2013 CITY OF RALEIGH
WATER RESOURCES ASSESSMENT AND PLAN

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EXECUTIVE SUMMARY

This is the second such assessment and plan developed to be issued by the City of Raleigh Public Utilities Department. It reflects new information gathered within calendar year 2013. While much remains unchanged, new data allows the City to look with greater clarity at its future water resource options as those actions needed to preserve existing water resources.

Within a planning window of 50-years beginning with the year 2010, the City of Raleigh will need additional water resources to support anticipated population growth.

	2011	2020	2030	2040	2050	2060
Surface Water Supply, mgd	77.3	77.3	77.3	77.3	77.3	77.3
Reduced Demand[1], mgd	--	1.9	4.5	8.7	14.4	15.2
Service Area Demand, mgd	51.9	64.4	78.2	91.3	102.71	115.00
Future Water Supply Need, mgd	--	0.0	13.8	14	25.41	37.7

The most significant change between this year's report and prior year planning is the repositioning and reprioritization of new water resource projects. This year's report was delayed to allow the report to coincide with the issuance of the *Triangle Regional Water Supply Plan*[2]. Four new water resource options have been determined to be technically feasible. These options are:

- New reservoir on the Little River

[1] Demand reductions acquired from water efficiency and reclaimed water utilization off setting new demand.
[2] Created by the Jordan Lake Partnership, of which the City is a member, the Triangle Regional Water Supply Plan is designed to assess the water supply needs for member organizations and to form the basis for future permitting efforts.

- Reallocation of storage in Falls Lake.
- Withdrawal of water from the Neuse River just above the Neuse River Wastewater Treatment Plant.
- Withdrawal of water from the Neuse River just below Falls Lake with the use of an existing quarry for storage.

Each of the alternatives involves difficult environmental, social and economic questions and the level of effort required to evaluate each alternative will be significant. To meet the need of our communities for the 50-year planning window, the City should seek to permit all four identified options in ascending order of difficultly. The Reservoir option has particular issues of note... it is unlikely that a new reservoir can be permitted and constructed until all other water resource alternatives with lower environmental impact are either implemented or shown not to be a viable alternative. This likely places the Little River Reservoir project in a later timeline than previously reported to the public, as it is likely that at least one other alternative will prove to be more viable through the permitting and construction process. A delay may also leave the Little River Reservoir project in jeopardy as the U.S. Fish and Wildlife Service considers a petition to list additional aquatic species in the Little River. One can argue the Little River Reservoir has a potential permitting “shelf-life” that may require earlier consideration of the project to retain it as a future water resource option. A resolution could be to permit multiple projects in the immediate future.

The trend for significant reductions in Per Capita Water Consumption (PCWC) continued in 2013, in keeping with State and National trends. These reductions in PCWC may allow for deferral of new water resource development but cannot be assumed to substitute for new water resources. Indeed, the service area of the Utility Department grew to 500,000 by June 1, 2013, with an average of 5,000 new customers per year utilizing the water and wastewater system. As potable water capacity, gained through new efficiency efforts, is provided to new customers, the overall water system begins to lose its ability to reduce consumption in response to drought conditions. This phenomenon is known as “demand hardening”. Staff will continue to evaluate this trend for impact upon water resource development schedules.

Region 4 of EPA has issued guidance that has significantly reshaped water resource planning in the southeast. Before EPA considers the use of any existing or proposed water resource as an alternative to address the need for additional potable water capacity, the City must take actions to ensure that, to the *maximum extent practicable*, it is implementing sustainable water management practices. As evolving regulatory frameworks like the EPA guidance document and the Ecological Flows Scientific Advisory Board continue to develop, and as environmental case law continues to expand and resources fall under more pressure, one can expect the threshold for

project mitigation to rise, not fall, and environmental permitting to become more difficult, not less.

In addition to the four identified alternatives, the City Council directed staff to pursue legislation designed to make indirect or direct potable reuse of wastewater a legally permissible water resource option. In response, draft legislation has been crafted with the cooperation of the Department of Environment and Natural Resources. City sponsored research is underway to inform this legislation with the goal of introduction of the legislation during the 2014 session of the North Carolina General Assembly.

The City's existing water resources continue to be stressed by outside impacts to water quality and unknown factors, such as land use changes and observed climate change that are impacting reliable yields in the City's reservoirs. The City's primary water source, Falls Lake, has received the protection of a State nutrient management strategy. Research indicates, however, that compliance with stage II of that strategy is not technically, logistically, or financial feasible without significant changes in technology and improvements in nutrient credit development and trading. The City continues to support innovative technologies and research to development a nutrient credit market thorough the assessment of a watershed protection fee, through land preservation under the Upper Neuse Clean Water Initiative and though active membership in the Upper Neuse River Basin Association.

Continued participation in efforts to protect water quality and efforts to understand trends in declining reliable yields are advised. To address EPA guidance regarding sustainable water practices, it is also advised to continue to invest in water infrastructure rehabilitation and repair. Over $237 million in infrastructure replacement is expected to address infrastructure installed prior to 1945, without improvements to water treatment facilities. Infrastructure replacement, new water resource development and preservation of existing water resources are expected to be some of the greatest challenges to the utility in the next 5-10 years and beyond.

Water resource planning and development will continue to require substantial investment, in terms of staff resources and consultant services.

Abbreviations Table

Capital Area Metropolitan Planning Organization	CAMPO
Clean Water Act	CWA
City of Raleigh Public Utilities Department	CORPUD
Environmental Impact Statement	EIS
Environmental Protection Agency	EPA
Endangered Species Act	ESA
gallons per capita day	gpcd
Interlocal Agreement	ILA
Jordan Lake Partnership	JLP
Local Water Supply Plan	LWSP
Million Gallons per Day	mgd
National Environmental Policy Act	NEPA
North Carolina Division of Water Resources	NC-DWR
North Carolina Division of Water Quality	NC-DWQ
Traffic Analysis Zones	TAZs
United States Army Corps of Engineers	USACE
United States Fish and Wildlife Service	USFWS
Wake County Board of Commissioners	WCBC
Water Treatment Plant	WTP
Water Utility Transition Advisory Taskforce	WUTAT

Background

The City of Raleigh Public Utilities Department (CORPUD) uses surface water from Falls Lake and from the Swift Creek Lake system (Lakes Benson and Wheeler) as its source for drinking water. Falls Lake, located northwest of the City of Raleigh, has a surface area of over 12,500 acres and can provide Raleigh with up to 100 mgd (peak day), 66.1 mgd (annual daily average) for the fifty-year reliable yield during the period of record and 63.4 mgd (annual daily average) for the drought of record in the Falls Lake basin (2007-08). The smaller Swift Creek lake system has a peak withdrawal rate of 20 mgd (peak day), 11.2 mgd (annual daily average) for the fifty-year reliable yield during the period of record, and a surprising 13.6 mgd for the drought of record for the Falls Lake basin (2007-08), indicating a different drought of record for the Swift Creek drainage basin[3]

In North Carolina water supply planning, the fifty-year reliable yield during the period of record is used to measure available water supply. The fifty-year reliable yield is defined as the drought (or low rainfall total) that has a 2 percent chance of occurrence based on the period of record. For the City of Raleigh that results in a reliable yield for its existing reservoirs of 77.3 mgd.

This storage supplies approximately 185,000 metered customers (with approximately 172,000 active meters) and a service area population of approximately 500,000 Wake County citizens. This public enterprise, which is administered by CORPUD, serves the City of Raleigh and the Towns of Garner, Wake Forest, Rolesville, Knightdale, Wendell and Zebulon. In calendar year 2013, the City's customer base used approximately 47.92 mgd, on an annual average, which is down from 48.6 mgd in 2012. Rainfall in 2013 was approximately 10" above average which may account for some of this reduction due to lower irrigation rates.

The City's long range water resource plan has been tied extensively to the construction of a new reservoir on the Little River. In 1971 a Wake County water and wastewater engineering study (Moore / Gardner, Edwards, Piatt and Wooten Engineers Task Force) identifies Little River as a possible site for a proposed water supply reservoir in eastern Wake County. This study's recommendation appears to have been the first time this site was identified to Wake County Board of Commissioners as a new source of water for a "regionalized" water and sewer system for the county. In 1986 an initial engineering study (Pierson & Whitman) of the potential of Little River site confirmed the 1971 study.

[3] The 83 year period of record for the Swift Creek lake system and Falls Lake indicate significant differences in regional topology and geographic location, combined with differ drainage basin characteristics and regional weather patterns lead to different droughts of record for each watershed, with 1981 as the worst drought of record for Swift Creek and 2007-08 for the Falls Lake watershed.

The conceptual project was for a new dam located on the Little River above Riley Hill Road. Other major milestones that occurred during this year were:

- East Wake Water Task Force formation to promote the proposed project, comprising Wake County, Raleigh, Knightdale, Wake Forest, Wendell and Zebulon.
- WCBC and Triangle J Council of Governments endorsement of the proposed project.
- WCBC holding the first public hearing on the proposed project.

In 1987, the Wake County Board of Commissioners (WCBC) voted to rezone approximately 26,000 acres within the Little River Watershed. This zoning remains in effect today. In 1988 the North Carolina Environmental Management Commission voted to reclassify Little River to WS-I from its source to the bridge at NC 97. The classification was subsequently adjusted to WS-II when DWQ expanded the classification system. In 1989 a preliminary engineering report from Hazen &Sawyer modified the location of the proposed dam to a site just above US 64. That study established normal pool elevation (El 260) and recommended land acquisition criteria for the county. In response to growing concerns about the project's viability, an initial environmental review was conducted in 1990 which found that neither wetlands nor endangered species issues would invalidate or obstruct the project. In 1993 the Preliminary Environmental Assessment (Hazen & Sawyer) expanded on the 1990 report and provided a more complete review of the issues identified in the Phase 1 Report. In 1994, the Little River Reservoir Interlocal Agreement (ILA) was approved by the City of Raleigh, Wake County and Wake municipalities of Knightdale, Wendell, Zebulon and Wake Forest to initially contribute approximately $1.6 million to acquire the land to be inundated by the proposed Little River Reservoir Project over a 10-year period. Wake County agreed to be the lead agency in the acquisition of property.

In 1995, Wake County began a multi-year program of acquiring property to be inundated by the proposed project. Initial focus was on acquisition of affected properties from willing sellers. The County effort was substantially completed by 2007. Approximately 8 parcels were acquired by condemnation. All of the condemnations have been completed with a total of approximately $15 million expended to acquire the inundated land. In 2006, the City of Raleigh agreed to be the lead agency in the design, permitting, construction and operation of a proposed reservoir. Raleigh retained the consulting firm of Hazen &Sawyer to proceed with wetlands delineation. In 2008, Raleigh entered into the Processing Agreement with the United States Army Corps of Engineers (USACE or Corps) for the preparation of the EIS for issuance of the construction permits needed to build the Little River Reservoir. Hazen and Sawyer was selected to develop the draft document. The City also completed an 8-year effort to merge water and sewer systems of Garner, Rolesville, Wake Forest, Knightdale,

Wendell and Zebulon into a “regionalized system”, envisioned 35-years earlier, and implemented the first funding of a Capital Improvement Program for design, permitting and construction of the Little River Reservoir.

Also in 2006, the Wake County Board of Commissions created a “Blue Ribbon Committee on the Future of Wake County”; they recommended that development of the Little River Project be expedited to the extent possible. A “Fast Track” permitting effort was recommended. In 2007/2008 the City agreed to repay Wake County through a series of repayments for land acquisition costs advanced by the County for inundated reservoir land (approximately $14 million after a $1 million contribution from partnering municipalities).

