additionally, These infrastructure facilities should be included in the estimated project costs, similar to the other alternatives evaluated.

RESPONSE The last sentence of the third paragraph in Section 3.9.4 has been revised as follows: "*The City of Sanford has obtained construction-related permits for the WFF expansion and raw water intake improvements.*" The opinion of probable project costs for Alternative 9 include engineering

fees related to obtaining construction permits.

194. Section 3.10, third paragraph, second sentence: This sentence states that the Cape Fear River is formally impaired, nutrient sensitive waters; however, earlier no formal impairments are listed and the river appears to not be classified as NSW (nutrient sensitive waters). Please clarify.

RESPONSE All water quality discussions have been relocated to Sections 4.14 and 5.15. Per Nora Deamer's comments, the DEIS text has been revised to state that the Cape Fear River basin is not nutrient impaired and not classified as Nutrient Sensitive.

195. Section 3.11: Please consider adding more information specific to the Fuquay-Varina area than is provided.

RESPONSE Literature is not available specific to groundwater quantity or quality in the Town of Fuquay-Varina service area. Section 3.12 (formerly Section 3.11) has been revised to reflect the 2022 USGS groundwater study in Wake County (refer to response to Comment #200) and DHHS water quality data specific to Wake County (refer to response to Comment #202.

196. Section 3.11, first paragraph: Please consider adding clarification between sentences two and four, considering that sentence three states they are "parallel" (i.e., "more than" and "approximately"). Please explain the context between the last two sentences. The document reads as if PWS wells are primarily used for irrigation.

RESPONSE The second and last sentences in the first paragraph of Section 3.12 (formerly Section 3.11) have been deleted to avoid confusion.

197. Section 3.11, second paragraph, last sentence: Please consider explaining the type of well the "GC" classification is used for and why the EMC is involved.

RESPONSE The last sentence of the second paragraph in Section 3.12 (formerly Section 3.11) has been revised as follows: "*A Class GC designation is assigned for groundwaters in which water quality is degraded and cannot be improved with treatment. Class GC designations are determined by the EMC on a case by case basis per 15A NCAC 02L .021*."

198. Section 3.11.1, first paragraph, third sentence: Please explain what is meant by "perception" in this context. Perhaps a citation if needed.

RESPONSE The third sentence of the first paragraph in Section 3.12.1 (formerly Section 3.11.1) has been revised as follows: "*The Town of Fuquay-Varina service area spans the fall line boundary between the Piedmont and Coastal Plain Physiographic Provinces. Groundwater in the Blue Ridge and Piedmont has not been traditionally considered for large water supply sources due to readily available surface water supplies and low groundwater yields*." The term "perception" should not have been used in this sentence.

199. Section 3.11.1, third paragraph, last sentence: Please explain if every well includes private and/or non-drinking water wells.

RESPONSE The last sentence of the third paragraph in Section 3.12.1 (formerly Section 3.11.1) has been revised to clarify that a 100 foot radius is required around every public water supply well for well point protection.

200. Section 3.11.1, sixth paragraph: Please consider identifying the systems reviewed to provide context to the relevancy of these selected. Please provide any communication you may have had with these systems, particularly regarding the accuracy of the listed well yields over time and other long-term

issues. Please provide any communication with Wake County, who has been conducting a significant, long- range groundwater study, including how their results compare to the results in this document.

RESPONSE This Wake County groundwater report was not available at the time the DEIS was going through Hazen quality control for submittal to DWR in early summer 2022. The sixth paragraph in Section 3.12.1 (formerly Section 3.11.1) used DWR approved LWSP data from Aqua North Carolina in Wake County and Micro in Johnston County for representative well yields. This sixth paragraph in Section 3.12.1 (formerly Section 3.11.1) has been deleted and replaced with the following new paragraph: "*In May 2022, USGS in conjunction with Wake County Environmental Services published an Assessment of Well Yield, Dominant Fractures, and Groundwater Recharge in North Carolina. This study characterized the fractured rock aquifer system to assess the sustainability of groundwater for the purpose of water use decisions. USGS inventoried all of the wells in Wake County and conducted a graphical analysis of well construction (e.g., well depth) to identify the correlation between well yield and well depth. Maximum well yield varied across Wake County, ranging from 0.1 to 150 gpm with a median well yield of 10 gpm. The 75th percentile of the well yield data from USGS was 20 gpm. USGS stated that new well yields will likely range between zero and the maximum value of 150 gpm.*"

The USGS study supports the conclusion in the DEIS that limited well yield is available for large water supply systems.

201. Section 3.11.1, eighth paragraph, second sentence: Please consider if Alternative 10 was considered as a "minimization" alternative to the IBT, as described in the first sentence of the paragraph, then explain why the full 8.4 mgd average day of the entire service area was evaluated. Please provide any other considerations given, including if the Neuse River basin portion of the service area was supplemented by groundwater to avoid an IBT. The use of "minimization" to describe this alternative is also found in the first sentence of the first paragraph of Section 3.11.

RESPONSE Section 3.12 (formerly Section 3.11) was revised to only include the 2055 water demands from the Town of Fuquay-Varina's Neuse service area. The well yield was also revised from 30 to 20 gpm/day to reflect the 75th percentile of the data from the 2022 USGS groundwater study in Wake County per response to Comment #201.

202. Section 3.11.3, third paragraph, sixth sentence: Please identify the location of the study and results presented.

RESPONSE Third paragraph in Section 3.12.3 (formerly Section 3.11.3) was edited to remove the water quality sampling reference. The fourth paragraph in this section was revised as follows: "*A study of private well groundwater quality sampling occurred between 2008 and 2009 and between 2018 and 2019 (DWR, 2021). The data was collected by the North Carolina Department of Human Health Services and analyzed by the State Laboratory for Public Health. The data was provided to DWR. The data indicated that private Wake County wells exceeded groundwater quality standards at 0.62 percent, 1.9 percent, and 5.4 percent for arsenic, copper, and lead, respectively. Iron, manganese, and zinc exceeded secondary groundwater standards at 23.91 percent, 22.68 percent, and 1.37 percent respectively. A 2015 study (DWR, 2015b) indicated a low susceptibility of radon in groundwater in Wake County in the vicinity of the Town of Fuquay-Varina's service area. Based on these available studies, groundwater quality in the proposed well field area appears to be variable."*

203. Section 3.11.3, third paragraph, sixth sentence: Please identify the location of the study and results presented in context with the Fuquay-Varina area. Please confirm these results and findings from the cited document.

RESPONSE Please refer to the response to Comment #202. The third paragraph has been revised to only report the groundwater quality data from Wake County, which includes the service area for the Town of Fuquay-Varina.

204. Section 3.12, second paragraph, last sentence: Please spell out the acronym, SDWA.

RESPONSE The acronym for SDWA was spelled out in the last sentence of the second paragraph in Section 3.13 (formerly Section 3.12) as well as added to the acronym list.

205. Section 3.12.1, third paragraph: A water system withdrawing water from a water body that contains some fraction of treated wastewater produced from an entity upstream is not generally considered "reuse" or "de facto reuse". To present the information in this context, provide citations, specific to NC. In NC, reuse generally refers to the use of treated wastewater prior to the discharge in a body of water. Many water systems across the state participate in reuse programs for a wide-variety of reasons, to include a reduction in the total discharge to a body of water to meet wastewater discharge (NPDES) permitting requirements. Unless the author is able to present a citation in rule or statute, the "'five-mile' de facto policy" is guidance provided by the PWSS that provides water systems a reasonable opportunity to adjust or cease withdrawals in the event of spills of untreated wastewater from an upstream WWTP.

RESPONSE The third paragraph in Section 3.13.1 (formerly Section 3.12.1) has been revised as follows: "*De facto reuse has been a part of normal operations for the vast majority of public water supplies. De facto reuse occurs due to upstream utilities discharging into water bodies that downstream users then withdrawal for water supply. Other than providing dilution and travel time between a wastewater outfall and a drinking water intake, there is no additional treatment required beyond conventional drinking water treatment. North Carolina does not have a code or regulation defining this situation. The DWR Public Water Supply Section has historically provided guidance to water systems that a wastewater treatment facility located at 5 miles upstream of a drinking water intake provides a reasonable opportunity to respond to a spill of untreated wastewater."*

206. Section 3.12.1, fourth paragraph: Please provide citations.

RESPONSE The information in the fourth paragraph of Section 3.13.1 (formerly Section 13.12.1) is general industry knowledge and not specific to a finding or conclusion that would require a reference.

207. Section 3.12.1, fifth paragraph: Please provide citations.

RESPONSE Citations were provided for the Texas and California references in the fifth paragraph of Section 3.13.1 (formerly Section 3.12.1).

208. Section 3.12.1, sixth paragraph: Please provide citations.

RESPONSE Citations were provided for industry studies related to advanced treatment processes in in the sixth paragraph of Section 3.13.1 (formerly Section 3.12.1).

209. Section 3.12.3, first paragraph: Please explain the context of reuse programs to residential irrigation. Please consider presenting other potential applications of reuse water.

RESPONSE A second paragraph in Section 3.13.3 (formerly Section 13.2.2) was added as follows: "*The Town of Fuquay-Varina does not have industry that would provide a use for reclaimed water. Only one industry is currently permitted to discharge to the Town's collection system. The flow from this industry is 25,000 gpd. The Town of Fuquay-Varina does not have a planned industrial park or other land use mechanisms for significant industrial growth."*

210. Table 3-25: Please explain what the total row represents for each column.

RESPONSE In Table 3-28 (formerly Table 3-25), the table rows indicate the number of residential homes constructed during the specified decade. The row headings have been updated as follows, "*Homes constructed between…*" The rows in Table 3-29 (formerly Table 3-26) have also been updated.

