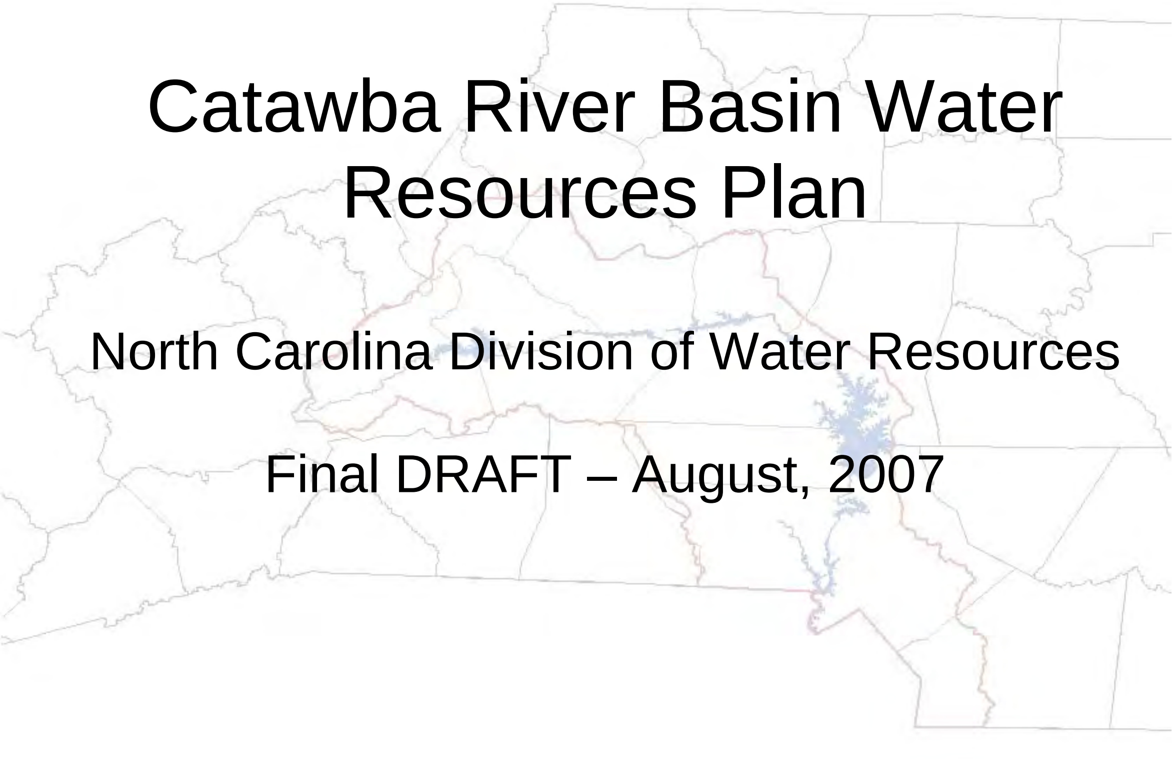
Catawba River Basin Water Resources Plan



North Carolina Division of Water Resources

Final DRAFT – August, 2007

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Executive Summary

The Catawba River Basin Water Resources Plan evaluates the present and future (2002 through 2050) conditions of this basin, in order to determine the water capacity of the Catawba River to serve future populations and at the same time to identify any potential trouble-spots or conflicts related to water supply and its demand. Chapter 2 begins with a look at the current and future conditions of each county located in the Catawba River basin in terms of population growth, land use, water use, and economic development.

Catawba River Basin in North Carolina provides water to eleven counties (located at least partially within the basin and which contains public water systems that rely on the basin for their water supply). Some of those counties include areas that have been experiencing very rapid population growth, like Charlotte Metropolitan Area. One point worth to be mentioned is that these River basin communities not only depend on the river for their water but also for their electricity. Section 2.2 describes the climatology and hydrology of the Catawba River basin and it covers the basic flow of the river, the reservoirs located on the river, stream flow characteristics and ground water characteristics, while the climatology of the basin is described through rainfall data, reservoir evaporation as well as a history of drought in the basin. The following section focuses on water supply and wastewater discharge in the basin. Each of the North Carolina drainage areas identified in the previous section is described in terms of which entities are making withdrawals and how these withdrawals have been projected to change during the period from 2010 to 2050. Section 2.4 focuses on Interbasin Transfer in the Catawba River basin and its future water transfer's projection, which includes transfer in and out of this River basin. The section following this one involves some issues that may impact water supplies: flood management and sedimentation in reservoirs.