From 2007 through today the City’s permitting effort for the Little River Reservoir has evolved into a larger, more complex water resource planning program driven by permitting difficulties and changes in water consumption patterns. As with many federal acts, the reach and complexity of the Clean Water Act (CWA), the Endangered Species Act (ESA) and the National Environmental Policy Act (NEPA) continue to evolve as new scientific data, changing regulatory guidance and litigation precedents shape the permitting process.

In 2009 the Jordan Lake Regional Water Supply Partnership (Jordan Lake Partnership or Partnership) was created with the primary purpose of jointly planning the expanded use of available water supply in Jordan Lake, which is located in the Cape Fear River Basin. Because the Partnership was committed to working collaboratively to enhance the sustainability and security of the region’s water supply resources through conservation and efficiency, interconnection, and coordinated planning and development of the Jordan Lake water supply, the Partnership was expanded to include the City of Raleigh and its utility service area. A total of 13 local governments and public bodies have joined the Partnership. Membership in the Partnership is voluntary. The members include the Town of Apex, Town of Cary, Chatham County, City of Durham, Town of Hillsborough, Town of Holly Springs, Town of Morrisville, Orange County, Orange Water and Sewer Authority (OWASA), Town of Pittsboro, City of Raleigh and its merger partners, City of Sanford, and Wake County. Even though the City of Raleigh did not regard Jordan Lake as a viable water resource option for itself (because of North Carolina’s Interbasin Transfer Rule), stable water supplies within the region would ensure reliable *emergency supplies* for the City while regional planning efforts will allow neighboring communities to support the City’s water supply planning efforts in the Neuse River Basin.

Between 2009 and 2013, the Partnership developed the *Triangle Regional Water Supply Plan* (TRWSP or Plan). The Jordan Lake Partnership contracted with Triangle J Council of Governments (TJCOG) to develop TRWSP, which is divided into two

volumes. *Volume I: Regional Needs Assessment*, identified the future service areas of the Region's water systems, determined future water supply demands, examined current water supply sources and estimated yields and presented the projected future water demands along with the future water supply needs for each water system, and for the Region as a whole. *Volume II: Regional Supply Options* presented an array of potential strategies for meeting those future needs. Volume I was published in 2012 and volume II was completed in December 2013. During this process, the City of Raleigh evaluated over 25 future water resource options:

City of Raleigh Water Supply Alternatives Summary		
Scenario	**Water Supply Alternative**	**Feasibility**
A.1 Falls Lake	Seasonal Raising of Normal Pool	Not Feasible – Falls Lake dam is a Dam Safety Action Class (DSAC) III. USACE policy does not allow actions that would raise the normal pool (guide curve) for DSAC I, II, or III dams.
A.2 Falls Lake	Dredge Falls Lake to Increase Volume	Not Feasible - excessive cost, spoil disposal difficulties. Resulting volume of 15.3 million cubic yard (1.53 million dump truck loads) would cover approximately 500 acres to a height of approximately 20 feet.
A.3 Falls Lake	Reallocate Storage in Sediment Pool to Water Supply Pool	Not Feasible – USACE has indicated the sediment pool is not available for permanent water supply needs; Congressional Authorization Required.
A.4 Falls Lake	Reallocate Storage in Conservation Pool to Water Supply Pool	Potentially Feasible – initial modeling indicates reallocation of 4.1 billion gallons (12,582 acre-feet) from the water quality pool to the water supply pool would leave sufficient water quality pool to meet downstream flow requirements under all historic hydrologic conditions (1929-2012).
B. Swift Creek	Increase size of Lakes Benson and Wheeler	Not Feasible – high impact to existing residential areas and impacts major roadways adjacent to the reservoirs. Federally Endangered Species present downstream.
C. Jordan Lake	Seek allocation from B. Everett Jordan Lake	Not Feasible – requires interbasin transfer from the Cape Fear River Basin to the Neuse River Basin. Would require return of flow to the Cape Fear River Basin, transfer distances exceed 40-miles one way.
D. Kerr Lake	Seek allocation from John H. Kerr Reservoir	Not Feasible – requires double interbasin transfer from the Roanoke River Basin to the Neuse River Basin, and return of treated wastewater flow to the Roanoke River Basin at high cost.
E. Middle Creek	Create inline reservoir on Middle Creek	Not Feasible – this alternative is similar to the Littler River Reservoir alternative; however, impacts and cost are greater given the considerable developed property acquisition and rezoning required, including property acquisition in Johnston County.
F. Buffalo Creek	Create inline reservoir on Buffalo Creek	Not Feasible – inadequate storage to produce desired yield, higher impacts and costs than the Little River Reservoir
G.1 Neuse River Intake	New Intake near the confluence of Richland Creek and the Neuse River	Not feasible – USACE would consider any impacts to the Falls Lake water quality pool to be a reallocation; therefore, this alternative is similar to the Falls Lake Reallocation Alternative A.4.
G.2 Neuse River Intake	New Intake upstream of NRWWTP on Neuse River	Potentially Feasible: – moderate Falls Lake water quality pool impact. Modeling shows the impact to the water quality pool for this alternative to be less than that for the reallocation alternative (A.4). Outstanding issues to be resolved are reclassification of the watershed for water supply.

City of Raleigh Water Supply Alternatives Summary Continued		
H.1 Offline Storage	Neuse River Intake near Richland Creek with Offline Storage	Potentially Feasible: alternative G.1 with the added cost to purchase an active rock quarry. Currently, the project cannot meet the yield as there is not enough volume in the quarry; therefore, this alternative would require a contribution from the water quality pool. This alternative would be more feasible as a future option, once there is more volume available in the quarry.
H.2 Offline Storage	Neuse River Intake upstream of NRWWTP with Offline Storage	Not Feasible- Neuse River intake at this location is capable of meeting the required yield without offline storage (See Alt. G.2). The addition of off line storage in the form of a quarry would not increase the technical feasibility of this option but would result in prohibitive costs associated with acquiring an active quarry with significant remaining operational life.
H.3 Offline Storage	Convert existing quarries for Low Flow Augmentation	Not Feasible- the USACE cannot provide a credit solely to the water supply pool for the low flow augmentation releases from other sources. If USACE could provide a credit it would be assigned to the conservation pool and split between the water supply (42.3%) and water quality pools (57.7%), resulting in a multiple quarry solution set that is cost prohibitive.
I.1 Groundwater Supplies	Multiple Local Wells	Not Feasible – yield insufficient for municipal water supply purposes.
I.2 Groundwater Supplies	Aquifer Storage and Recovery	Not Feasible – fractured rock aquifers of the Piedmont Triassic Basin cannot support aquifer storage and recovery
I.3 Groundwater Supplies	PCS Phosphate, Aurora, NC	Not Feasible – requires remote WTP and 105 miles of 36-inch water main, easement acquisition would require NCGA support, final costs prohibitive.
J. Purchase Water	Acquire water from an existing system with access capacity	Not Feasible – existing systems inside and outside of the Neuse River Basin do not have adequate long-term supply to meet required need.
K. Wastewater Reuse	Use of wastewater to supplement or off set potable water.	Not Feasible – “reclaimed” water utilization is included in the demand projections to the maximum extent practicable under North Carolina regulations.
L. Water Efficiency	Water Efficiency Improvements within System	Not Feasible – water conservation/water efficiency measures are included in the demand projections to the maximum extent practicable.
M Combination of Alternatives		Potentially Feasible – Combinations of alternatives will be developed and evaluated.
N. No Action		Not Feasible - does not meet Purpose and Need.
O.1 Other Existing Lakes	Harris Lake	Not Feasible – inadequate available storage to develop required yield.
O.2 Other Existing Lakes	Stormwater Lakes	Not Feasible – inadequate available storage to develop required yield.
Preferred/traditional - planned option	Little River Reservoir	Potentially Feasible – approximately 26,000 acres of land around the reservoir has a WS-II watershed classification for water supply; the inundated land has been purchased by the City of Raleigh in order to preserve the area for its future intended use; and the yield accounts for a minimum release of 3.3 cfs to maintain downstream aquatic habitat, which includes the presence of federally endangered species.

Four water resource options have been determined to be technically feasible. These options are:

- New reservoir on the Little River (Preferred/traditional -planned option)
- Reallocation of the water conservation pool storage in Falls Lake (Option A.4)
- Withdrawal of water from the Neuse River just above the Neuse River Wastewater Treatment Plant (Option G.2)
- Withdrawal of water from the Neuse River just below Falls Lake with the use of an existing quarry for storage (Option H.1)

Each of the alternatives involves difficult environmental, social and economic questions and the level of effort required to evaluate each alternative will be significant. Further discussion of options will occur later in this document.

As the cumulative yield of each option is assumed to be 13.7 MGD[4], three of four options would be needed, with assumed water efficiency and reclaimed water use, to meet the needs in 2060 (50-year planning window). If water efficiency or reclaimed water use goals are not met, all four alternatives would be necessary. To reflect this finding, the Triangle Regional Water Supply Plan recommends that the City should seek to permit all four identified options, in ascending order of difficultly.

This recommendation will be presented to the Raleigh City Council and the elected leadership of the six communities served by CORPUD for consideration and comment in 2014.

[4] The benchmark for future project costs and yield, the Little River Reservoir, has been used to establish viability. Additional research is necessary to determine the ultimate yield of each Neuse River option.

Water Supply Demand Projections

Region's local governments and public water systems of the Jordan Lake Partnership jointly met to discuss means and methods for regional water supply demand projections[5].

Water demand projection methodologies varied widely by partner, as each had differing amounts and quality of water use data, land use data, and growth projections. The Partnership did not adopt a single methodology for all systems due to these differences. Each partner submitted their base data, projection methodologies, assumptions, and projections early in the TRWSP planning process. TJCOG collected the most recent version of water demand projections from each partner, including as much information on methodology as possible, and presented the results to all partners. Early meetings among the Partnership members led to several areas of discussion related to projection methodologies, including methods for reporting non-revenue (rather than "unaccounted-for") water. Non-revenue water was characterized on the basis of various system components, such as treatment plant process water, finished water used for distribution system maintenance (line flushing), plus other non-revenue elements, including water lost due to system leakage. Partnership members agreed to the importance of reducing non-revenue water to the greatest extent possible. They also agreed to specify and incorporate anticipated water use efficiency improvements into their projections. Accordingly, each system's projection summary includes a description of water use efficiency efforts and progress to date, as well as how additional (future) efficiencies are incorporated into their demand projections.

Peer review of each Partner's demand projections by other Partnership members was a key element of this document and was accomplished by several methods: questions and critiques of structured individual presentations to the whole group and through the submittal of anonymous peer review evaluations of each system's base data and assumptions, projection methodology, and overall credibility. This process included both scaled ratings and unstructured comments. Some partners requested help from TJCOG in evaluating options for their projections and in comparing their data and assumptions to those of other Partnership members. Each Partnership member's initial projections and methods were then further revised in response to those comments and procedures, resulting in approximately a 10% overall reduction of the initial demand projections. Finally, all Partnership members had the opportunity to review and comment on three successive drafts of this document, including the individual system summaries.

[5] Large elements of this section are repeated in the Triangle Area Regional Water Supply Plan, Volume I

Many of the conventions adopted by the TRWSP (methods for reporting non-revenue water, incorporation of water efficiency goals into projections) have long been components of CORPUD water resource planning. CORPUD also uses historic water consumption data and detailed community land use and population forecasts to project future water use.