211. Section 3.12.3, second paragraph, last sentence: Are the exceedances and reductions mentioned based on the annual average?

RESPONSE The residential meter data in Table 3-29 (formerly Table 3-26) is an average of the 2019 billing data for the specified decade. A footnote has been added to the table.

212. Section 3.12.3, third paragraph, seventh sentence: Please explain how irrigation use for any water system offsets the potable water use, as described.

RESPONSE In the third paragraph of Section 3.13.3 (formerly Section 3.12.3), the following text has been added: "*This evaluation demonstrates that the overall irrigation use is a fraction of the Town of Fuquay-Varina's water demand and therefore does not contribute to a substantial offset in potable water use. A statistically significant difference was not found at a confidence level of 0.05 if the overall per capita use of 85 gpcd is offset annually by the average summer difference in per capita use at 3.1 gpcd per Table 3-26.*"

213. Section 3.12.3, fifth paragraph, last sentence: Please explain why agricultural land not being identified in the Town's land use plan excludes developing a reclaimed water program.

RESPONSE The last sentence of the fifth paragraph in Section 3.12.3 (formerly Section 3.12.3) specifically discusses irrigation of agricultural land per the 15A NCAC 2U rules: "*Agricultural land uses are not identified in the Land Use Plan. Therefore, developing a reclaimed water program via the 15A NCAC 2U Rules (e.g., crop irrigation) is not a viable solution.*" The previous paragraphs provide an analysis of the Town of Fuquay-Varina's residential irrigation demand compared to the single family residential use.

214. Section 3.12.3: Please consider evaluating land application of treated wastewater in the source basin, including spray fields and golf courses.

RESPONSE The analysis in Section 3.13.3 (formerly Section 3.12.3) is specific to residential irrigation use to offset potable water demand. The Town of Fuquay-Varina does not have outdoor golf courses in the Cape Fear portion of the service area. As stated in the last paragraph of Section 3.13.3, the Town's land use planning is comprised of residential, commercial, and mixed density uses. Large contiguous acreage is not available in the Town's service area, including the Cape Fear portion of the Town's service area. Approximately 2,300 acres of land would be required to dispose of the entire 6 mgd transfer using reuse quality water at 1 inch per acre week.

215. Section 3.13.1, third paragraph, last sentence: Please explain how this trend has directly affected the Town of Fuquay-Varina.

RESPONSE The last sentence of the third paragraph of Section 3.14.1 (formerly Section 3.13.1) was provided as a description of the Town's industrial and institutional per capita use trends. This sentence has been deleted to avoid confusion.

216. Section 3.13.1, fourth paragraph: Please provide appropriate citations.

RESPONSE References have been added to the fourth paragraph in Section 3.14.1 (formerly Section 3.13.1).

217. Section 3.13.1, fifth paragraph, last sentence: Given that the Town is witnessing significant growth in new construction, please provide the demand range for newer homes.

RESPONSE The second to last sentence in the fifth paragraph of Section 3.14.1 (formerly Section 3.13.1) provides the demand range for new homes, as follows: "*Annual average water use post 2000 falls between 149 and 156 gpd/meter.*"

218. Section 3.13.1, seventh paragraph, first sentence: Please provide the location of the region that was the basis of the study.

RESPONSE A sentence has been added to Section 3.14.1 (formerly Section 3.13.1) as follows: "*The survey included utilities from fourteen states representing multiple geographic regions to include North Carolina, Georgia, Canada, Washington, Oregon, California, Pennsylvania, Arizona, Texas, Colorado, Florida, Illinois, Nevada, and Connecticut.*"

219. Section 3.13.1, ninth paragraph, last two sentences: Please consider providing the regional per capita data to support this claim. The selected per capita value (85 gpcd in this example) represents an "average" per capita and should not be intended to ensure full coverage related to "year-to-year fluctuations" for the planning period.

RESPONSE The last paragraph in Section 3.14.1 (formerly Section 3.13.1) has been revised as follows: "*A total per capita total use of 85 gpcd for the Town of Fuquay-Varina was carried forward in the water demand projection analysis over the planning period. Per Section 2 of this EIS, the Town of Fuquay-Varina's total per capita use is less than other communities in the Cape Fear and Neuse River basins with a difference ranging from 5.4 gpcd to 69.1 gpcd. Out of the utilities compared, only the Town of Holly Springs demonstrated a total per capita use comparable to the Town of Fuquay-Varina. Per Table 2-5, the total per capita use for Raleigh Water and Cary-Apex is 90.44 and 95.3 gpcd, respectively. Total per capital use for other utilities in the Cape Fear and Neuse River basins range from 72 to 125.6 gpcd. The Town of Fuquay-Varina's per capita use is comparable to national per capital use trends and exceed or comparable to regional per capita use trends.*"

220. Section 3.13.3, first paragraph, first sentence: Please explain how a flat rate pricing structure, instead of the more common increasing block pricing structure, encourages water conservation.

RESPONSE The first sentence in the first paragraph of Section 3.14.3 (formerly Section 3.13.3) has been revised. The paragraph was revised to correct that the Town has a uniform rate structure, not a flat fee rate structure. Customers are charged for every 1,000 gallons used on top of the minimum base rate. The paragraph has been revised, as follows: "*The Town of Fuquay-Varina has implemented a uniform rate structure for water consumption charges inside and outside corporate limits. The minimum base water rate increases based on meter size (e.g., larger meters are charged a higher minimum base rate). Water users pay a rate per 1,000 gallons consumed beyond the minimum base rate. Therefore, customers are charged for the water consumed via the actual metered use. The rate structure applies to base water meters and irrigation meters. Per the Town's Code of Ordinances Part 5, Chapter 1, Article B, water users outside of corporate limits are assessed rates double of the corporate limit rate. The Town of Fuquay-Varina's rate structure does not inhibit water conservation. Per Sections 2 and 3.13.3 of this EIS, the Town exhibits some of the lowest total per capita water use rates in the Cape Fear River basin.*"

221. Section 3.13.4, first paragraph, third sentence: Please explain how this AMI system will "enhance and promote water conservation."

RESPONSE The first paragraph in Section 3.14.4 (formerly Section 3.13.4) has been revised as follows: "*In July 2018, the Town of Fuquay-Varina initiated a conversion of the Town's monthly drive-by Automated Meter Reading (AMR) system to an advanced meter reading system, or Advanced Metering Infrastructure (AMI) system. The AMI system provides hourly reading through a fixed radio network. The Town of Fuquay-Varina has approximately 250 miles of water line, over half of which is greater than 20 years old. The AMI system provides Town staff real-time usage information to enhance and promote water conservation, reduce water leaks in the system, and improve operational efficiency. Town staff receive leak alerts from the AMI system that staff investigates daily. The conversion to the AMI system provides 720 water meter readings per each billing cycle in lieu of the one monthly reading currently collected with the existing AMR technology. Therefore, the Town of Fuquay-Varina's customers are more informed about water use in the monthly water bill.*"

222. Section 3.13.5: Please provide any data on usage of the website by customers. Also, include any promotion conducted by the Town to make customers aware of the service.

RESPONSE Section 3.14.5 (formerly Section 3.14.5) has been revised to add the following paragraph: "*The Town of Fuquay-Varina offers online services to their residents via an online services webpage: https://www.fuquay-varina.org/372/Online-Services. Town of Fuquay-Varina customers have the opportunity to sign up and view and pay for consumption through eUtilities. Alternatively, customers can receive detailed daily consumption and notifications of high usage periods (e.g., leaks) via the on-line service eMeters. Currently, the Town of Fuquay-Varina has 18,043 active utility accounts. Approximately 16,800 customers, or 93 percent of total customers, have registered for the Town's eUtilities and eMeters online services.*"

223. Section 3.13.6: Please provide details on the reasons for the decline in non-revenue water over the past 5 years. Please provide a listing of the major water projects the Town has undertaken over the past 5-10 years to improve water efficiency and reduce non-revenue water, include specific financial commitments the Town has made for future projects. Please provide an explanation for why the Town has not conducted a formal water audit, such as the AWWA water audit, and if there are any plans for conducting such a study.

RESPONSE Section 3.14.6 (formerly Section 3.13.6) has been revised to add the following text to the end of the first paragraph: "*Over the last ten years, water use has increased with growth and the Town of Fuquay-Varina's distribution system has extended to approximately around 100 miles. In general, the percentage of non-revenue water has declined as a result of newer infrastructure and greater use. The Town of Fuquay-Varina averages 2,500 feet of waterline replacement per year. Recent projects have replaced 2-inch galvanized waterline with 6-inch PVC waterline to increase water quality, quantity and pressure in the system. The Town of Fuquay-Varina Board of Commissioners currently funds $500,000 per year towards waterline replacement and is increasing the annual amount to $1,000,000 per year in fiscal year 2024/2025*."

224. Section 3.13.7, third paragraph: Please provide details on any water conservation programs or initiatives by the Town since passing the current water conservation measures in 2008, particularly in advance of the proposed IBT request, to ensure the Town meets or exceeds the strictest water conservation measures and initiatives regionally.

RESPONSE The Town of Fuquay-Varina has not modified their water conservation ordinance since 2008. As a comparison, the Towns of Cary and Apex last modified their water conservation ordinances in 2009 and 2010, respectively. New text has been added to Section 3.14.17 (formerly Section 3.13.7) has discussed in the response to comment #226.

225. Table 3-27: For ease of reading, please state the water conservation stage on every page.

RESPONSE A page break has been inserted in front of every water conservation stage in Table 3-31 (formerly Table 3-27). Each water conservation stage starts on a new page.