Chapter 3 presents a simulation model description, with the model input information, assign basin plan demand to the model and observe response to the river system. Then it moves to the description of the drought management plan and data management necessary to cover the surface and groundwater sources. It starts by describing the CHEOPS model developed in order to test the potential responses of the river to future demands and then presents the results of these tests. For the Catawba Rive basin water supply plan, the CHEOPS model has been used to simulate long-term demand growth, using a base year of 2002 and projecting water demand toward the year 2050, and to figure out how demand will impact the entire river system. Demands from each water intake in the model are aggregated to each drainage area, or reservoir level, so are the return flows. Since the river system works as a unit, any unmet demand from one drainage area can be met from another drainage area. The model set ups were for the two general groups of baseline or existing conditions and demand, and future licensed conditions and projected demand. The projected demands have High, Low and

LWSP options for the projected decades of 2010, 2020 and 2050, with 2002 set up as baseline, resulting in 10 different scenarios for the reservoirs as a whole.

In the section about the summary of the model results, the Mutual Gain (MG) critical intake safe yield quantities are compared to the modeled net withdrawal data as output and input withdrawal data to determine the sustainability of the reservoirs for the future. The net withdrawal data have been averaged for the 75 years, and the difference between the input and output withdrawals are low.

At the demand–supply side, the demands for a scenario year are fixed throughout the 75 years of variable hydrology in order to determine the impacts on the reservoir system, while the water supply from the watershed for any year depends upon the hydrological condition of the watershed and the operational constraints determined by the hydrological conditions. The demands can be met fully or partially according to the simulated conditions. Therefore the surplus or shortage after the withdrawal varies over time and for the different demand options. The inclusion in the model of the LIP to simulate future operational conditions has the purpose of making the problems of the water supply be more manageable. For example, if at the beginning of the month the hydrological or storage condition becomes unfavorable or falls at or below certain trigger levels, the LIP stages would be triggered and that stage would remain in effect for the rest of the month for this particularly system. In summary, an earlier trigger can conserve water by maintaining lower storage levels for longer periods and thus any long severe drought can be avoided in the long run.

Last sections of the chapter 3 presents some of the reservoir outflow percentiles plots and the reservoir elevation plots, where both of them include daily data from the years 1954 and 2002 and compare to dry conditions, and ends describing Duke Energy’s drought contingency plans.

Chapter 1 - Introduction

The Catawba River begins in the western end of McDowell County, west of the Town of Old Fort. It flows in an easterly direction, forming part of the boundary between Caldwell and Burke Counties and the boundary between Alexander and Catawba Counties, along which it changes to a southerly direction. The River continues to form county boundaries as it flows southward, running between Iredell and Catawba Counties and along Mecklenburg County's borders with Lincoln and Gaston Counties. The River then continues on into South Carolina, where, after merging with several other rivers to become the Santee River, it eventually flows out to the Atlantic. Figure 1-1 shows the location of the river basin in North Carolina.