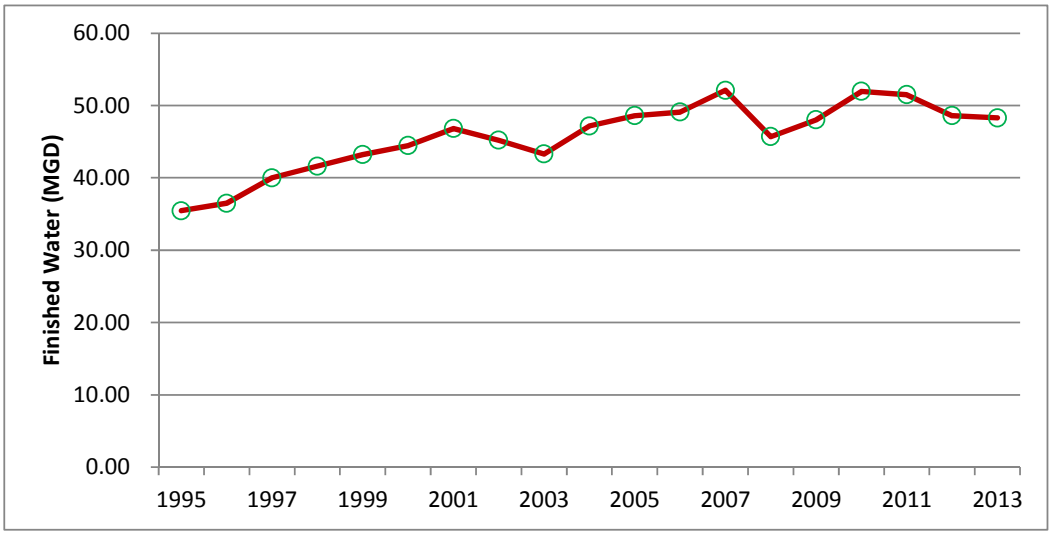

Figure 1: Raleigh Historical Finished Water Production (MGD)

Table 1: Raleigh Service Area Future Population Projection (MGD).

Total Population Projections for Service Area					
Year					
2010	2020	2030	2040	2050	2060
483,253	638,544	799,142	963,217	1,134,247	1,316237

Table 2: Raleigh Service Area Future Water Demand Projection (MGD).

Sector	2010	2020	2030	2040	2050	2060
Residential	29.43	36.45	44.26	51.67	58.12	65.08
Commercial	11.44	14.17	17.2	20.09	22.56	25.26
Industrial	1.30	1.61	1.96	2.28	2.57	2.88
Institutional	3.4	4.186	5.08	5.93	6.72	7.52
WTP Process	0.13	0.16	0.19	0.23	0.26	0.29
Distribution Process	2.18	2.7	3.28	3.83	4.26	4.77
Other Non-Revenue	4.16	5.15	6.26	7.3	8.22	9.20
Total	**52**	**64.4**	**78.2**	**91.3**	**102.71**	**115.00**
GPCD	**107**	**100.8**	**97.8**	**94.8**	**90.6**	**87.4**

Table3: Raleigh Future Water Demand Projection (percent of total demand).

Sector	2010	2020	2030	2040	2050	2060
Residential	56.6%	56.6%	56.6%	56.6%	56.6%	56.6%
Commercial	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%
Industrial	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
Institutional	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%
WTP Process	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
Distribution Process	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%
Other Non-Revenue	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Population projections for the City of Raleigh and its merger partners seem to uniformly agree on continued growth. Continued growth of up to 15,000 additional citizens in all seven communities has occurred between 2010 and 2013. Several population estimates have been developed; most are primarily based upon the Water Quality Study and Master Plan Update (Hazen and Sawyer, 2008a) and subsequent updates to the data for Traffic Analysis Zones (TAZs) from the Capital Area Metropolitan Planning Organization (CAMPO).

The most recent projections are based on population projections through 2035 that were developed by the Capital Area Metropolitan Planning Organization (CAMPO), and that were the basis for the 2035 Long-Range Transportation Plan (LRTP). The 2035 LRTP was approved by the Transportation Advisory Committee, the CAMPO policy board in May 2009. The population projections for 2040 were generally calculated based on extrapolation of the CAMPO projections from the 2035 LRTP, corrected for annual population figures announced by the North Carolina Office of State Budget and

Management. During this review period, CAMPO developed new base data sets for revised population projections. Review of those data sets and projections indicated no significant differences between previous population projections and new 2040 LRTP population projections, which were published in the newly renamed 2040 Metropolitan Transportation Plan.

City of Raleigh's projection methodology lumps all demand and non-revenue uses together. In order to disaggregate the sector usage for the purpose of this report, the percentage breakdowns for each of the sectors from 2010 are simply carried forward to all the projection years. As a result, the City's sector-based demand estimates are only representative of current conditions, and should not be used to interpret how the water use by sector will change.

Water Efficiency and Conservation

Raleigh has paid an increasing amount of attention to water efficiency over the last seven years. *Efficiency* is a term used to describe the minimum water use of certain plumbing fixtures or water using appliances. *Conservation*, on the other hand, is a term that is used to describe the water use habits of individual customers. Based on the averaged potable water consumption data from 2009 and 2010, the City of Raleigh service area (i.e. Raleigh, Zebulon, Rolesville, Wendell, Knightdale, Wake Forest and Garner) consumed an average of 103.8 gallons per capita day (gpcd). There is inherent variability in annual gpcd that must be recognized in demand projections. Where there are national trends showing a decline in per capital demand, environmental impacts and economic activity have significant impacts on gpcd from year to year. From the historic record, it is apparent that gpcd varies year-over-year, nearly 10% of total demand in any year. The calendar year 2013, for example, was the 8th wettest year on record for our region, with an average rainfall of approximately 53 inches, as opposed to the 43.34 inches the region receives on average.

Variability in year-over-year gallon per capita demand is, however, significantly smaller driver in long term projections than variability in potential population growth scenarios. In this year the gpcd average demand was 96 gpcd. Because this falls within the known variability for the service area, no changes in assumed gpcd in forward projections is recommended at this time, thus the base planning number remains 103.8 gpcd.

While this compares favorably with other similarly sized systems throughout the United States, it is anticipated that further reductions will be realized in the future through the following actions:

- continued development of the Reuse system,
- continued support of water fixture replacement incentives, though use of cost benefit analysis may result in individual program modifications,
- reduction of elective use demand due to tiered rate implementation,
- continued indoor water fixture efficiencies through Federal regulation.

From 2009 to 2013, water supply demand projections assumed that significant reductions in per capita water consumption would be realized from personal conservation efforts and the installation of more efficient fixtures and appliances by our customer base. The projections also assumed continued growth of the reclaimed water system and the eventual prohibition of outdoor irrigation with potable water. At least for the near term, there is significant uncertainty regarding the social or political acceptability of proposed per capita reduction strategies or the degree with which those reductions strategies will be implemented.

As an example, the 2007 City of Raleigh reclaimed water master plan assumed 3 mgd average daily demand and 8-10 mgd peak day demand from a 187 mile reclaimed water distribution system networked throughout the City's service area. Implementation of the first of seven plan phases has raised serious questions regarding final system costs and the ultimate consumption demands for reclaimed water by current and future customers. A revised reclaimed water master plan is expected to address these questions and will be available in 2014.

Other water conservation and efficiency assumptions have been similarly challenged. The City Attorney's Office concluded that the City is not able to require the installation of cutting edge water efficiency fixtures and appliances. In addition, the City Attorney's Office advised that the City's program to incentivize such fixtures and appliances should be limited to fixtures or appliances expected to stay in the residence when ownership changes. City proposals to ban outdoor irrigation have met will mixed responses, which demonstrate lack of politically cohesive support for this measure.

Because of this evolving understanding, the water conservation and efficiency assumptions used in the 2012 report are also used in the 2013 report. For this revised report, the following assumptions are adopted:

- Total water demands are based on the average of 2009 and 2010 water demand characteristics of the combined services area.
- Reductions due to residential efficiency based only on retrofitting of residential housing units to incorporate fixtures that meet 1994 water use standards, not WaterSense™ standards.
- Reductions due to reuse will be based on commercial and industrial non-irrigation demands and unregulated irrigation demands until the City's reclaimed water master plan is updated.
- Reduction due to limits on outdoor irrigation will be based on one-half of projected outdoor irrigation demands.

As of November 1st, 2010, the CORPUD implemented a tiered rate pricing structure for our all residential potable water service customers. The current rates are summarized below:

Table 4: CORPUD Rate Tiers.

TIER	VOLUME IN CCF	RATE PER CCF
1	0 - 4	$2.28
2	4 - 10	$3.80
3	10 +	$5.07*

*ALL IRRIGATION ACCOUNTS BILLED AT TIER 3 RATES

It important to note the City has adjusted upward the rates associated with sanitary sewer service, continuing to place financial pressure on rate payers who then look to water conservation as a means to reduce costs.

It is not yet clear how further rate increases will impact demand. Based upon the experience in many other communities with tiered or “conservation” rate structures, it is likely that average and maximum demand will continue to decrease in response to the acute financial impact on elective uses such as irrigation. It is difficult to quantify the overall impact of the new rate structure at this time, but it is expected that it will have a substantial impact on the current irrigation demand and other similar uses. Assuming that the irrigation demand is reduced by 50 percent, the reduction for outdoor irrigation is estimated to represent 2.5 gpcd.

The United States Environmental Protection Agency (EPA) established the Water Sense Program in 2006 to promote high levels of water efficiency in common indoor water fixtures such as toilets, faucets and showerheads. In addition, the EPA created the Energy Star Program to encourage the purchase of energy efficient appliances such as clothes washers and refrigerators. The Energy Star Program also includes water efficiency as a criterion for some products such as clothes washers. It is estimated that the appliance/fixture replacements over time will represent an additional 5.0 gpcd reduction due to the improved efficiency of the new models.

Future reductions in potable water consumption attributed to the City’s reclaimed water program are based on historical water demands for commercial and industrial non-irrigation uses and unregulated irrigation usage; reductions could represent an additional 1.5 gpcd savings by 2040.