226. Section 3.13.7: Please consider including an ending paragraph for this important section that summarizes the information from Table 3-27 and provides an argument that the Town has a sufficiently strong water conservation plan, measures, and initiatives to meet the statutory requirements for an IBT Certificate.

RESPONSE Section 3.14.7 (formerly 3.13.7) has been revised to add a new Table 3-30 and new text summarizing the Town of Fuquay-Varina's water conservation measures compared to the Towns and Cary and Apex. The new text and Table is as follows:

"Per General Statute §143-215.22L, water conservation of the IBT applicant must be equal to the most stringent water conservation measures in the source basin. The applicant is required to

minimize the transfer to the extent practicable. An evaluation of existing water conservation protocols in the Cape Fear River basin (e.g., source basin) was conducted as part of this minimization alternative.

The Town of Fuquay-Varina Board of Commissioners passed a Water Conservation Ordinance in January 2008 that went into effect in May 2008. The ordinance mandates year-round water conservation measures (Code of Ordinances Part 5, Chapter 1, Article C) and stage 1 through 3 water conservation mandates. The Town of Fuquay-Varina has not made any changes to the ordinance since 2008. The ordinance applies to all users connected to the Town of Fuquay-Varina's water system (e.g., inside and outside corporate limits). The Town of Fuquay-Varina has not implemented Stage 4 or 5 restrictions.

Table 3-31 provides a summary of the Town of Fuquay-Varina's most significant water conservation measures compared to the Towns of Apex and Cary. The Towns of Cary and Apex have the most restrictive Stage 1, 2, and 3 requirements in the Cape Fear River basin as a result of the Cary/Apex IBT. The Town of Cary adopted a revised conservation ordinance in July 2009 with a modification in January 2010. The most recent water conservation ordinance for the Town of Apex is dated April 2010.

The Town of Fuquay-Varina's water conservation ordinance is equivalent to the water conservation measures for the Towns of Cary and Apex. All three Towns require mandatory year-round irrigation restrictions limited to irrigation three days per week on alternating days by street address. All three towns do not limit indoor or outdoor water use on a year-round basis. In a stage 1 water shortage restriction, the Town of Fuquay-Varina does allow outdoor irrigation on alternating limited days. The Towns of Cary and Apex limit outdoor irrigation to one day per week in a stage 1 restriction. The Town of Fuquay-Varina limits outdoor water use during stage 1, 2, and 3, whereas the Towns of Cary and Apex do not prohibit outdoor use until stage 3. The Town of Fuquay-Varina requires indoor use to be reduced by 10 percent, 20 percent, and 30 percent for stage 1, 2, and 3 water restrictions, respectively. The Town of Apex limits indoor use in all three stages. The Town of Cary does not limit indoor use until severe restrictions in Stage 4 and 5. The Town of Fuquay-Varina does not limit new turf permits during a stage 1 restriction compared to the Towns of Cary and Apex. Other water conservation measures, such as restrictions on hand watering and new turf permits in stages 2 and 3 are directly comparable across all three town ordinances.

The Town of Fuquay-Varina's water conservation ordinances meet the requirements of General Statute §143-215.22L. Per the aforementioned discussion, the Town of Fuquay-Varina's water conservation mandates differ slightly compared to the Towns of Cary and Apex; however, the Town of Fuquay-Varina has demonstrated that their 2008 water conservation measures are effective. The Town of Fuquay-Varina's water use metrics exceed other communities in the Cape Fear River basin.

Table 3-33 provides a summary of the water conservation measures for communities in the Cape Fear River basin as a comparison to the Towns of Fuquay-Varina, Apex, and Cary. The list of conservation measures in Table 3-28 is not exhaustive. Each community has nuances and/or exceptions to water conservation ordinances and policies that cannot be reflected in a summary table. Appendix B provides an extensive summary of water conservation measures for each community. The applicable code, ordinance, or policy is referenced for each water conservation measure. Water conservation stages or levels are meant to be additive. For example, restrictions in Stage 1 are also required in Stage 2 unless superseded by a more stringent requirement."

Table 3-31: Summary of Water Shortage Response and Conservation Measures for Towns of Fuquay-Varina, Apex, and Cary

	Water Shortage Response Stages	Outdoor Spray Irrigation	Hand watering, drip irrigation, subsurface irrigation, athletic field maintenance	Other outdoor water use (e.g., pressure washing, car washing, filling/topping off swimming pools)	New Turf Watering Exception Permits	Indoor Water Use Restrictions
Fuquay-Varina	Mandatory year-round	Three days per week	Allowed	Allowed	Allowed	None
Apex	Mandatory year-round	Three days per week	Allowed	Allowed	Allowed	None
Cary	Mandatory year-round	Three days per week	Allowed	Allowed	Allowed	None
Fuquay-Varina	Stage 1	**Three days per week**	Allowed	**Business Only, No pool filling, Wash vehicles at home Monday to Friday only**	**Allowed**	**Reduce consumption by 10%**
Apex	Stage 1	One day per week	Allowed	Allowed	No new permits issued, permits issued prior to water shortage can continue	Limit indoor water use
Cary	Stage 1	One day per week	Allowed	Allowed	No new permits issued, permits beginning more than 14 days after stage 1 date rescinded	None
Fuquay-Varina	Stage 2	**One day per week, Night only**	**One day per week, Night only**	**Recycled Car Wash Only, Therapy Pools Only**	Prohibited	**Reduce consumption by 20%**
Apex	Stage 2	Prohibited	Allowed	Allowed	Prohibited	Limit indoor water use
Cary	Stage 2	Prohibited	Allowed	Allowed	Prohibited	None
Fuquay-Varina	Stage 3	Prohibited	Prohibited	Prohibited	Prohibited	**Reduce consumption by 30%**
Apex	Stage 3	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited
Cary	Stage 3	Prohibited	Prohibited	Prohibited	Prohibited	Limited to normal Tier 1 indoor winter use
Fuquay-Varina	Stage 4/5	Not adopted	Not adopted	Not adopted	Not adopted	Not adopted
Apex	Stage 4/5	Prohibited	Prohibited	Prohibited	Prohibited	Limit indoor water use
Cary	Stage 4/5	Prohibited	Prohibited	Prohibited	Prohibited	Reduce normal winter use by 15%

Notes: 1. **Red Text** indicates Town of Fuquay-Varina measures less stringent than Cary and Apex. **Green text** indicates Town of Fuquay-Varina measures more stringent than Cary and Apex

227. Section 3.14, second paragraph, last sentence: Please detail what is included in the “15 percent of engineering”.

RESPONSE The last sentence of the second paragraph in Section 3.15 (formerly Section 3.14) has been revised to clarify that 15 percent for engineering includes design services, construction services, administration, and legal.

228. Section 3.14, third paragraph, fourth sentence: Please ensure that Alternatives 9 A/B/C are treated equally to the other alternatives with regards to assigning costs. Since several of the other alternatives also have partners that will share in the cost of the project or if much of the infrastructure is already in place.

RESPONSE The cost opinions in the EIS reflect the capital cost that the applicant, the Town of Fuquay-Varina, will be responsible for paying as a result of implementation for each alternative.

229. Table 3-28: Ensure that all cost estimates provide full breakdowns and itemizations for all projected costs for all alternatives.

RESPONSE An itemized cost breakdown is provided in an Appendix of the EIS.

Section 4.0

230. Section 4.0, second paragraph, last sentence: Please consider providing an explanation.

RESPONSE: Alternative 13 was incorrectly listed as not being discussed in Section 5. An explanation as to why Alternatives 11 and 12 are not discussed in Sections 4 and 5 has been added to the end of the second paragraph.

231. Section 4.1, first paragraph, first sentence: Section 3.11 (Alternative 10) does not discuss any of the project area as located in the Coastal Plain. Please clarify.

RESPONSE: Section 4.1 of the DEIS has been revised to address the Coastal Plain.

232. Section 4.1: Please consider including maps to illustrate what is described in the first and second paragraphs.

RESPONSE: The physiographic province boundary has been added to Figure 3-1 and a reference to this figure has been added to Section 4.1 of the DEIS.

233. Section 4.9, second paragraph, first and last sentences: Throughout Section 3.0, including the cost estimate section, appears to suggest that alternatives 9A/B/C will require a new intake. Please clarify as needed.

RESPONSE: Alternative 9A/B/C/D will utilize infrastructure that will be existing at the time this project moves forward. The City of Sanford is in the process of obtaining construction permits for an expansion to the existing Sanford WFF, including a new intake and raw water main. The new intake is a whole and complete project, separate from the proposed conveyance line associated with this project. The new intake and treatment plant upgrades will take place regardless of this project; however, the upgrades will be sufficient to support alternatives 9A/B/C/D.

234. Section 4.9, third paragraph: Please define and explain the differences between a 100-year floodplain and a floodway.

RESPONSE: The differences between a 100-year floodplain and floodway have been added to the first paragraph of Section 4.9 of the DEIS document.

235. Section 4.9, fourth paragraph, last sentence: Please explain why floodways have not been designated in Lee County.

RESPONSE: FEMA does not conduct flood studies. FEMA incorporates flood studies done by others (e.g., consultants) into periodic updates of FEMA maps through the LOMR/CLOMR process.

236. Section 4.14.2, fourth paragraph: Please consider adding a map or depiction.

RESPONSE: Surface water classifications are shown on Figure 4-8 and a reference to the figure has been added to the fourth paragraph of Section 4.14.2.

237. Section 4.14.3, second paragraph, last sentence: Please consider including the findings from the fish community sampling sites in the project area.