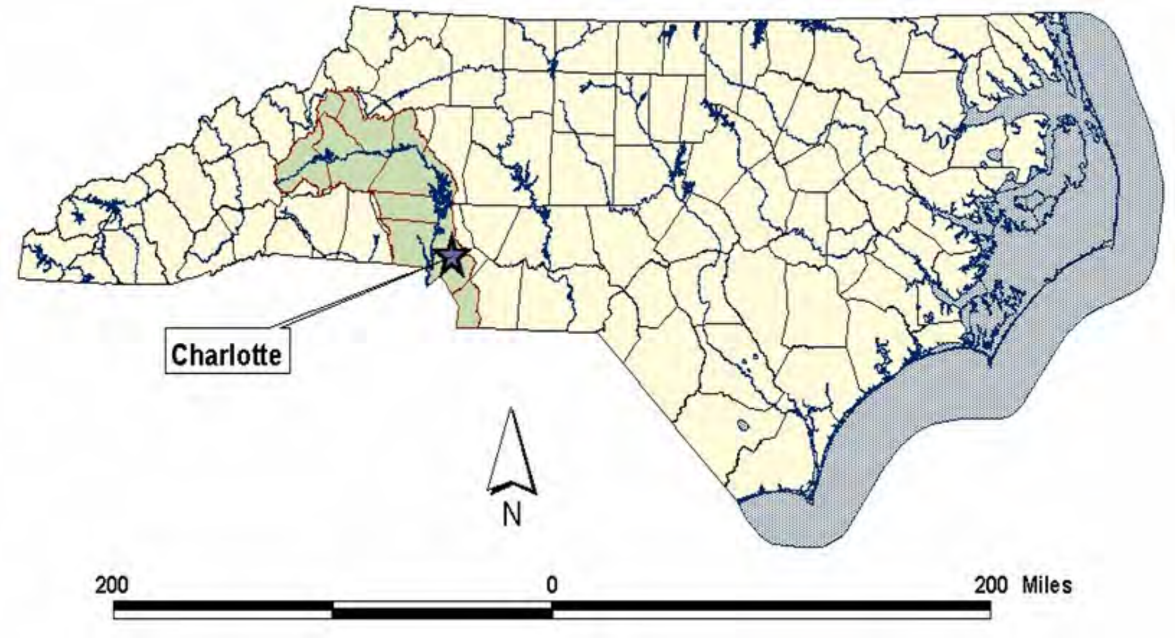

Figure 1-1: Catawba River Basin Location

The 3,279 square miles of the Catawba River Basin in North Carolina provides water to at least a portion of eleven counties (see Figure 1-2), which contain a number of urban areas, including Charlotte, Hickory, and Gastonia. These communities depend on the river not only for their water, but also for electricity. A network of 7 dams and their accompanying reservoirs are used as power sources, for hydropower and steam plants, sources of coolant, for coal-fired and nuclear power plants, and water sources, with intakes located in the reservoirs which serve a majority of the local communities.

The Catawba River Basin houses an area of North Carolina that is experiencing very rapid growth, namely in and around the Charlotte Metropolitan Area. Portions of Union and Gaston Counties have been projecting, and experiencing,