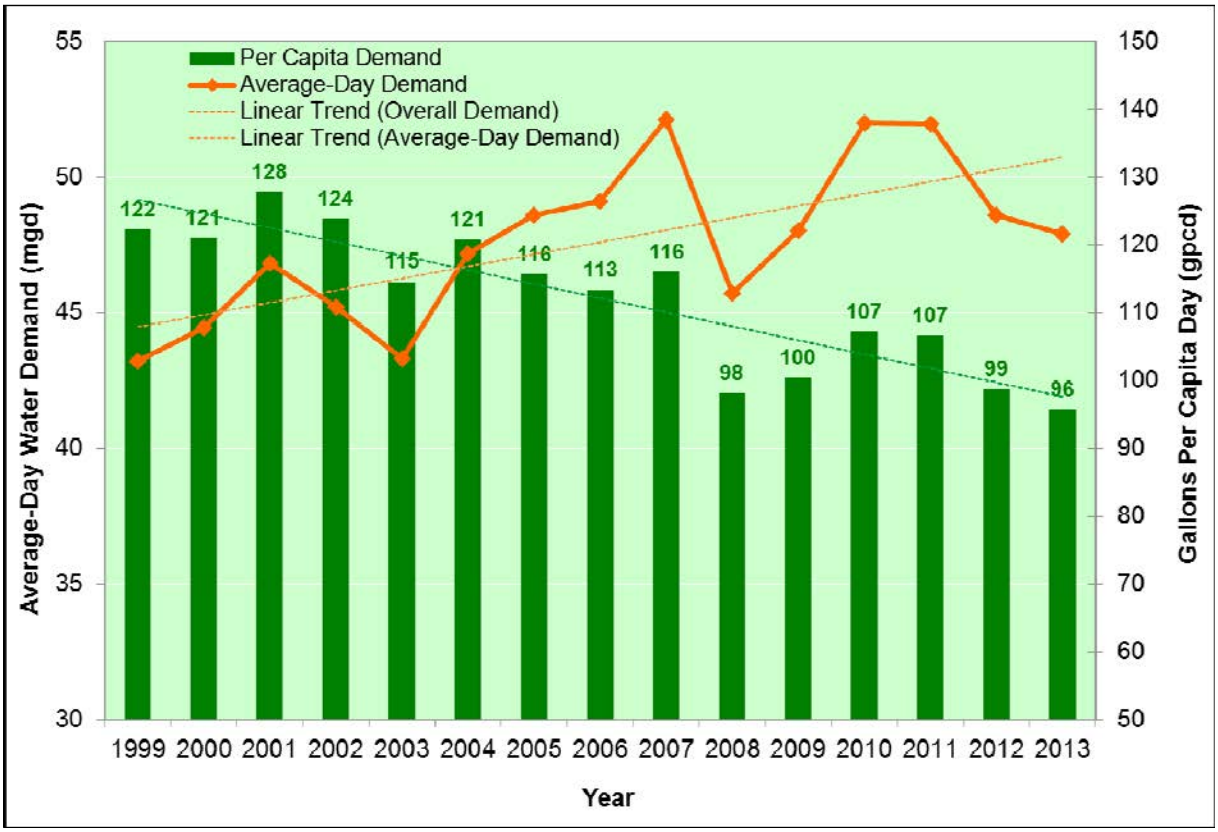

Figure 2: Impacts of Water Conservation Programs

In summary, it is estimated the that combined savings of the reclaimed water distribution program, expansion of the water fixture replacement incentive program, residential demand impact from the tiered rate structure, and improved efficiency of replacement water fixtures and appliances will result in an approximate 9% reduction of the current average demand of 103.8 gpcd by 2040.This reduction to 94.8 gpcd appears to be a realistic goal and in line with other Triangle area municipal systems such as the Town of Cary and OWASA, which have realized similar reductions thanks to their own conservation and efficiency improvement efforts.

For the 2050 and 2060 estimates, Raleigh's projections further assume that all outdoor irrigation with water treated to drinking water will be phased out. This water need may be met in the future by on-site reuse, reclamation, rainwater harvesting or other measures. This change will lead to an anticipated reduction of 2.4 gpcd. It is also assumed that building code standards will dictate new levels of efficiency, acquiring an additional 5 gpcd in reductions for the service area between 2040 and 2060. It is uncertain at this time when the actions required to acquire all assumed reductions for the planning period will become socially or politically acceptable alternatives. Without continued conservation/efficiency gains and increased use of reclaimed water, water supply demand projections must be adjusted upward.

Water Supply Needs

As described previously, the City' non-revenue use percentages are built into the projection based on the approximate 2010 percentage breakdown, and conservation measures such as aggressive leak detection, can't be included directly under this projection methodology. Nonetheless, Raleigh is committed to good stewardship of its distribution system, and aims to maintain a non-revenue percentage of roughly 12% of demand. Furthermore, Raleigh's WTPs have onsite reuse of process water, which diminishes the WTP Process water usage to a miniscule percentage of demand (~0.25%).

Table 6: Raleigh Existing Water Supply (MGD).

Source	2010	2020	2030	2040	2050	2060
Falls Lake	66.1	66.1	66.1	66.1	66.1	66.1
Lake Benson and Lake Wheeler	11.2	11.2	11.2	11.2	11.2	11.2
Total	**77.3**	**77.3**	**77.3**	**77.3**	**77.3**	**77.3**

City of Raleigh's primary source of water is Falls Lake, which yields 66.1 MGD on a 50-year reoccurring reliable yield. The Little River draft EIS projections indicate that Lake Benson and Lake Wheeler system may provide 11.2 MGD on a 50-year reoccurring reliable yield and the (potential) Little River reservoir may provide up to 14 MGD if it is built. The proposed Little River Reservoir is not included in supply projections for the calculation of need.

Table 7 Raleigh Future Water Supply Need (MGD).

System	2010	2020	2030	2040	2050	2060
Raleigh	**0.0**	**0.0**	**0.9**	**14.0**	**25.4**	**37.7**

Water Resource Alternatives

Since 2009, the City of Raleigh has reviewed with intensity a range of alternatives to the Little River Reservoir. Over 25 alternatives and combination of alternatives were reviewed with varying levels of scrutiny (listed in detail on pages 10 and 11) to arrive at a list of three technically viable alternatives. These alternatives appear to be technically feasible, although the social, political and final environmental impacts have yet to be quantified. The first alternative considers a reallocation of storage within Falls Lake.

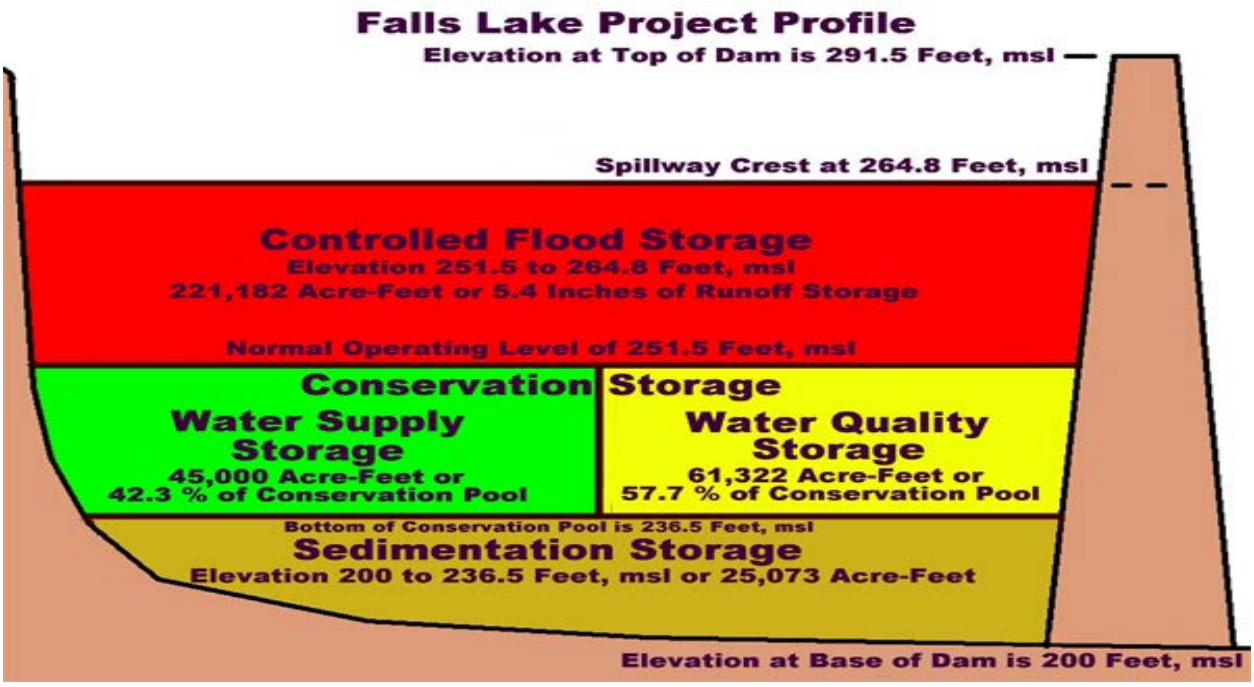

Figure 3: Falls Lake Storage Profile

As highlighted in figure 2, Falls Lake is a Corps of Engineers multifunction lake with dedicated storage for many of those functions. Although research indicates permanent reallocations from the *controlled flood storage* pool or the *sedimentation storage* pool are impracticable, an exchange between the remaining storage pools does appear to be technically feasible. The City of Raleigh, through a contract with the Corps of Engineers, has exclusive rights to the *water supply storage pool*, which provides 45,000 Acre-Feet (14.7 billion gallons) of storage. The water supply storage pool is 42.3% of the *conservation storage* pool. The remaining 57.7% (61,322 acre-feet or 20 billion gallons) of the conservation storage pool is dedicated to *water quality storage,* which is that part of total lake storage dedicated to maintaining flows for downstream uses, including biota support, agriculture, and water supply. Engineering studies to-date indicate that a reallocation from the water quality storage pool to the water supply storage pool of 4.1 billion gallons only reduces the available water quality pool from 25% to 12.1% during the lowest point of storage during the drought of record with no water supply pool remaining.

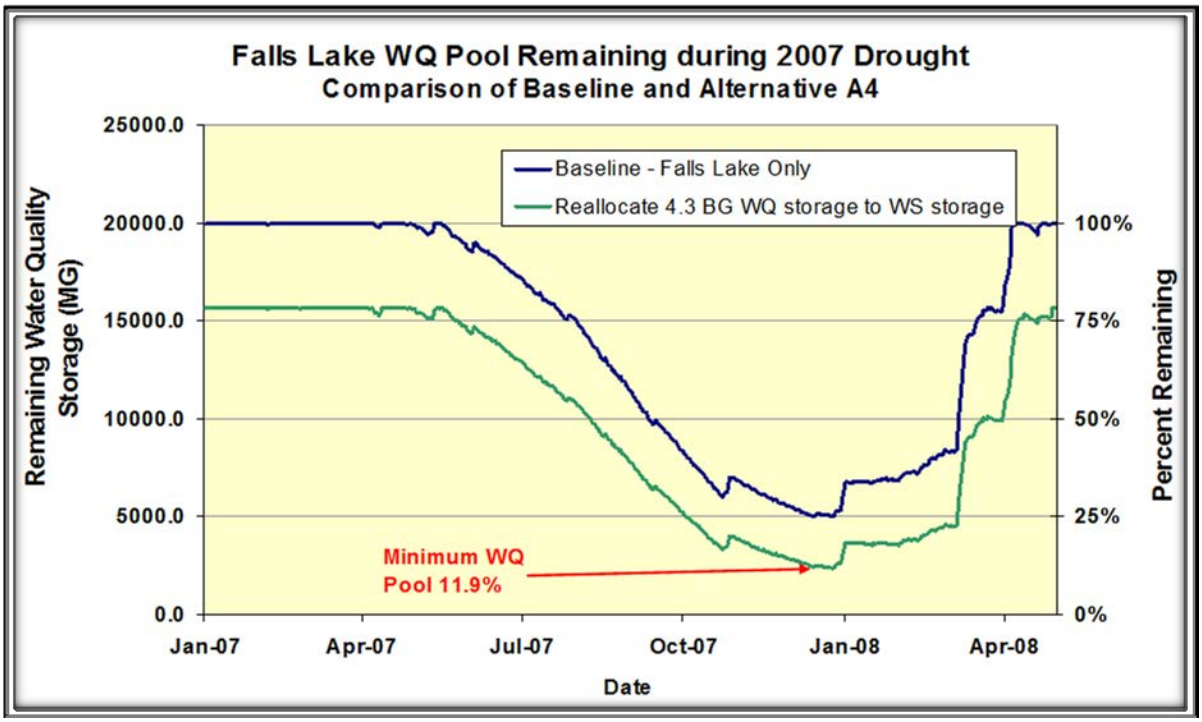

Figure 4: Falls Lake Storage Profile for Water Quality Pool during Record Drought

This unusual result arises from the geographical location of the reservoir and the City, its NPDES discharges and the controlling gauge in Clayton. The City returns as much as 90% of the water withdrawn from Falls Lake to the Neuse River via the Smith Creek wastewater treatment plant and the Neuse River wastewater treatment plant. In the droughts of 2003 thought 2008, 87% of water used from Falls Lake was returned to the Neuse. Because this return is above the stream gauge used to control releases from Falls Dam, only 10% to 13% of allocation transferred between the pools is lost by downstream uses.