RESPONSE: Additional findings from the fish community sampling sites have been added to Section 4.14.2 of the DEIS document.

238. Table 4-15: Please discuss how Alternative 9 (preferred alternative) will improve or further degrade existing conditions (i.e., Chlorophyll A violation at the Sanford water supply intake and the fair benthic bioclassification at Terrible Creek). Please consider including the proximity of the Terrible Creek WWTP to the Terrible Creek sampling site, perhaps in the discussion adjacent to Table 4-15.

RESPONSE: Section 4.14.3 has been modified to include the following statement: "The Terrible Creek WWTP receiving stream (e.g., Alternative 9C) is listed as meeting designated uses."

Additionally, the following paragraph has been added to Section 4.14.3: "*The Cape Fear River basin is not officially classified as a nutrient sensitive waters. However, the Cape Fear is recognized by DWR as being nutrient over enriched. In a 2018 presentation to EMC, DWR cited recent algal blooms and nutrient over-enrichment as causes of impairment. DWR assembled a monitoring plan for the middle Cape Fear River basin with data collection initiated in 2019 and 2020. Per DWR, water quality conditions decline during periods of low flow, which potentially result in high chlorophyll-a concentrations. The Cape Fear River upstream and downstream of Lillington is currently not 303d listed for dissolved oxygen or chlorophyll-a. The Cape Fear River upstream and downstream of Lillington also does not list any category 4 or 5 impairments.*"

239. Section 4.14.3, eighth paragraph, sixth sentence: The use of the Terrible Creek WWTP is the basis for nearly all of the alternatives, particularly the preferred alternative. Please clarify.

RESPONSE: The eighth paragraph, sixth sentence in Section 4.14.3 has been deleted for clarity. Section 4.14.3 is a description of the existing environment. The DEIS text has been revised to clarify that the Terrible Creek WWTP is infrastructure incorporated into the alternatives analysis discussion in Section 3.

240. Section 4.14.4: Please consider discussing the Coastal Plain if any of the project area is within the Coastal Plain physiographic province.

RESPONSE: A discussion of the Coastal Plain was added to Section 4.14.4.

241. Section 4.15.1.1, second paragraph, second sentence: Please clarify the "minority population percentage that exceeds that of North Carolina."

RESPONSE: The DEIS text was revised to add "*(e.g., 31.3 percent)*" as a reminder of the minority population of North Carolina, which is stated in the paragraph in Section 4.15.1.

Section 5.0

242. Section 5.0, fourth paragraph: Measurable values need to be defined for every evaluation, otherwise the technical document (i.e., EIS) will only serve to support the opinions or discretion of the author, which may or may not be the opinions held by the lead agency or reader.

RESPONSE Section 5, Environmental Consequences, has been written using standards set forth by the North Carolina Department of Administration in the Environmental Assessment Guidelines. Per the guidelines in Section E (Predicted Environmental Effects of Projects), quantifiable impacts are necessary in all categories, where feasible. Estimated quantifiable impacts are provided in sections where deemed feasible based on available published mapping and data. Where impacts cannot be quantified at this time, definition of impact intensities is based on National Environmental Policy Act definitions for context and intensity.

243. Section 5.0, fifth paragraph, second sentence: Please clarify what is meant by "raw water storage facilities" in this context.

RESPONSE: The term "raw water storage facilities" refers to raw water storage areas/reservoirs. The fifth paragraph in Section 5.0 has been revised with this change in terminology.

244. Section 5.1.1, second paragraph, fourth sentence: Please clarify if this statement is intended to represent the potential indirect and cumulative impacts from all of the alternatives. Please consider providing any available demonstration or evidence.

RESPONSE: Section 5.1.1 of the DEIS text has been revised to provide clarification.

245. Section 5.3.2: Please consider including information regarding any coordination between the development of the various land use plans. Please consider including the land use plans that most directly affect this project area or provide citations to support the statement in the last sentence.

RESPONSE: Section 5.3.2 of the DEIS text has been modified for clarification and a citation has been added.

246. Section 5.4.1, sixth paragraph, second sentence: Please consider providing a similar level of quantitative impact assessment as is done here (i.e., 1.0 acre) for the other sections.

RESPONSE: Reference to the quantification table provided in Section 4 has been added to Section 5.4.1.

247. Section 5.6.1.1: Please provide the basis for this determination given that the document states no research has been conducted for this subject.

RESPONSE: The comment appears to be in reference to the statement that "*No **indirect** impacts to archaeological resources are anticipated to occur*….". Therefore, no changes to the document have occurred for text associated with **direct** impacts. Relative to indirect impacts to archaeological resources, the text has been modified to state that "***Indirect** impacts to archaeological resources are possible from the proposed project regardless of which alternative is chosen*."

248. Section 5.9, last sentence: Please clarify if this statement is intended to represent the potential indirect and cumulative impacts from all of the alternatives. Please consider providing any available demonstration or evidence.

RESPONSE: The DEIS text has been modified for clarification. The last sentence of Section 5.9.1 has been modified to state that "*Indirect or cumulative impacts, if any, are anticipated to be negligible for all alternatives since growth and development in the service area is anticipated to continue regardless of the project.*"

249. Section 5.9.1, second paragraph, last sentence: It is questionable that impacts that will likely require permitting are minor. Providing a quantifiable basis for the impact determination is needed.

RESPONSE: Additional information has been added to Section 5.9.1 of the DEIS for clarification.

250. Section 5.9.1, sixth paragraph, last sentence: Please provide the basis for the "moderate" determination. Perhaps consider using the quantified values such as those presented in Table 5-4 to make the impact severity determination.

RESPONSE: The last sentence of Section 5.9.2 has been modified to state: *"Alternatives 1 and 3 will create an unknown amount of new floodplain and floodplain area. However, due to the large amount of floodway and floodplain impacted by implementation of Alternatives 1 and 3, as noted in Table 5-4, direct and permanent impacts to floodplain and floodway in association with Alternatives 1 and 3 are considered moderate.*"

251. Section 5.10, second paragraph: Please consider providing an explanation for the permitting determination (i.e., discussions/coordination with agency staff, permit criteria or other).

RESPONSE: Section 5.10 of the DEIS text has been revised to add a sentence stating that coordination with the regulatory agencies will take place, as necessary, to ensure adherence to regulations associated with the CWA.

252. Section 5.10.1, second paragraph, last sentence: Given that the permanent impacts associated with most alternatives (Table 5-5) are greater than 1 acre, please provide the rationale for why these impacts were all determined to be "minor".

RESPONSE: The impact rationale for permanent impacts associated with most alternatives is determined to be minor due to the preexisting condition of the sites. The alternatives discussing more than one acre of impact will require upgrades to existing infrastructure. Although impacts greater than one acre are permanent, Alternatives 1 and 3 will create large bodies of jurisdictional water and associated wetlands. A statement has been made in Section 5.10.1 of the DEIS to clarify the impact rationale determination.

253. Section 5.11.1, first paragraph, third sentence: Please explain why Alternatives 9A & 9B are not included.

RESPONSE: Additional details related to proposed intake installation in the Cape Fear River has been added to the first paragraph of Section 5.11.1 in the DEIS regarding Alternatives 9A/B/C/D. The infrastructure will be existing at the time this project moves forward; therefore, no construction activities associated with the raw water intakes will take place for Alternatives 9A/B/C/D.

254. Section 5.13.2.2, second paragraph, last sentence: Please consider providing information related to the "current" occurrence.

RESPONSE: A statement has been added to Section 5.13.2.2 to clarify where current occurrences are discussed within the DEIS.

255. Section 5.13.2.7, first paragraph, second sentence: Need to state that this is the proposed locations for all of the listed infrastructure.

RESPONSE: Information relative to no bald eagle nests within a 2-mile radius of the WTP site has been added to Section 5.13.2.7 of the DEIS.

256. Section 5.14.1, fourth paragraph, last sentence: Impacts associated with stream crossings, particularly those that involve open trench installation as described, will require permitting and should therefore be considered significant. Please provide an explanation for the “minor” determination.

RESPONSE: Open trench installation associated with proposed stream crossings will require permitting; however, no permanent impacts will occur. Impacts are anticipated to be minor due to the temporary nature of the work and the impacts. All stream crossings will be restored to original grade following installation of the pipes. An updated statement has been added to Section 5.14.1 of the DEIS.

257. Section 5.14.1, fifth paragraph, third sentence: Please consider providing a map or depiction to clarify this statement, particularly in regards to Alternatives 4, 5, 8A, and 8B.

RESPONSE: The river basin boundary is illustrated in Figure 4-7 and is referenced in Section 5.14.1 of the DEIS text.

258. Section 5.14.1.1, first paragraph: Please provide an explanation for the “minor” determination.

RESPONSE: Open trench installation associated with proposed stream crossings will require permitting; however, impacts are anticipated to be minor due to the temporary nature of the work. All stream crossings will be restored to original grade following construction. A statement has been added relative to the aforementioned has been added to Section 5.15.1.1 (formerly Section 5.14.1.1 of the DEIS.

259. Section 5.14.1.1, second paragraph, last sentence: Please explain how all other projects other than the preferred alternative will have permanent, direct, minor, adverse impacts. Please provide the impact analysis for Alternatives 9A/B with an explanation as to how they are different.

RESPONSE: Alternatives 9A/B/D will not require construction of a new raw water intake; therefore, no permanent impacts will take place in perennial streams. All impacts associated with Alternatives 9A/B/D will be temporary in nature. Clarification related to this topic has been provided in paragraph two of Section 5.15.1.1 (formerly Section 5.14.1.1).