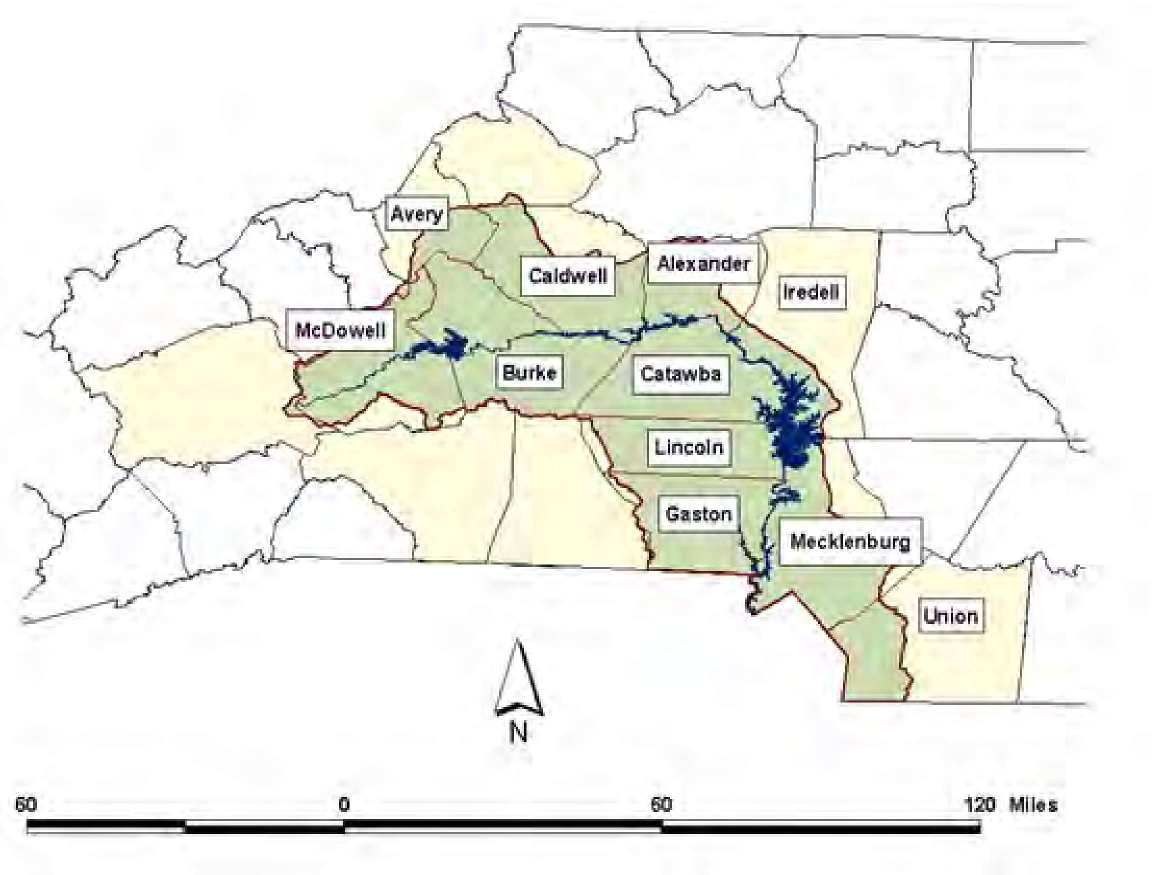

Figure 1-2: Counties in the Catawba River Basin

phenomenal increases in development. At the same time, much of the basin has been losing its industrial enterprises, with furniture manufacturing and textile plants being moved overseas. All of this adds up to a region that is changing rapidly, making a study of its water resources timely, if not imperative. Under way at this time as well is Duke Energy's[1] relicensing process. In 2008, Duke Energy's license to operate the dams on the Catawba River is due to expire, and consequently they are in the middle of a lengthy and complex relicensing effort for which they have completed a number of studies, including a Water Supply Study, which is cited occasionally throughout this report.

The purpose of this report is to elucidate the present and future conditions of this basin, in the process determining the capacity of the Catawba River to serve future populations and identifying any potential trouble-spots or conflicts. It begins with a look at the current and future conditions of each county at least partially located in the Catawba River basin in terms of population, land use, and economy. From there, it moves to a discussion of the water supply and wastewater discharge organized by drainage areas (see Figure 1-3), as defined by HDR[2] in Duke Energy's Water Supply Study. This discussion includes public

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[1] Former Duke Power

[2] Consultant

water systems, self-supplied industrial and residential entities, agricultural uses, interbasin transfer, and water used for electricity production. Water quality and other issues that may affect water supply are briefly touched upon, following which is an exploration of any future water resources that may need to be identified. The following section describes the CHEOPS model developed in order to test the potential responses of the river to future demands and presents the results of these tests, and gives a brief description of the implementation of drought management plan in the reservoir systems and necessary data management needs for better aerial coverage.