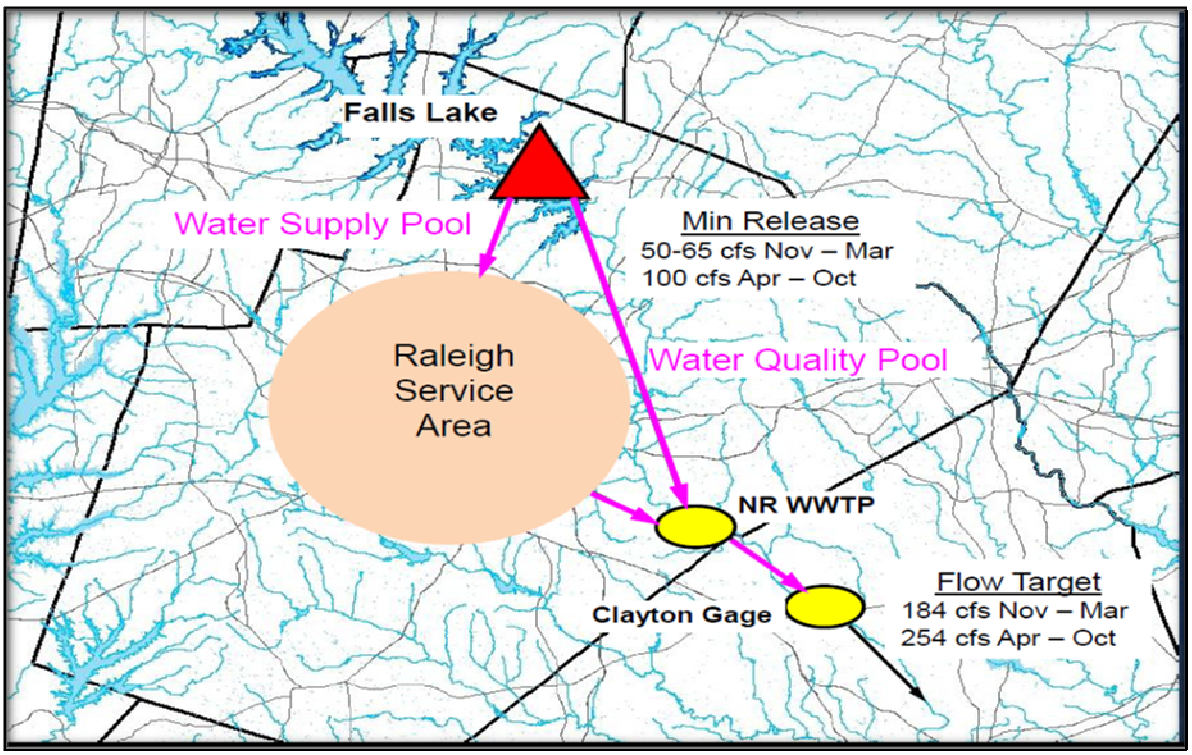

Figure 5: Raleigh Use and Return via the NRWWTP

This alternative is judged at this time to have the lowest potential permitting thresholds, as such in the summer of 2013, the Raleigh City Council authorized its staff to begin a formal reallocation process. A formal request was submitted by the City of Raleigh to the United States Army Corps of Engineers (USACE) to begin the reallocation study and the City has committed to funding the study.

This alternative has several unknowns that must be answered before it can move forward as a viable alternative to the Little River Reservoir as the next additional water resource for the City. Those unknowns include:

1. An unknown impact on water quality in Falls Lake as it applies to compliance with the Falls Lake nutrient management strategy. No or negligible impact must be demonstrated.
2. Although the USACE indicates a reallocation between the water supply storage pool and the water quality storage pool does not require U.S. Congressional authorization, a reallocation study is required to be conducted by the USACE. The USACE is currently reviewing a study request by the City.
3. Although the North Carolina Division of Water Resources (NC DWR) indicates that a reallocation between the water supply storage pool and the water quality storage pool is possible and supported by NC DWR, a formal process for assigning State interests (if such occur) in the water quality pool does not exist. This could leave any reallocation more vulnerable to litigation challenging any agency action.

4. The Neuse River wastewater treatment plant discharge currently makes up 49% of the 7Q10 [6] of the Neuse River. A reduction in average releases from the dam over time will increase this percentage and it may negatively impact the City's ability to permit additional discharge flows from the NRWWTP.
5. The reach of the Neuse River between Falls Dam and the NRWWTP also has a minimum flow regime that would be protected, although this section of the river could have lower flows, on average, as water is diverted through the City of Raleigh water and wastewater systems to final discharge from the Neuse River and Smith Creek wastewater treatment plants. However, the target flows below the dam can be met.

The second alternative that remains viable and requires more study is a water withdrawal from the Neuse River below Falls Dam near Richland Creek with side stream storage in an existing quarry.

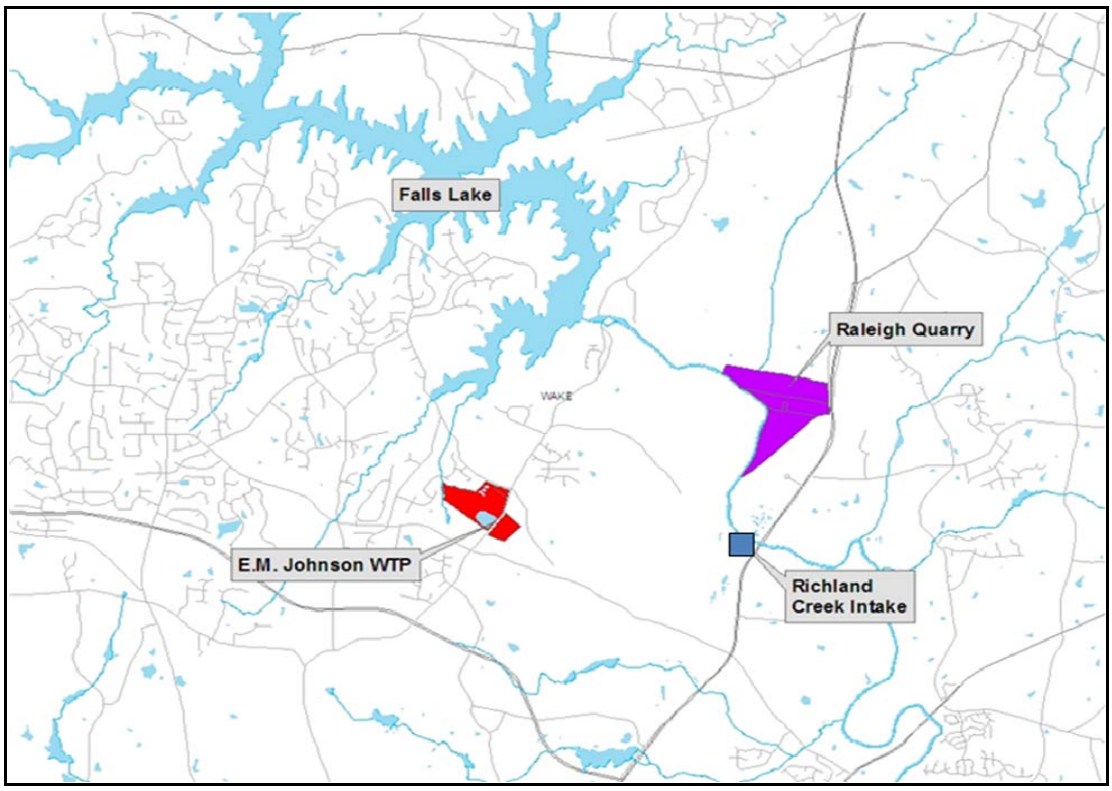

Figure 6: Neuse River Intake with Quarry Storage Option

This option takes advantage of the relative proximity of an active quarry to an existing water supply watershed (Richland Creek) and the E.M. Johnson water treatment plant. Like the Falls Lake reallocation alternative, this option would essentially require additional releases from Falls dam as the quarry in question is too small to supply the

[6] 7Q10 refers to the lowest flow in a river or stream over seven consecutive days in a ten year interval. It is often used as a benchmark to determine assimilative capacity of a receiving water body, dictating NPDES permit conditions

anticipated new system demand from high flow storage alone. Engineering studies indicate that a Neuse withdrawal with side stream storage increases the available water supply pool from 25% to approximately 26% during the lowest point of storage during the drought of record. These estimates are based on a quarry volume of approximately 4 billion gallons (BG). The existing quarry volume is estimated at approximately 2.7 BG.

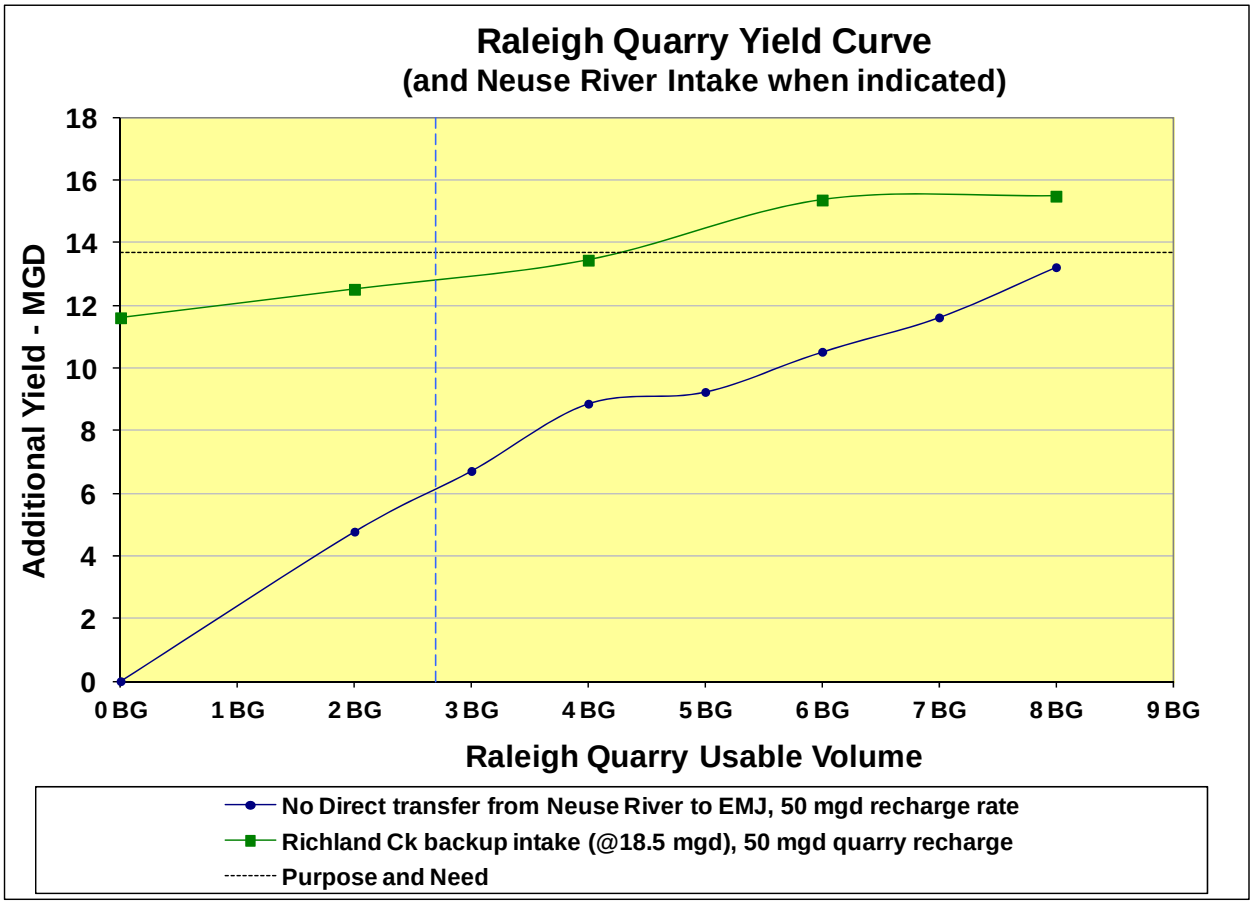

Figure 7: Potential Reliable Yield from Neuse River Intake with Quarry Option

This alternative has several unknowns that must be answered before it can move forward as a viable alternative to the Little River Reservoir as the next additional water resource for the City. Those unknowns include:

1. An unknown impact on water quality in Falls Lake as it applies to compliance with the Falls Lake nutrient management strategy. No or negligible impact may be required.