260. Section 5.14.1.1, fourth paragraph, first sentence: Please clarify that a raw water intake was considered in the cost estimate for 9A/B.

RESPONSE: Opinion of probable project costs and a summary of infrastructure are provided in Section 3.15 (formerly Section 3.14) and in an Appendix.

261. Section 5.14.1.3, first paragraph, third sentence: Please explain “anti-frac out measures”.

RESPONSE: A statement relative to anti-frac out measures has been added to Section 5.15.1.3 (formerly Section 5.14.1.3).

262. Section 5.14.1.3, second paragraph: Please consider stating whether permitting will be required.

RESPONSE: Due to the use of trenchless construction techniques, no impacts will occur to the Cape Fear River. Therefore, no permitting will be required for pipe installation. The DEIS has been updated to include this statement as suggested.

263. Section 5.14.2.1, first paragraph, last sentence: Please consider including the CWA permit as an attachment.

RESPONSE: The City of Sanford is in the process of obtaining a 404/401 permit.

264. Section 5.14.2.2, first paragraph, first sentence: Please clarify that no wastewater will be sent to the North Harnett WWTP for Alternatives 9A or 9B.

RESPONSE: Wastewater will be conveyed to the North Harnett Regional WWTP from the Town of Fuquay-Varina's service area in the Cape Fear River basin. The Town of Fuquay-Varina's Terrible Creek WWTP in the Neuse River basin will continue to serve businesses and residents in the Neuse River portion of the Town's service area. The statement in Section 5.14.2.2, "*Alternatives 2, 4, 5, 6, 7, 9A, and 9B do not include a return of water to the Cape Fear River basin*," refers to the *interbasin transfer* of water from the Neuse to the Cape Fear. Section 5.14.2.2 of the DEIS text has been revised to clarify that these aforementioned alternatives do not include the interbasin transfer of water from the Neuse to the Cape Fear.

265. Section 5.14.2.3, second paragraph: This paragraph states that the Cape Fear River is impaired, nutrient sensitive waters; however, earlier no formal impairments are listed and the river appears to not be classified as NSW (nutrient sensitive waters). Please clarify.

RESPONSE Section 5.15.2.3 (formerly Section 5.14.2.3) has been revised to reflect Nora Deemer's discussion (second comment).

266. Section 5.14.2.3, fifth paragraph: In order to provide a full evaluation of the alternatives presented, as required by an EIS, and specifically those alternatives that propose to increase the wastewater flows in the Cape Fear, a water quality model evaluation/analysis of these additional inputs in the Cape Fear River at or near the discharge location(s) should be conducted.

RESPONSE Section 5.14 and 5.15 have been edited to provide context for water quality impacts. Please refer to response to David Wainwright's comment in bullet point #5.

267. Section 5.14.3.3, fifth paragraph, last two sentences: Please explain how the impacts can be both "major" and "negligible" for the same alternative on the same resource.

RESPONSE Section 5.14.3.3 has been revised to accurately reflect the anticipated direct, indirect, and cumulative impacts of Alternative 10.

268. Section 5.15, first paragraph: To avoid confusion, please use the language in the statute referenced, and please be explicit as to what DWR is the "steward" of. DWR is not the steward of models owned and managed outside of the agency.

RESPONSE The first paragraph of Section 5.14 (formerly Section 5.15) has been modified to reflect the language revisions in Section 1.5.8.

269. Section 5.15, second paragraph, third sentence: DWR does not have hydrologic models for all of the river basins in North Carolina.

RESPONSE The third sentence of the second paragraph in Section 5.14 (formerly Section 5.15) has been modified.

270. Section 5.15, third paragraph: Please provide a citation.

RESPONSE A citation was provided for the third paragraph of Section 5.14 (formerly Section 5.15).

271. Section 5.15.1, first paragraph, second sentence: Please provide the year of "current" information.

RESPONSE The year 2022 was added to the second sentence of the first paragraph in Section 5.14.1 (formerly Section 5.15.1).

272. Section 5.15.1, third paragraph, last sentence: Please consider explaining “flow splits”.

RESPONSE The third sentence in the last paragraph has been modified in Section 5.14 (formerly Section 5.15). The reference to flow split was removed. This terminology referred to the inflow apportioning process between water quality pool and water supply pool. The text indicates that the CFNCRB model was updated for the Falls Lake Reallocation.

273. Section 5.15.2: Please provide citations throughout this section.

RESPONSE Additional citations were added to Section 5.14.2 (formerly Section 5.15.2).

274. Section 5.15.2, tenth paragraph, third sentence: Please clarify the average that is being discussed (i.e., daily, monthly, annual)

RESPONSE The referenced statement was to the monthly average discharge and these values are provided in Table 8 in Appendix F of the DEIS. Section 5.14.2 (formerly Section 5.15.2) was revised to reference to the monthly average discharge in the river at the CFPUA intake being much higher than the demand is now in item #1 in the tenth paragraph.

275. Section 5.15.2, tenth paragraph, last sentence: Please provide context that this scenario depends on the current condition/level of the water quality pool and is outside of the management and operations plan of the lake. Therefore, it would be a request to the USACE and not an obligation of the USACE.

RESPONSE This potential solution is now included in the numbered list under paragraph 10, in item #4 in Section 5.14.2 (formerly 5.15.2). The text has been revised to state that application of this solution would be at the discretion of the USACE under current policy. However, evolving conditions in the basin under severe climate change may prompt a more proactive policy change. Additional thoughts on this solution are located in Appendix F Section 4.

276. Section 5.15.2, eleventh paragraph, first sentence: Please consider providing context that downstream users do not have a water supply allocation from Jordan Lake; therefore, the drought plans directly associated with Jordan Lake would not be expected to account for water shortages downstream of Lillington.

RESPONSE This comment suggests that downstream users would need a water supply allocation from Jordan Lake for their water supply needs to be considered under the Jordan Lake Drought Contingency Plan (DCP). While we agree the type of relief suggested would require some discretionary grace from the State and USACE, we disagree that an allocation is a prerequisite for such consideration. The 2008 DCP for Jordan Lake implies broad discretionary authority is available to the State of North Carolina for drought management and that “*the project will be operated to meet water supply requirements and water quality low flow releases*” (page 6 of 2008 DCP). The DCP language does not appear to limit water supply concerns to allocation holders. Furthermore, actions available after the water quality pool is completely exhausted, which are covered in items 2 and 3 on page 9 of the 2008 DCP, suggest the DWR would have broad latitude, in consultation with the USACE, to balance water supply and water quality needs. It is anticipated that this latitude would also be the case in less severe stages of drought before the conservation pool is exhausted with the caveat that the DCP does not address outright shortages downstream in earlier drought stages. Shortages downstream of Jordan Lake have not historically been an issue, which is a point made in Appendix F Section 4. A water supply allocation for downstream users could be a different potential solution.

277. Section 5.15.2, eleventh paragraph, last sentence: According this sentence, this proposed project is dependent on a policy change or discretionary operations change from the USACE to avoid potential downstream impacts. Please clarify as needed.

RESPONSE The DEIS text never intended to suggest the project is dependent upon a policy change

or discretionary operation by the USACE. The downstream impacts to CFPUA and LCFWSA arise regardless of the Town of Fuquay-Varina's preferred water supply alternative. This paragraph has been reworded to clarify that the impacts to CFPUA and LCFWSA are minimally affected by the implementation of the Town's preferred water supply alternative. The DEIS has been revised to state factors that would alleviate these impacts and potential solutions; however, these statements are suggestions are not project-related solutions or actions.

278. Section 5.15.4, second paragraph, first sentence: Please explain the relevance of this project to an analysis conducted over 10 years ago.

RESPONSE The 2014 Cary-Apex IBT is the most recent IBT Study conducted in this region. This IBT is in the same basin and many of the same utilities interested in the Cary/Apex IBT will also be interested in the Town's IBT Study.

279. Section 5.15.4, ninth paragraph, second sentence: Not all releases from Jordan Lake are conducted to merely maintain the flow targets. Please explain why high flow releases are made in the context of this sentence. Citation needed.

RESPONSE The DEIS text has revised this statement to "*During periods of low flow...*" The 2008 Drought Contingency Plan is also cited.

280. Section 5.15.4, ninth paragraph, third sentence: Please consider including the "drought plans" used in development of the OASIS model as an appendix. Please explain what is meant by "removal of the limitation".

RESPONSE The third sentence of the ninth paragraph in Section 5.14.4 (formerly Section 5.15.4) has been revised to clarify the subject of the statement to be the Jordan Lake Drought Contingency Plan (DCP). The 2008 DCP is referenced in DEIS Section 10 (*Literature Cited)*.

281. Section 5.15.4, ninth paragraph, last sentence: Please explain how the flows from the Deep River maintain flows for the Cape Fear River, not just releases from Jordan Lake.

RESPONSE The contribution from the Deep River was included into the last sentence of the ninth paragraph in Section 5.14.4 (formerly Section 5.15.4).

282. Section 5.15.4, tenth paragraph, fourth sentence: Please provide a citation.

RESPONSE The 2008 DCP is now a citation in the DEIS.

283. Table 5-11, page 5-47: Under Alternatives 9A/B, the water supply for the Town of Dunn appears to be impacted 0.25% of the time. Under the No Action, the water supply for Town of Dunn is impacted 0.12% of the time. Please provide a detailed analysis or drought triggers as provided in the Water Shortage Response Plans (WSRPs) to demonstrate how the Town of Dunn will continue to meet its demands. This level of evaluation also needs to be conducted for water systems such as Fayetteville PWC and the communities supported by Lower Cape Fear Water and Sewer Authority who do not have their water conservation triggers within the OASIS model. Perhaps this evaluation is achievable by use of the OASIS data outside of the model, through a post-process activity.