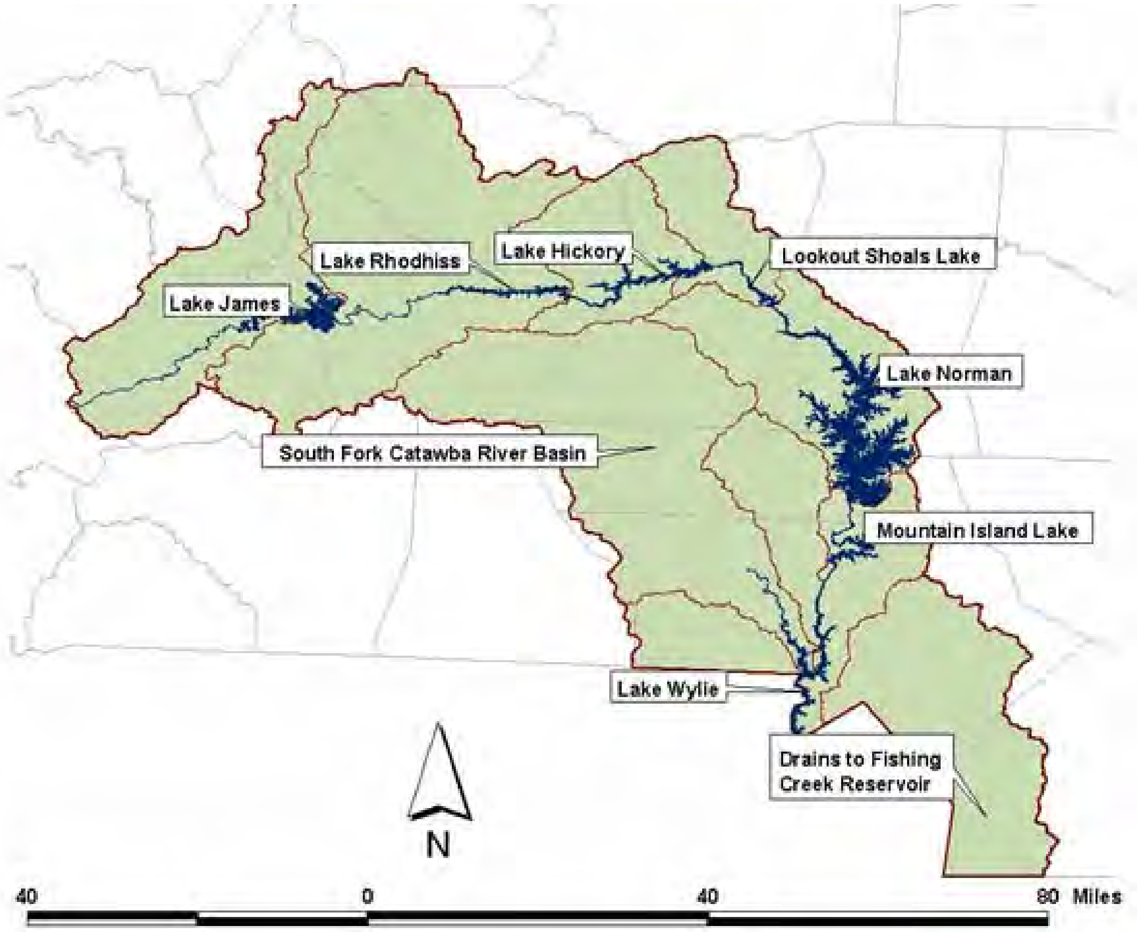

Figure 1-3: Catawba River Lakes and Associated Drainage Areas

Chapter 2 - Existing Water Resources Situation

The purpose of this section is to outline the current state of the Catawba River basin. It begins with a description of each county located at least partially within the basin and which contains public water systems that rely on the basin for their water supply. These descriptions highlight issues surrounding population, economic development, land use, and coverage by water supply systems. The current population of the county as well as population projections, both for the county as a whole and for each of the public water systems located within the county, and economic development projections are provided from a variety of sources.

The next section is a description of the climatology and hydrology of the Catawba River basin. The description of the hydrology of the basin covers the basic flow of the river, the reservoirs located on the river, stream flow characteristics, and ground water characteristics. The climatology of the basin is described through precipitation data as well as a history of drought in the basin.

The following section focuses on water demand and wastewater discharge in the basin. Each of the North Carolina drainage areas identified in the previous section is described in terms of which entities are making withdrawals and how these withdrawals have been projected to change during the period from 2010 to 2050. Using this information, the discharges to and from each drainage area are similarly characterized.

The next two sections focus on particular types of withdrawals and discharges. The first is on interbasin transfers, water withdrawn from one basin for use and eventual discharge in another.

Section 2.1 County Summaries

(a) McDowell County

In the northwest corner of the Catawba River basin (Figure 2-1), McDowell County houses the river's headwaters. According to the North Carolina Division of Water Quality's Catawba River Basinwide Water Quality Plan, approximately 86% of the County is located inside the Catawba River basin (1999). The first in a series of reservoirs along the Catawba River, Lake James, originates in McDowell County and shares a portion of the county line with Burke County.

The Town of Old Fort and the City of Marion are the only two municipalities in McDowell County. The smaller of the two, the Town of Old Fort, is located in the eastern portion of the County along the Catawba River and has an estimated 2004 population of 975. The City of Marion is located near the intersection of US-70 and US-221, just south of the Catawba River near the western shoreline of Lake James and has an estimated 2004 population of 4,975 (U.S. Census Bureau).