2. The quarry is privately owned and many years away from exhausting its mineral resources. The owner has shown no interest in a voluntary sale of the quarry and damages from condemnation of the quarry will include compensation for lost mining revenues (mineral rights). That acquisition cost, while unknown, could be substantially higher than the anticipated cost of the Little River Reservoir.
3. The recent L&S Water Power v. Piedmont Triad Rural Water Authority decision from the North Carolina Supreme Court confirmed that potable water suppliers have subservient water use rights to those with classic riparian water use rights. This negatively impacts any efforts in North Carolina to develop new water resource, including new reservoirs and new intakes in free flowing rivers.
4. The recent listing of the Atlantic Sturgeon as a federally protected Endangered Species known to inhabit the Neuse River and the pending removal of the Milburnie Dam will add important new challenges to securing a permit for a Neuse River intake.

The final identified alternative is also a Neuse River intake, with water withdrawn from the river just upstream of the discharge from the Neuse River wastewater treatment plant.

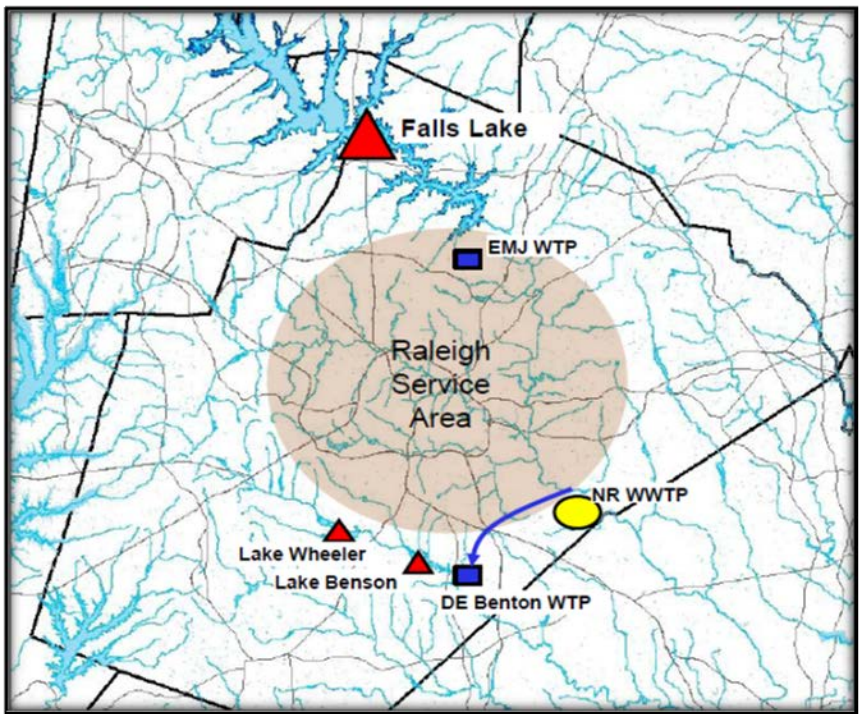

Figure 8: Concept Diagram for Neuse River Intake Upstream of NRWWTP

This alternative would take advantage of the additional drainage area that occurs between the Falls Lake dam and the Neuse River WWTP, which is located near the

Wake County-Johnston County line. The additional drainage area would limit the impact of this alternative on the water quality storage pool; engineering studies indicate that a Neuse withdrawal with side stream storage reduces the available water quality pool from 25% to 22.3% during the lowest point of storage for the drought of record with no water supply pool remaining.

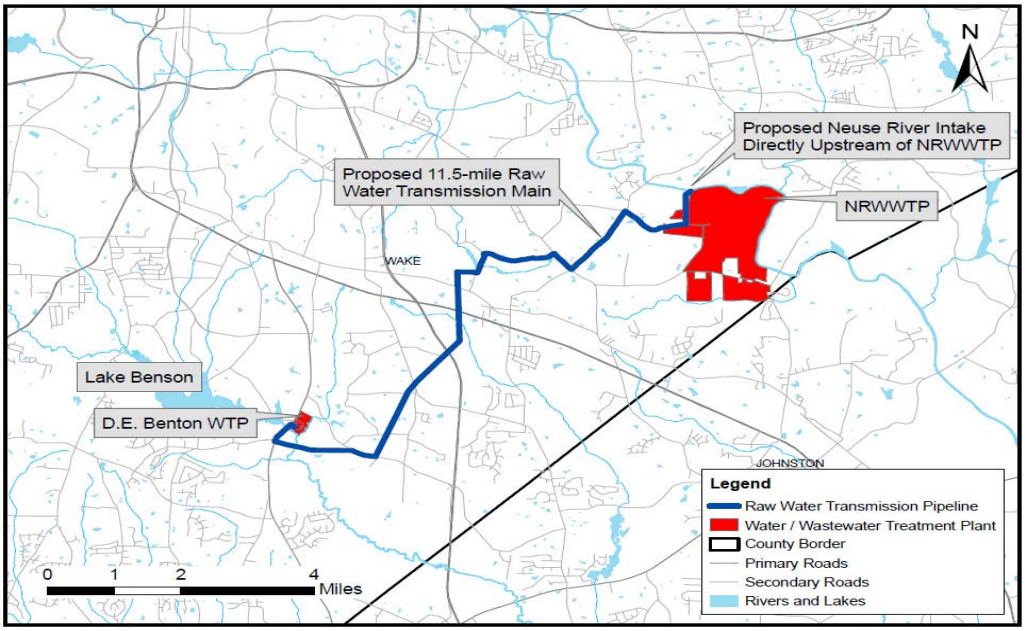

Figure 9: Neuse River Intake above the NRWWTP

This alternative has several unknowns that must be answered before it can move forward as a viable water resource. Those unknowns include:

1. An unknown impact on water quality in Falls Lake as it applies to compliance with the Falls Lake nutrient management strategy. No or negligible impact may be required.
2. A water supply intake at this location would require the implementation of a new water supply watershed overlay zoning district up to ten miles upstream of the new intake. The new district could have the effect of limiting development within the district. Because much of the area in question is undeveloped and minority ownership is significant, social justice questions may arise. A new water supply watershed overlay district may also require municipal management and ownership of mandated stormwater control devises within the water supply watershed.

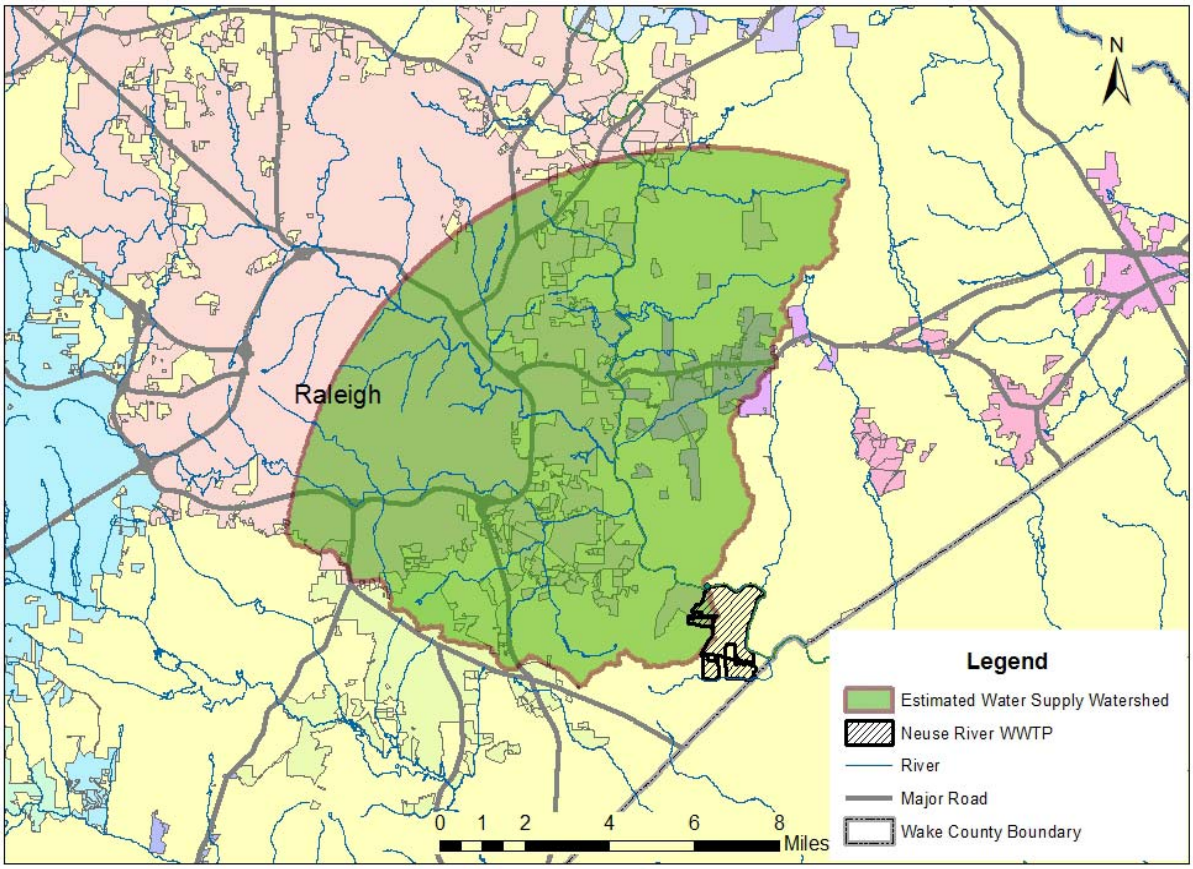

Figure 10: Required Water Supply Watershed Classification for Alternative

3. The recent L&S Water Power v. Piedmont Triad Rural Water Authority decision from the North Carolina Supreme Court confirmed that potable water suppliers have subservient water use rights to those with classic riparian water use rights. This negatively impacts any efforts in North Carolina to develop new water resource, including new reservoirs and new intakes in free flowing rivers.
4. The recent listing of the Atlantic Sturgeon as a federally protected Endangered Species known to inhabit the Neuse River and the pending removal of the Milburnie Dam will add important new challenges to securing a Neuse River intake.

Each of the alternatives involves difficult environmental, social and economic questions and the level of effort required to evaluate each alternative will be significant.

As the cumulative yield of each option is assumed to be 13.7 MGD[7], three of four options would be needed, with assumed water efficiency and reclaimed water use, to

[7] The benchmark for future project costs and yield, the Little River Reservoir, has been used to establish viability. Additional research is necessary to determine the ultimate yield of each Neuse River option.

meet the needs in 2060 (50-year planning window). If water efficiency or reclaimed water use goals are not met, all four alternatives would be necessary. To reflect this finding, the Triangle Regional Water Supply Plan recommends that the City should seek to permit all four identified options, in ascending order of difficultly.