RESPONSE Table 5-10 has been added to Section 5.14.4 to provide additional information regarding the WSRP activation severity and duration for the City of Dunn. The updated modeling results show the same trend referred to in this comment; however, the WSRP activation frequency is now 0.17% for the No-Action alternative and 0.23% for the preferred Alternative 9A/B. These events are triggered whenever the flow at Lillington drops to less than 225 cfs, which may happen in a Jordan Lake Drought Stage 3 or Stage 4. Per Table 5-10, these events are always brief: the median event length is just over a week and the worst case event is less than three weeks in duration. The additional statistics that clarify the event severity are basically the same in the No-Action alternative

as in the preferred Alternative 9A/B and any other option for water supply from the Cape Fear Basin except Alternatives 6 and 7. The City of Dunn and the Town of Benson (by virtue of their purchase from Dunn) will spend slightly more time in a Stage 1 Voluntary Conservation in Alternative 9 than otherwise in the No-Action alternative. According to the CFNCRB model results, mitigation with a return of wastewater to the Cape Fear (Alternatives 9C and 9D) offer no improvement in this particular metric. There is no substantial difference between the No-Action alternative and the preferred Alternative 9A/B in the frequency of reaching any mandatory conservation stages (Stages 2, 3, or 4). The Town of Fuquay-Varina's preferred alternative will not affect the City of Dunn's ability to meet its customers' water supply needs. The same conclusion applies to the City of Fayetteville. Fayetteville's system reliability is 100%.

284. Table 5-12: Please provide the minimum flow values and durations of those flows at the nodes provided.

RESPONSE This comment is interpretated as a reference to the minimum flows at Lillington, Fayetteville, Clayton. Table 6 in Section 3.3 of Appendix F provides a discussion of 7Q10 conditions at these nodes. Under the historical hydrology and 2055 conditions, the lowest flow recorded in the 91 year simulation is between 170 cfs and 182 cfs at Lillington. At Fayetteville, that range is 203 to 211 cfs and at Clayton is 190 cfs. The lowest flow metric is less than the 2025 baseline by approximately 23 to 35 cfs at Lillington, 116 to 124 cfs at Fayetteville, and 10 cfs at Clayton. Durations would depend on the flow threshold. We suggest sticking to the 7Q10 since that has a defined duration (7 days) and frequency (statistically a 10% chance of occurring in any year).

285. Section 5.15.4, thirteenth paragraph, last sentence: Please consider clarifying that the cost will be the responsibility of the Town of Fuquay-Varina.

RESPONSE Costs are discussed in Section 3.15 (formerly Section 3.14).

286. Section 5.15.5, third paragraph, last sentence: Please explain how impact determinations are made in this situation.

RESPONSE The lowest percentage of demand that was met on the worst day in the record for the CNRM and MIROC climate scenarios was reported.

287. Section 5.15.5, fourth paragraph: This paragraph appears to state that the avoidance of potential impacts associated with this proposed project are dependent upon discretionary actions by regulatory agencies during a time of a water supply emergency, likely for all in the basin. The applicant should assume that the regulatory agencies will strictly follow the existing plan. Please explain or revise as needed.

RESPONSE The DIES text has never stated that the proposed project was responsible for the described impacts. The future conditions arise regardless of the choice of the Town's water supply alternative. Furthermore, the choice of the Town's water supply alternative does not prevent potential mitigation measures for climate change impacts from being implemented. We have attempted to clarify this point in the revised DEIS and revised Appendix F.

288. Section 5.0: Please provide discussion and analysis for Harnett County's proposed new intake on the Cape Fear River near the Town of Erwin as described in the Harnett Regional Water System 2021 LWSP.

RESPONSE Section 3.6.1 of the DEIS has been revised to clarify that Harnett County has not initiated any studies to permit water infrastructure at the Erwin site. The DEIS reflects the planning numbers and data reflected in the approved LWSPs.

Section 6.0

289. Section 6.0, fifth paragraph, first sentence: Please provide specific quantifiable (i.e., values) metrics for the terms, “negligible, minor, moderate, and major” for each subject presented that uses these terms to define impacts and associated mitigation measures.

RESPONSE: Text directing the reader to Section 5 has been added to the first sentence of the fifth paragraph of Section 6.0.

290. Table 6-2: Please provide the measures (i.e., actions) the Town has in place or is proposing to implement to mitigate for any potential impacts either defined by the hydrologic model results or potential indirect and cumulative impacts as a result of the preferred alternative. These mitigation actions should be measurable with regard to the projected and potential impacts.

RESPONSE As stated in the DEIS, the Town of Fuquay-Varina’s current programs, policies, and ordinances meet the intent of General Statute §143-215.22L.

291. Table 6-2, water use: Please provide the specific water conservation and INI projects that have been implemented from recommendations in this plan and specific projects or line items that have received committed funding by the Town Council.

RESPONSE Table 6-2 has been updated with key A.14 describing the Town’s investments in water conservation.

292. Table 6-2, Surface Water Resources: To fully evaluate the alternatives presented, as required by the EIS process, the applicant needs to conduct water quality modeling of the source basin before determining that the impacts are “unknown”.

RESPONSE Table 6-3 has been updated to reference the new text provided in Section 5.14 and 5.15 with respect to water quality impacts.

Section 7.0

293. Section 7.0, first paragraph, fourth sentence: Considering that the Town, based on the information provided, has one of the weakest water conservation programs in the region, this document has not demonstrated that there is not significantly more potential for water savings by implementing more stringent water conservation measures and initiatives. Some examples include and not to be taken as all inclusive, Stage 3 is the first stage for the Town that indoor water use reductions are called out. Nearly all other water systems had already implemented this requirement in previous/earlier stages. Stage 3 is also the first noted stage for reductions in commercial and industrial water use, and even that is discretionary. There are no mandatory restrictions on commercial or industrial demand, and customers are still allowed to fill pools even in the worst stages of drought. Not only is water conservation a significant concern related to the viability of Alternative 12 and the demand projections as a basis for the purpose and need of the project, but water conservation and efficiency are significant concerns consistently held by the Environmental Management Commission and the public for all IBT projects. The Town needs to demonstrate that they are good stewards of the current resource in order to provide confidence to all concerned parties that they will be good stewards of the proposed future resource.

RESPONSE The Town of Fuquay-Varina has one of the strongest water conservation programs in the region as described in Section 3.14.17 (formerly 3.13.17). Revised text has been added to Section 3.14.17 to provide more detail and clarity of the Town’s program with respect to other programs in the region. Please refer to response to comment #226. Additionally, new text and a new table has been added to Section 2.5 to provide a comparison of the Town of Fuquay-Varina’s water use metrics to other communities in the Cape Fear and Neuse River basins. Please refer to response to comment #34. The EIS has demonstrated that the Town’s water conservation measures are effective given that the Town has one of the lowest water use metrics in the region (e.g., Cape Fear

and Neuse River basins).

A specific response by comment is provided as follows:

- Stage 3 is the first stage for the Town that indoor water use reductions are called out. Nearly all other water systems had already implemented this requirement in previous/earlier stages.
    - Response: The Town of Fuquay-Varina requires indoor water use restrictions in Stages 1, 2, and 3. Indoor use must reduce consumption by 10%, 20%, and 30% in stages 1, 2, and 3, respectively. In comparison, the Town of Cary does not require indoor use restrictions until Stage 4. The Town of Apex limits indoor use in stages 1, 2, and 3 but does not mandate a reduction in consumption. Refer to revised text in Section 3.14.17 (formerly 3.13.7).
- Stage 3 is also the first noted stage for reductions in commercial and industrial water use, and even that is discretionary. There are no mandatory restrictions on commercial or industrial demand, and customers are still allowed to fill pools even in the worst stages of drought.
    - Response: The Town of Fuquay-Varina limits outdoor water use in stage 1. Pool filling is prohibited in Stages 1, 2, and 3 and vehicle washing is restricted. The Town of Fuquay-Varina's outdoor water use mandates are more restrictive than either the Towns of Cary or Apex, which do not limit outdoor water use until stage 3.

Division of Water Resources Comments on Revised Draft EIS, September 2024

ROY COOPER
Governor
ELIZABETH S. BISER
Secretary
RICHARD E. ROGERS, JR.
Director

NORTH CAROLINA
Environmental Quality

September 5, 2024

MEMORANDUM

FROM: Harold Brady, SEPA Review Coordinator - DWR – WPS

TO: Mary Sadler, Hazen

SUBJECT: Town of Fuquay-Varina –Interbasin Transfer request for water supply from the Cape Fear River to the Neuse River

The Division of Water Resources (DWR) has reviewed the responses to the first round of comments related to the revised initial draft Environmental Impact Statement (EIS) document and have the following comments,

Phrasing:

1. Comment #5: It seems the statement, “The preferred alternative water supply results in a requirement for an interbasin transfer (IBT) certificate…” is inconsistent with alternatives 9 C & D mentioned in the paragraph. Please consider revising.
2. Comment #205: The use of the term "defacto reuse" is likely misleading, as the Town currently has no reuse or reclaimed water program. This is important to avoid confusion with several water systems in the source basin that do have such programs.