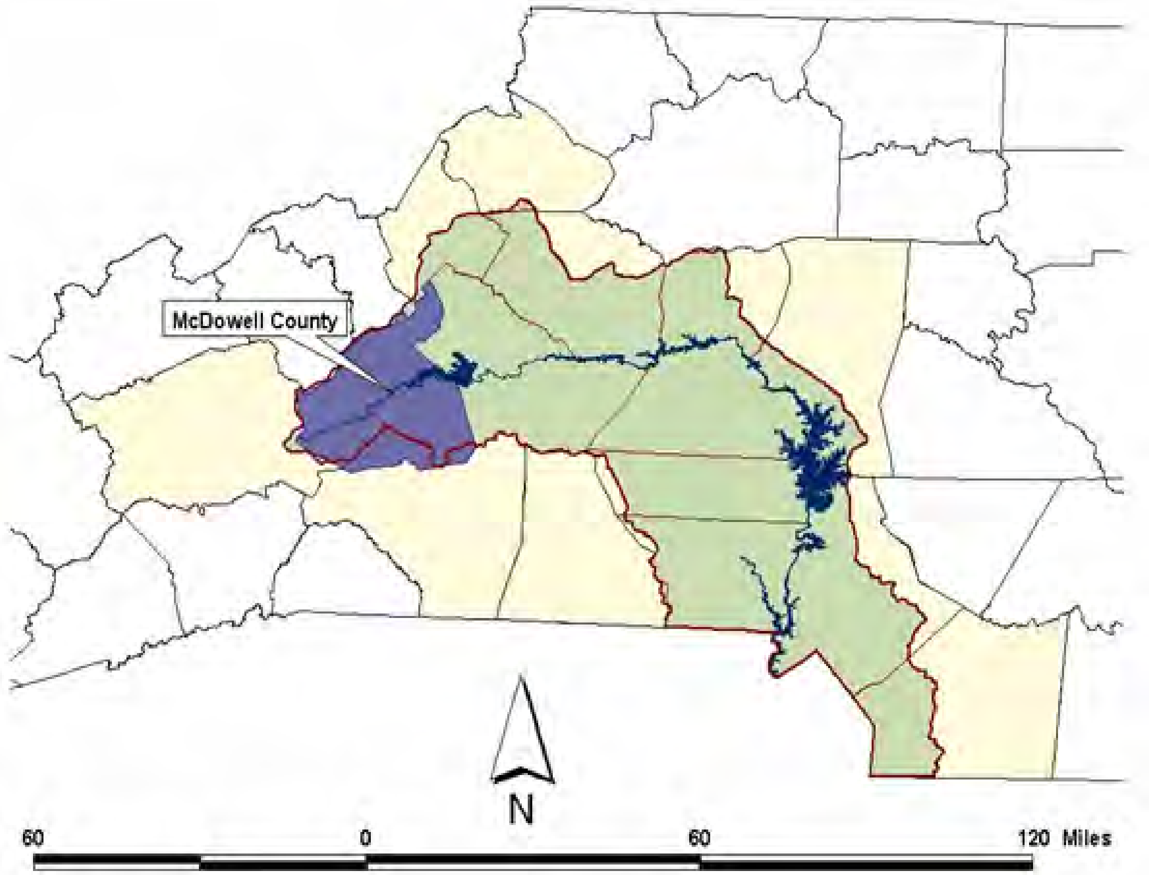

Figure 2-1: McDowell County Location

The majority of the northwestern part of the County falls within the Pisgah National Forest's borders, which run diagonally through the county, through the Town of

Old Fort, just north of the City of Marion (U.S. Forest Service). The total acreage of the County is 282,688 (North Carolina Department of Agriculture and Consumer Services 2002), with 70,914 acres located in the Pisgah National Forest (U.S. Forest Service 2004). According to the North Carolina Department of Agriculture 2002 Census of Agriculture, there were 24,441 acres of farmland in McDowell County in 2002, of which only 5,589 acres were harvested cropland (North Carolina Department of Agriculture and Consumer Services 2002).

The Comprehensive Economic Development Strategy for the Isothermal Planning Region, which includes McDowell County, notes that, unlike other regions in the state, manufacturing has decreased, while service sector employment has not increased significantly (Center for Regional Economic Competitiveness 2005, 1). The local economy in McDowell County is heavily reliant on the manufacturing industry, which employed 42.8% of the County's workforce, during the second quarter of 2005. From the beginning of 2004 through May of 2005, employment opportunities appeared to be on a downward trend. From January through May of 2005, two employers announced a total of 520 job losses (North Carolina Department of Commerce 2005).