This recommendation will be presented to the Raleigh City Council and the elected leadership of the six communities served by CORPUD for consideration and comment in 2014.

Innovative Water Resource Options

Several alternatives not currently considered viable could become practicable if conditions change. These alternatives include the use of stormwater as a potable water source or surrogate. Currently considered non-viable because of the costs involved (an estimated $45-$65 per gallon), a change in the national regulatory focus on stormwater, specifically the introduction of numeric standards for stormwater quality and quantify, could change the cost-benefit-analysis. Evolving regulatory standards that require stormwater capture and treatment are envisioned by some observers of the EPA. If such future regulation is promulgated, stormwater capture for use as potable water will be reevaluated as a water resource option.

A similar reconsideration of the direct or indirect use of reclaimed water as a source water for a potable water treatment plants may be possible in the future. Reclaimed water is highly treated wastewater plant effluent, currently authorized for non-potable uses such as general irrigation, cooling water, food crop irrigation (at highest quality) and any other non-potable water applications. Source water is any water taken from an impoundment or river into a potable water treatment plant to be converted into potable water. The current regulatory framework does not support the intentional use of reclaimed water as source water. On March 1, 2013, the Raleigh City Council authorized staff to work with NC DENR to draft legislation that would allow local communities to explore the recycling of reclaimed water to surface drinking water supplies when the fifty year future needs of a local water supply system cannot be met within its river basin. The legislation would allow North Carolina to join such states as Virginia, Colorado, Texas, Florida and California in allowing such projects to be considered. By the end May, 2013, draft legislation was prepared. The legislation was drafted to apply statewide in scope but limitations within the bill effectively limit its application to the City of Raleigh and perhaps one or two other communities. This limited application would allow one of the State’s largest and most sophisticated utility systems to pilot means and methods for later application statewide. The legislation is shaped to limit exposure of unregulated water constituents by limiting the total source water contribution of reclaimed water to twenty percent. This percentage was chosen, in

part, through observation of water systems in North Carolina with similar percentages of wastewater treatment plant effluent as constituents of their source water. It is also the percentage used by NC DENR as a trigger in depth stream impact evaluations; this percentage is lower than those contemplated by other States.

A goal of the City in 2014 is to see the draft legislation introduced and considered by the North Carolina General Assembly.

Unfortunately, reclaimed water utilization is a viable water resource option only within a limited range of investment. The preponderance of the evidence indicates that reclaimed water, in and of itself, is not a cost effective “single avenue” alternative to additional water resource needs but it is expected that State and Federal regulatory agencies will expect some “reasonable” investment in reclaimed water implementation as a mitigation measure for future utility projects.

Finally, allocation requests from other reservoirs such as Jordan Lake or Kerr Lake are not currently considered technically viable because of the significant legal barriers to interbasin transfer within North Carolina. If the interbasin transfer law is modified in the future or if regional partnerships are developed to allow better access to existing water supplies, the City should be prepared to revisit out-of-basin water resource alternatives.

Status of Existing Water Resources

As noted above, the City’s existing water resources are critical assets to our community. Those water bodies are subject to various influences, including the impacts of changing land use patterns in the upper watershed, the impacts of pollutant loading to the water bodies and potential climate change impacts.

Water quality sampling at the E.M Johnson water treatment plant raw water intake in Falls Lake indicates cyclical trends of declining then stabilizing water quality from 1995 to 2013. The waters of the Upper Neuse River Basin in North Carolina have many challenges meeting the demands of society and the environmental standards in place for those waters. Constructed in the early 1980’s, Falls Lake, like Jordan Lake, is a shallow Piedmont lake with inherent difficulty meeting water quality standards for chlorophyll-*a* because of its geology and its topographic location below pre-existing urban centers.

A complex set of laws, rules, guidance, and policies governs activities in the Falls Lake watershed. The recently adopted Falls Nutrient Strategy Rules overlay several previous regulations, including the Neuse Estuary Total Maximum Daily Rules (TMDL) and NPDES MS4 permits for Phase I and Phase II of the 1972 municipal and State water supply watershed regulations.

In 2008, NC DWQ and EPA placed Falls Lake on the Section 303(d) list of impaired waters because of violations of the State's water quality standards for chlorophyll-a, a proxy for algae. The NC DWQ and EPA also listed Falls Lake above I-85 as impaired for turbidity in 2008. The NC DWQ investigation and modeling of the sources of nutrients adversely impacting the Lake's water quality showed that 15% of the nutrients come from septic systems.

In 2005, the North Carolina General Assembly enacted SL 2005-190 (SB 981, Clean Lakes Act), which directed the North Carolina Environmental Management Commission (EMC) to develop and adopt a nutrient management strategy to reduce nitrogen and phosphorus pollution in Falls Lake by July 1, 2008 (later extended to July 1, 2009). In 2009, the General Assembly enacted SL 2009-486 (SB 1020, Improve Upper Neuse River Water Quality), which extended the deadline again until January 15, 2011.

At its March 2010 meeting, the EMC voted to send draft Falls Lake nutrient rules to public hearing and comment. Broken into two stages, the first stage (Stage I) of the rules was developed with the expectation that it will reduce nitrogen pollution by 20% and phosphorus pollution by 40% from the 2006 baseline within ten years, with most of those reductions occurring within the last four years. DWQ water quality modeling suggests that this reduction will restore water quality to meet standards in the lower lake, where the City of Raleigh's raw water intake resides.

On November 18, 2010, the EMC adopted the nutrient management rules for Falls Lake, with an effective date of January 15, 2011. The North Carolina Rules Review Commission approved the rules with minor technical language changes and the rules took permanent effect on January 15, 2011.

These rules include requirements for newly developing lands, lands that are currently developed (i.e., existing development), agriculture, and wastewater. The state estimates that the Falls Rules will cost approximately $1.3 billion over the next 30 years. It is estimated that implementation of early components of the Falls Rules, known as Stage I, may arrest continued degradation of water quality in the lake and forestall the need to install advance treatment technology at the E.M. Johnson water treatment plant (WTP). Research indicates, however, that compliance with Stage II of that strategy is not technically, logistically, or financial feasible without significant changes in technology and improvements in nutrient credit development and trading. The City continues to support innovative technologies and research to development a nutrient credit market thorough the assessment of a watershed protection fee, through land preservation under the *Upper Neuse Clean Water Initiative* and though active membership in the *Upper Neuse River Basin Association*.

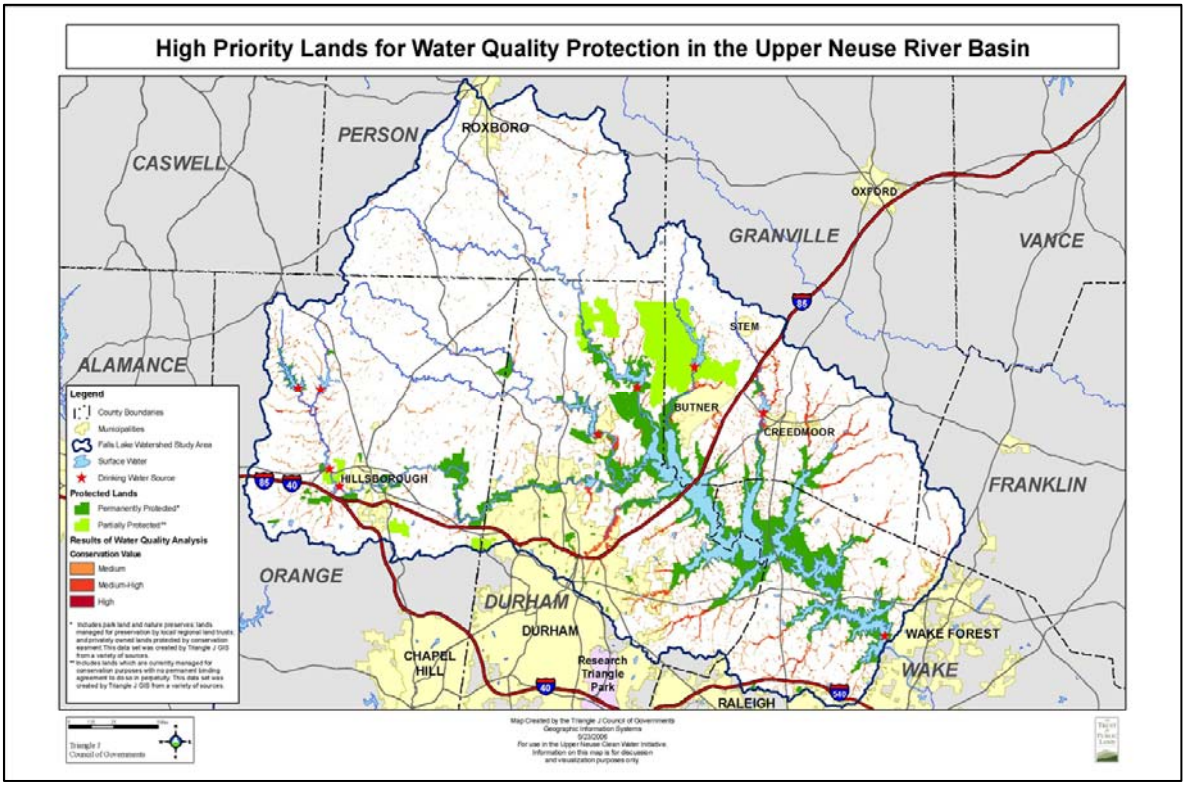

Figure 11: High Priority Lands for Quality Protection in the Falls Lake Watershed

In 2005, the City of Raleigh and the Conservation Trust of North Carolina partnered to create the Upper Neuse Clean Water Initiative (UNCWI). With a mission to prioritize and, through voluntary actions, protect those lands most critical to the long term safety and health of all drinking water supplies for the communities in the Upper Neuse River Basin, UNCWI has conserved 68 properties with 64 miles of streamside buffer, totaling 6,300 acres valued at $65 million. Both the City of Raleigh and the City of Durham have created watershed protection fees as part of regular utility billing to fund such conservation projects Unfortunately, reductions in State and Federal funding and incentives for conservation, lower property values, and landowners' reticence means land trusts will do fewer projects in the coming years.

In November 2011, the Raleigh City Council approved an ordinance providing the City with more flexibility on the type of watershed protection projects that could be funded. It also created a new Watershed Protection Advisory Task Force which was charged with recommending a mission and vision for the UNCWI program in accordance with guiding principles established by the City's Water Utility Transition Advisory Task Force and the strategic plan of the City's Public Utilities Department, as accepted by the City Council. It was also charged with reviewing the watershed protection funding ordinance and the

range of projects suitable for program funding. The Watershed Protection Advisory Task Force will meet four to six times over a six-month period in 2014 to develop a set of recommendation for the City Council to consider.

The *Upper Neuse River Basin Association* (UNRBA) was formed in 1996 to provide an ongoing forum for cooperation on water quality within the 770-square-mile Falls Lake watershed. A voluntarily formed Association, the UNRBA assumed a lead role in implementation of the Falls Lake Nutrient Strategy with the advent of SL 2010-115 In 2011, the UNRBA began a project to evaluate the regulatory framework of the Falls Lake Nutrient Management Strategy as allowed by the Rule, which calls for a reevaluation of Stage II of the rule in 2021. In January 2012, the UNRBA contracted Cardno ENTRIX to conduct the technical and regulatory review of the Falls Lake Nutrient Management Strategy necessary to make informed decisions regarding the next steps to implementation of the re-examination. Over the next several years, the UNRBA will work with NC DENR and other stakeholders to develop a framework for a reexamination of Stage II and to create future monitoring and modeling approaches to support that reexamination. The UNRBA is also working to develop relationships and necessary regulatory tools to remove identified barriers to implementing so format of Stage II. The success of the Falls Rules will depend on regional cooperation in their implementation and continued water quality monitoring to insure the actions taken have measurable effects. Changing drinking water standards may also drive the need for advanced treatment technologies independent of improvements to Falls Lake.