Water Conservation:

The Town is strongly encouraged to conduct a formal water audit. Attached are links to the AWWA audit as well as NCDWR's small system audit (Comment #223).
https://www.ncwater.org/WUDC/app/LWSP/files/AWWA_Free_Water_Audit.xlsx
https://www.ncwater.org/WUDC/app/LWSP/files/small_system_water_audit.xlsm
Based upon information in the EIS and readily available information on water system webpages, DWR disagrees with the applicant’s assertion that the Town’s existing water conservation measures and initiatives, when considered collectively, are equal to or more stringent than all other water systems in the source basin. In general, OWASA and the Town of Cary appear have more stringent water conservation programs/plans. Primary actions and initiatives include more stringent irrigation rules, restricting usage in summer to winter-time demand, and reclaimed water programs. Other water conservation measures and actions from other water systems in the source basin include, an annual water conservation

event and a financial incentive program for changing out older less efficient appliances by the Fayetteville PWC and the City of Greensboro imposing "excess use rates" and compelling commercial and industrial customers to reduce demand by specific percentages. To bring the Town closer to meeting this statutory requirement, one recommendation is for the Town to consider initiating a reclaimed water program. The intent of having a reclaimed water program is not to completely handle the 6 mgd demand related to the transfer. It is intended to be part of a larger water conservation program to minimize the transfer, particularly reducing the peaking, potentially leaving greater available capacity of the North Harnett WWTP. Barring other potential constraints, this action would allow for more water to be returned to the source basin (Comment #214).

Demand Projections:

Based on the information in the Draft EIS as well as LWSP data, DWR staff question the methodology employed to determine the per capita rate used in the projections for the proposed project. For communities with particularly strong growth, the average total per capita demand over the most recent five-year period has been employed with previous projects to better account for the changing conditions than a ten-year time-period. This is due to the fact that newer development incorporates more modern water saving features than older homes do. This assertion appears to be confirmed by the data, considering that the average from 2012-2017 is 85.3 GPCD compared to the significantly smaller average from 2018-2023 (i.e., most recent five years of data) of 78.8 GPCD. Interestingly, the most recent 2023 LWSP data shows a per capita demand of 74 GPCD. Once the methodology used in the EIS for developing projections is resolved, the subsequent LWSP projections will need mirror those findings.

DWR does not disagree with the assertion by the applicant that the per capita used for the analysis (85 GPCD) is within the range of other per capita demand values from neighboring water systems during a similar time period; however, that is merely a check of the reasonableness of the methodology which values from both methodologies (5-year & 10-year averages) fall within (Comments #34, 219). It should not be used as a justification.

It appears that because the 512 properties are in the Neuse IBT basin, their consumptive losses should be added to the Neuse transfer, not subtracted. Please correct as necessary (Comment #163). Please explain the actions that are likely causing the difference of 40 GPCD between summer and winter per capita demand. Please describe what the Town is doing to minimize and control peaking (Comment #212).

Modeling:

During the public meetings in 2020, many members of the public voiced their concern about this proposed project causing water quality impacts in both the source and receiving basins, particularly from the presence of emerging compounds. Please provide an acknowledgement of this concern and a clear statement as why the applicant is not planning to conduct any water quality studies for this proposed project, particularly in light

of the downstream concerns from emerging compounds (Comment #174). The applicant has expressed concern over the cost of modeling, but the Division feels that a steady state model or mass balance assessment for a conservative constituent could potentially provide the needed insight into potential changes in pollutant concentrations as a result of the transfer.

As well, DWR reiterates its request for the applicant develop an analysis to quantify, using the WSRPs, the rate and frequency that downstream users such as, Fayetteville PWC and CFPUA, are projected to go into water conservation stages, similar to the analysis conducted for other downstream water systems (Tables 5-9 & 5-10), as a result of this proposed project. Please consider working with staff from Fayetteville PWC and CFPUA, if necessary, to assist in interpreting their triggers in context with data from the OASIS model (Comment #283). Additionally, the number of occurrences of any water conservation trigger/stage needs to be reported in Tables 5-9 and 5-10.

Cost estimates:
Have been reviewed by staff from the Division of Water Infrastructure (DWI). There are no comments or issues.

Please contact Harold Brady, Water Supply Planning, 919-707-9005, harold.m.brady@ncdenr.gov, or Linwood Peele, Water Supply Planning, 919-707-9024, linwood.peele@ncdenr.gov, if you have questions regarding these comments.

Response to Division of Water Resources Comments on Revised Draft EIS, February 2025

Hazen and Sawyer
4011 West Chase Blvd., Suite 500
Raleigh, NC 27607

February 17, 2025

Mr. Harold Brady
Water Planning Section
Division of Water Resources
1611 Mail Service Center
Raleigh, NC 27699-1611

Re: Response to Agency Comments, Revised Draft EIS
Interbasin Transfer for Water Supply from Cape Fear to Neuse River Basin
Town of Fuquay-Varina

Dear Mr. Brady,

On behalf of the Town of Fuquay-Varina, Hazen and Sawyer is submitting responses to Division of Water Resources (DWR) comments on the revised Draft Environmental Impact Statement (DEIS). The revised DEIS was submitted to DWR for review on February 28, 2024. Comments on the revised DEIS were received from DWR on September 5, 2024. The response to DWR's September 2024 comments is as follows:

Phrasing:

Comment #5: It seems the statement, "The preferred alternative water supply results in a requirement for an interbasin transfer (IBT) certificate…" is inconsistent with alternatives 9 C & D mentioned in the paragraph. Please consider revising.

Response: Comment #5 is related to the changes made to the first and second paragraphs in Section ES-3. The sentence has been revised to state: *The preferred alternative results in a requirement for an interbasin transfer (IBT) certificate to transfer water from the Cape Fear River basin (2-3) to the Neuse River basin (10-1).*

Comment #205: The use of the term "defacto reuse" is likely misleading, as the Town currently has no reuse or reclaimed water program. This is important to avoid confusion with several water systems in the source basin that do have such programs.

Response: The term de facto reuse was removed from the DEIS.

Water Conservation:

Comment: The Town is strongly encouraged to conduct a formal water audit. Attached are links to the AWWA audit as well as NCDWR's small system audit (Comment #223).

https://www.ncwater.org/WUDC/app/LWSP/files/AWWA_Free_Water_Audit.xlsx
https://www.ncwater.org/WUDC/app/LWSP/files/small_system_water_audit.xlsm

Response: The Town is budgeting for a water audit to be conducted in Fiscal Year 25/26. The DEIS text has been updated to reflect this planned schedule.

Comment: Based upon information in the EIS and readily available information on water system webpages, DWR disagrees with the applicant's assertion that the Town's existing water conservation measures and initiatives, when considered collectively, are equal to or more stringent than all other water systems in the source basin. In general, OWASA and the Town of Cary appear have more stringent water conservation programs/plans. Primary actions and initiatives include more stringent irrigation rules, restricting usage in summer to winter-time demand, and reclaimed water programs. Other water conservation measures and actions from other water systems in the source basin include an annual water conservation event and a financial incentive program for changing out older less efficient appliances by the Fayetteville PWC and the City of Greensboro imposing "excess use rates" and compelling commercial and industrial customers to reduce demand by specific percentages.

Response: Section 3.14 of the DEIS contains a detailed discussion of the water conservation measures for the Town of Fuquay-Varina and communities in the Cape Fear River basin. Table 3-30 has been updated to include the Town's proposed changes to their existing water conservation program. DWR was consulted on these proposed changes in the fall of 2024.

Comment: To bring the Town closer to meeting this statutory requirement, one recommendation is for the Town to consider initiating a reclaimed water program. The intent of having a reclaimed water program is not to completely handle the 6 mgd demand related to the transfer. It is intended to be part of a larger water conservation program to minimize the transfer, particularly reducing the peaking, potentially leaving greater available capacity of the North Harnett WWTP. Barring other potential constraints, this action would allow for more water to be returned to the source basin (Comment #214).

Response: Reclaimed water as a transfer minimization alternative was addressed in Section 3.13 of the DEIS. Section 3.13.3 of the DEIS provides an analysis of reclaimed water use for the Town of Fuquay-Varina. The evaluation demonstrated that the Town's irrigation use is a very small fraction of the Town's potable water demand. A statistically significant difference was not found at a confidence level of 0.05 if the overall per capita use of 85 gpcd is offset annually by the average summer difference in per capita use at 3.1 gpcd. A reclaimed water program will not offset a reduction in per capita demand to minimize the interbasin transfer.

Seasonal irrigation use also does not affect the capacity of wastewater treatment facilities. Peak wastewater flow typically occurs during the winter months when there is negligible demand for reclaimed water. As noted in the DEIS, a reclaimed water program will not provide capacity at the North Harnett WWTP.

Demand Projections:

Comment: Based on the information in the Draft EIS as well as LWSP data, DWR staff question the methodology employed to determine the per capita rate used in the projections for the proposed project.

For communities with particularly strong growth, the average total per capita demand over the most recent five-year period has been employed with previous projects to better account for the changing conditions than a ten-year time-period. This is due to the fact that newer development incorporates more modern water saving features than older homes do. This assertion appears to be confirmed by the data, considering that the average from 2012-2017 is 85.3 GPCD compared to the significantly smaller average from 2018-2023 (i.e., most recent five years of data) of 78.8 GPCD. Interestingly, the most recent 2023 LWSP data shows a per capita demand of 74 GPCD. Once the methodology used in the EIS for developing projections is resolved, the subsequent LWSP projections will need to mirror those findings.

DWR does not disagree with the assertion by the applicant that the per capita used for the analysis (85 GPCD) is within the range of other per capita demand values from neighboring water systems during a similar time period; however, that is merely a check of the reasonableness of the methodology which values from both methodologies (5-year & 10-year averages) fall within (Comments #34, 219). It should not be used as a justification.