Water *quantity* in Falls Lake is based upon the relationship between storage volume in the lake, the drainage area above Falls Dam, land uses in that watershed and rainfall during the year. With the advent of newly available computer models such as the OASIS model commissioned by the State of North Carolina, the City can project water quantity availability using the 83 year period of record as an indicator, adding in drought response. Recent analysis of trends within that period of record has yielded troubling results.

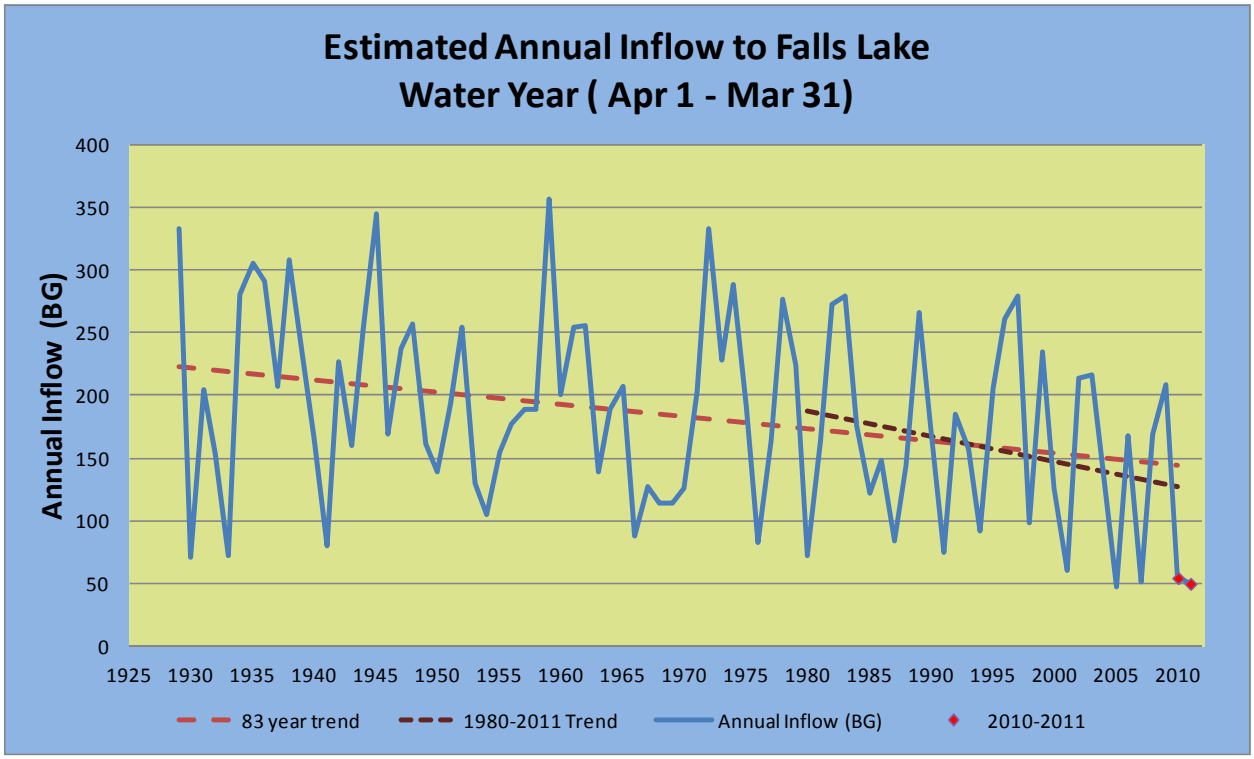

Figure 12: Trend Analysis of Declining Inflow Into Falls Lake

Figure 12 is a graphical representation of that analysis. Over the 83-year record, a trend of declining *inflows* of water to Falls Lake is apparent. Inflow refers to water flowing into Falls Lake from streams, rivers and groundwater. Over the 83-year record almost one billion gallons per year less is flowing into the area that became Falls Lake. Even more concerning, a review of the last thirty years of the record shows a downward trend equivalent to a loss of two billion gallons per year, on average of inflow into Falls Lake. The result of this trend is a reduction in reliable yield for Falls Lake. The reliable yield for Falls Lake has declined from 68 mgd for the 50 year reoccurring drought to 66.1 mgd as of 2012. It is recommended that study of this issue continue to determine the source of the trend and to incorporate the potential results of the trend into future water resource planning.

Water quality in the Swift Creek lake system continues to be challenged by the influence of urbanization in the upper Swift Creek watershed. In the late 1980s and early 1990s, Wake County, Raleigh, Cary, Garner, and Apex jointly developed (with the North Carolina Division of Water Quality) and adopted the Swift Creek Land Management Plan as a guide to managing development in the watersheds of Lake Wheeler and Lake Benson so as to protect water quality in those existing or potential water supply reservoirs. The Wake County Board of Commissioners adopted the Swift Creek Land

Management Plan on April 19, 1990. Session Law 1998-192, adopted by the North Carolina General Assembly on October 22, 1998, prohibits Wake County (and other parties to the Plan) from adopting any development ordinance or granting any development permit that would be inconsistent with the standards and provisions of the Swift Creek Land Management Plan adopted on April 19, 1990.

In response to continued water quality challenges in Swift Creek, the EPA and the North Carolina Division of Water Quality (NC-DWQ) implemented a TMDL for the watershed that drains to Lake Wheeler on March 12, 2009. In 2013, several tributaries draining to Lake Benson were proposed for listing on the 303d list. The City continues to monitor water quality in both Swift Creek lakes. Trend analysis will determine if further protective action is required.

It is also important to note that the recent return to the Swift Creek Lake system as a water supply will impact their recreational use. Water levels at Lakes Benson and Wheeler will fluctuate with the demand of the customer base and the natural inflows to both reservoirs. This fluctuation is expected to range from zero to six feet from the top of the spillway. At approximately three feet below full elevation, trailer mounted boats will not be able to utilize the boat launches at Lake Wheeler and the lake will be closed to all but small, hand launched water craft. A communications plan has been developed to explain this change. In 2013, the City also began a boundary survey of both Lakes Benson and Wheeler to facilitate discussions with neighboring property owners who may have inadvertently encroached on City property. In 2014, the City will continue its efforts to restore and preserve water quality in Swift Creek.

Less visible than the water resources (but just as important), the City's water treatment facilities and water distribution system are also critical assets to our community. Although the new Dempsey E. Benton water treatment plant provides our water system with needed redundancy, the E.M. Johnson facility is aging and in need of rehabilitation and repair in the near future. While the City's water distribution system is fortunate to have as much as 60% of its 2,300 miles of pipe network installed after 1980, making the network relatively young; as much as 11% of the pipe network was installed before World War II (1941-1945) and is nearing the end of its useful life. Most of the this pipe is found in the central cores of the communities our utility serves and the cost to replace this pipe over the next 20-30 years is estimated to be more than $237 million. The E. M. Johnson WTP was constructed in 1967 and the facility has seen numerous expansions and upgrades over the 45 year timeframe. The components of a water treatment facility have various life cycles and much of the Johnson facility is in need of rehabilitation and repair. Significant rehabilitation and repair was previously scheduled to coincide with a planned expansion and upgrade of the facility necessary to address declining water quality in Falls Lake. With the advent of the Falls Lake Nutrient Management Strategy

and the results of new water conservation and efficiency, expansion has been delayed, but the repair and replacement component of the expansion project must be re-evaluated as necessary to insure the integrity of the facility.

Evolving Regulatory Expectations

Any new water resource project will be subject to a changing regulatory environment as the reach and complexity of the CWA, the ESA and the NEPA continue to evolve in light of new scientific data. Several recent or pending Federal and State actions and processes have already or will likely influence water resource option selection.

As an example, on June 21st, 2010, EPA Region 4 issued guidelines on water efficiency measures for water supply projects. These guidelines significantly reshaped water resource planning in the southeastern United States. The guidelines establish four sustainable water management practices that must be implemented to the "maximum extent practicable" before EPA would consider or approve new water resource alternatives. The first of those practices was defined as "effective management," which includes a description of how the utility has or will implement water consumption reduction goals, increase public understanding, involve water users in decisions and how it would use an integrated resource management approach. The second is defined as "pricing for efficiency," which is full cost pricing and conservation pricing. The third practice, "efficient water use," refers to leak detection and abatement, metering all water users, and a requirement for building codes to include the most efficient technologies, rain water harvesting, and landscaping to minimize water use. The final practice, "watershed approaches," refers to developing water budgets on a watershed scale, seeking opportunities for wetland restoration, groundwater recharge and reuse of graywater and reclaimed water. The water conservation and efficiency assumptions and goals within the City's water resource plan, as well as the tiered rate structure, were shaped or influenced by this EPA guidance document.

A second Federal process that may influence future water resource planning is the pending ESA listing work plan issued by the United States Fish and Wildlife Service (USFWS or Service). As a result of litigation and subsequent settlement with WildEarth Guardians and the Center for Biological Diversity, the USFWS established a court approved multi-year work plan to review 250 species on the 2010 threatened or endangered candidate notice for review of list; 75 of the species on the candidate list are known to exist or have existed in waters of North Carolina. Five in particular are native to the Little River and other waters of the piedmont. The outcome of this listing process could add additional species of concern. If this occurs, it will lead to new challenges to securing permits for projects that impact, directly or indirectly, waters those species habitat.

Finally, there is a North Carolina General Assembly directive to establish the flows in waters of the State necessary to maintain ecological integrity. In 2010, House Bill 1743 directed the Department of Environment and Natural Resources to develop hydrologic models for each river basin in North Carolina. An important part of this bill requires the department to determine the flows needed to maintain "ecological integrity" in surface waters. The bill further authorized the creation of a Science Advisory Board to assist the department in assessing these "ecological flows". A critical term in the enabling legislation is "all essential water uses", which includes a much broader suite of use such as "water needed to sustain human and animal life" and "a minimum amount of water necessary to support and sustain the economy of the State, region, or area."

The EFSAB provided its draft recommendation in November 2013. An important component of the recommendations includes a two part strategy that included a percentage-of-flow standard and a biological-response standard, designed preserve the magnitude, timing, frequency, duration, variability and rate of change of streams with and without human influence. The recommendation will result in negative impacts to new water resource permitting projects in away not envisioned or supported by the enabling legislation. The applied effect of new ecological flow criteria would be to reduce yields in some existing and proposed reservoirs and limit utilization of free flowing streams and rivers. Although the 2010 legislation specifically prohibits the use of the hydrologic models and their component ecological flows to impose any additional regulatory requirements related to water quality or water resources, requirements in the federal CWA and NEPA to use the best available science will have the practical effect of introducing State new permitting thresholds into any new water quality or water resource permitting process. In 2014 the City will comment on the potential impacts of the EFSAB recommendations.

Conclusion

As noted throughout this second water resource assessment, our current water sources are essential to the vitality, economic health and the very existence of our communities. Continued evaluations of our current and planned water resources will be a fundamental task of the Public Utilities Department. New water resource development is very difficult, making the protection of existing water resources even more important. Along with that protection will be the need to ensure aging infrastructure is maintained and replaced in a timely manner.