Response: Section 2.2.1 of the DEIS and Appendix B have been revised to add the 2023 Local Water Supply Plan data for the Town of Fuquay-Varina. The text has also been revised to provide additional clarification for the 85 gpcd value used in the water demand projections. In the last several years, the Town of Fuquay-Varina has seen a change in the mix of residential and commercial use in the service area. Historically the Town of Fuquay-Varina's land use has consisted of single-family homes and a few commercial businesses. With the recent economic development, the Town of Fuquay-Varina has seen a change from new construction of residential single-family homes to construction of multi-family complexes and increased commercial businesses to support residential development. This change in development type is reflected in the Town's commercial and institutional account growth over the last five years.

Comment: It appears that because the 512 properties are in the Neuse IBT basin, their consumptive losses should be added to the Neuse transfer, not subtracted. Please correct as necessary (Comment #163).

Response: Text edits to the DEIS were made.

Comment: Please explain the actions that are likely causing the difference of 40 GPCD between summer and winter per capita demand.

Response: The average difference in summer and winter per capita use is 3.10 and 2.86 gpcd, respectively, per Table 3-29 of the DEIS. There is a difference of 41 gpd/meter for single-family residential use for homes constructed between 2010 and 2019. However, the annual average, summer, and winter metered use for homes constructed between 2010 and 2019 is slightly less than the prior decade (e.g., homes constructed between 2000 and 2009). Homes constructed between 2010 and 2019 comprise 41 percent of the total number of residential accounts, which is the largest percentage of residential home construction in the Town's history. The 41 gpd/meter summer residential use difference may be due to irrigation for new landscaping. Two footnotes were added to Table 3-29 to provide clarification.

Comment: Please describe what the Town is doing to minimize and control peaking (Comment #212).

Response: Section 3.14.4 of the DEIS provides a discussion of the Town's Advanced Metering Infrastructure (AMI) system. The AMI system provides Town of Fuquay-Varina staff real-time usage information to enhance and promote water conservation, reduce water leaks in the system, and improve operational efficiency. Town of Fuquay-Varina staff receive leak alerts from the AMI system that staff investigate daily. Section 3.15.5 of the DEIS provides a discussion of the *eUtilities* and *eMeters* online services that the Town provides to customers. Customers can receive detailed information regarding daily consumption and notifications during high water use periods. Approximately 93 percent of the Town's customers have registered for these online services. The new AMI system, *eUtilities*, and *eMeters* on-line services will help minimize and control spikes in water use to assist with reducing the maximum month and maximum day demand and peaking factors.

Modeling:

Comment: During the public meetings in 2020, many members of the public voiced their concern about this proposed project causing water quality impacts in both the source and receiving basins, particularly from the presence of emerging compounds. Please provide an acknowledgement of this concern and a clear statement as why the applicant is not planning to conduct any water quality studies for this proposed project, particularly in light of the downstream concerns from emerging compounds (Comment #174). The applicant has expressed concern over the cost of modeling, but the Division feels that a steady state model or mass balance assessment for a conservative constituent could potentially provide the needed insight into potential changes in pollutant concentrations as a result of the transfer.

Response: Hazen prepared a Technical Memorandum for the Town in January 2021 that summarized the comments received during the State Environmental Policy Act (SEPA) scoping phase. The comments are sorted by those received from the public, utilities and municipal government, and state agencies. This Technical Memorandum has been included in Appendix G of the DEIS.

The water quality comments from the public and other utilities referenced potential impacts on water quality due to emerging contaminants, specifically per- and polyfluoroalkyl substances (PFAS) and 1,4-dioxane (1,4-D). Comments indicated that PFAS and 1,4-D could potentially be returned to the Cape Fear River basin through the Harnett County North Regional WWTP or to the Neuse River basin through the Town of Fuquay-Varina's Terrible Creek WWTP.

There are several challenges associated with assessing the water quality impact of PFAS and 1,4-D. Water quality standards have not been promulgated by the EPA or DEQ for PFAS or 1,4-D. Additionally, a certified analytical method for PFAS in a wastewater and surface matrix has not yet been promulgated per 40 CFR 136. Additionally, peer-reviewed water quality models are not available to address emerging contaminants in ambient waters. In the event water quality standards for PFAS or 1,4-D are promulgated and incorporated into NPDES permits, wastewater dischargers must comply with NPDES effluent limit discharge requirements, including the Town of Fuquay-Varina.

DWR did not provide comments in the SEPA scoping phase that water quality modeling was required of the applicant. Additionally, DWR conveyed to the applicant during a scoping meeting in February

2020 that water quality modeling was not necessary for the evaluation of the impacts of the interbasin transfer. In lieu of water quality modeling, an analysis of the low flow statistics from the CFNCRB model was used as a proxy to qualify potential water quality impacts. Four categories of relevant discussion are included in Section 5.14.3.3 of the DEIS: potential climate change impact to hydrology, cumulative impact related to Cape Fear River basin development, project-related impacts to 7Q10, and USGS gage accuracy and CFNCRB model precision. Section 5.16.2 of the DEIS also summarizes the results of the CFNCRB model in assessing impacts to water quality.

The CFNCRB modeled differences in 7Q10 between any two alternatives using historical hydrology are less than 10 cfs at Lillington and at the other gage sites. A value of 10 cfs is approximately 0.3 percent of the median discharge at Lillington and less than 4 percent of the historical 7Q10. The CFNCRB model's precise accounting suggests that there is a small difference across the full range of alternatives. In reality, the measurable differences between alternatives are indiscernible due to USGS gage accuracy. For example, the Lillington gage was assigned a "Good" rating in the low-flow range of 250 to 600 cfs, which translates to a margin of error of +/- 25 to 60 cfs.

Comment: As well, DWR reiterates its request for the applicant develop an analysis to quantify, using the WSRPs, the rate and frequency that downstream users such as, Fayetteville PWC and CFPUA, are projected to go into water conservation stages, similar to the analysis conducted for other downstream water systems (Tables 5-9 & 5-10), as a result of this proposed project. Please consider working with staff from Fayetteville PWC and CFPUA, if necessary, to assist in interpreting their triggers in context with data from the OASIS model (Comment #283). Additionally, the number of occurrences of any water conservation trigger/stage needs to be reported in Tables 5-9 and 5-10.

Response: The first revision to the DEIS could not quantify the rate and frequency that Fayetteville PWC and Cape Fear Public Utilities Authority (CFPUA) would be in a water conservation stage. The Water Shortage Response Plans (WSRP) available for Fayetteville PWC and CFPUA at the time the DEIS revisions were submitted to DWR did not include quantifiable water shortage response triggers. In the second round of DWR comments, Fayetteville PWC, CFPUA, and Lower Cape Fear Water and Sewer Authority (LCFWSA) published updated WSRPs in July 2023, December 2023, and May 2023, respectively. The updated WSRPs for LCFWSA and the CFPUA do not contain quantifiable triggers.

Hazen updated the DEIS analysis for Fayetteville PWC to include the quantifiable triggers from the updated WSRP. Section 5.14.3.1, Tables 5-8 and 5-9, and Attachment F of the DEIS were revised with the updated analysis for Fayetteville PWC.

Cost Estimates:

Comment: Have been reviewed by staff from the Division of Water Infrastructure (DWI). There are no comments or issues.

Response: Comment noted. The cost opinions in the DEIS were updated for EPA's published 2025 nominal interest rate per Circular A-94 (M-25-08) and the published 2024 annual average Engineering News Record (ENR) construction cost index.

Hazen and the Town of Fuquay-Varina appreciate the time and consideration of DWR staff to assist with this important project.

Sincerely,

Mary E. Sadler, PE
Associate Vice President

cc: Jim Seymour, Town of Fuquay-Varina
Mike Wagner, Town of Fuquay-Varina
Linwood Peele, Division of Water Resources
Reed Palmer, Hazen and Sawyer

Response to Division of Water Resources Comments on Revised Draft EIS, June 2025

Hazen and Sawyer
4011 West Chase Blvd., Suite 500
Raleigh, NC 27607

June 20, 2025

Mr. Harold Brady
Water Planning Section
Division of Water Resources
1611 Mail Service Center
Raleigh, NC 27699-1611

Re: Response to Agency Comments, Revised Draft EIS
Interbasin Transfer for Water Supply from Cape Fear to Neuse River Basin
Town of Fuquay-Varina

Dear Mr. Brady,

On behalf of the Town of Fuquay-Varina, Hazen and Sawyer is submitting a final response to the Division of Water Resources (DWR) comment on the revised Draft Environmental Impact Statement (DEIS). The revised DEIS was submitted to DWR for review on February 28, 2024. Comments on the revised DEIS were received from DWR on September 5, 2024 with a second revised DEIS submitted to DWR in February 2025. The response to DWR's comment is as follows:

Comment:

Section 2.2.1 Per Capita Demand: The total per capita demand should not be generated by applying the categorical use type connections growth rate to the per person water use consumption rate. Applying the connections growth rate to the per person consumption rate is an "apples to oranges" comparison. As well, applying the connections growth rate to the gpcd rate suggests that the water system is becoming less efficient rather than more efficient over time.

> Response: Hazen has revised the Technical Memorandum *Population, Water Demand, and Interbasin Transfer Projections* and the revised DEIS to reflect recent conversations with DWR staff regarding the 10-year per capita use average (2013 to 2022) to support the Town's 85 gpcd unit water use. The weather model analysis is now an appendix to the Technical Memorandum. The revised Technical Memorandum is attached.

Sincerely,

Mary E. Sadler, PE
Associate Vice President

Hazen

cc: Jim Seymour, Town of Fuquay-Varina
Mike Wagner, Town of Fuquay-Varina
Linwood Peele, Division of Water Resources
Reed Palmer, Hazen and Sawyer