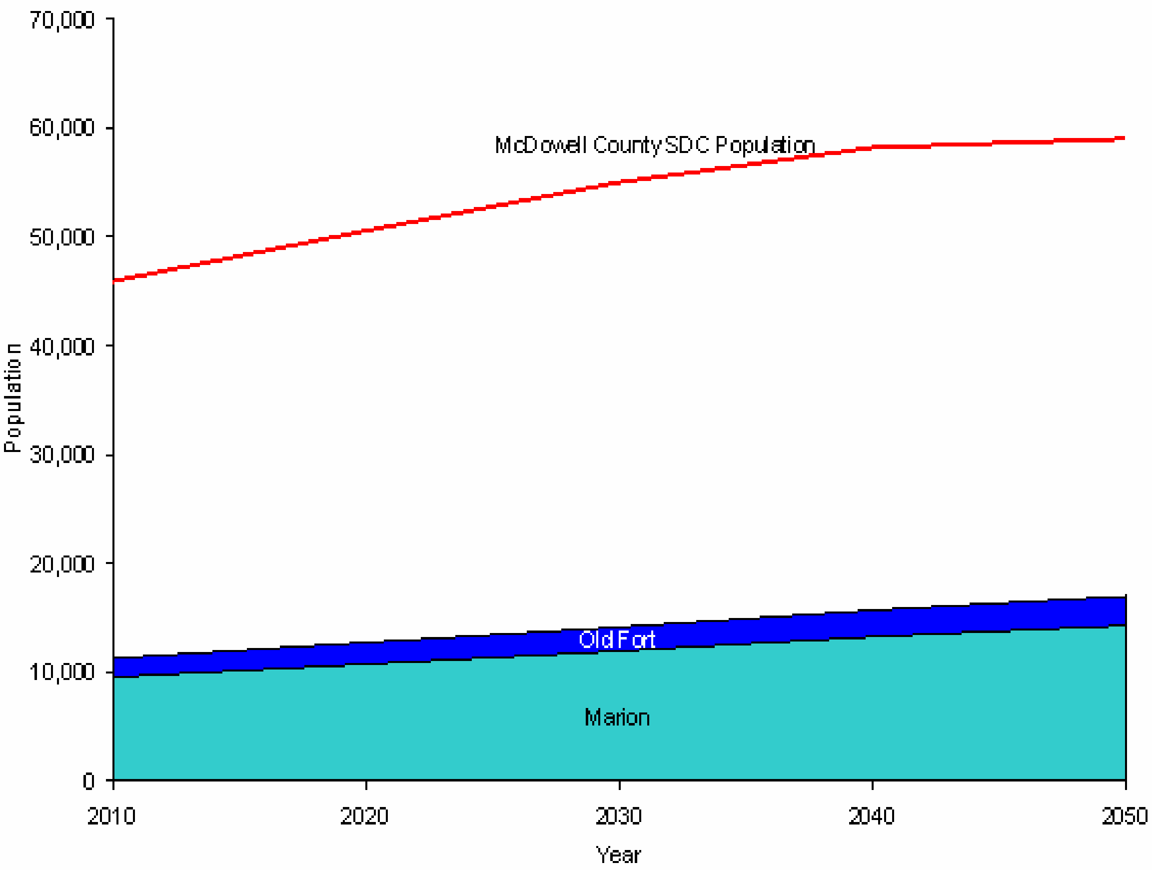

Figure 2-2: SDC Projection vs. LWSP Projections

The population in McDowell County is expected to steadily rise through 2050[3] (see Figure 2-2) (North Carolina State Data Center). The Town of Old Fort anticipates a population increase from 1,740 people in 2010 to 2,700 by the year 2050. The City of Marion expects a slightly higher population growth from 9,510 people in 2010 to 14,270 by 2050.

Most of the areas north and south of US-70 in McDowell County fall within the City of Marion and the Town of Old Fort's water service areas. A small community water system, Little Switzerland, is located in the northwestern portion of the County; however, it is not within the Catawba River basin and therefore not discussed in this report.

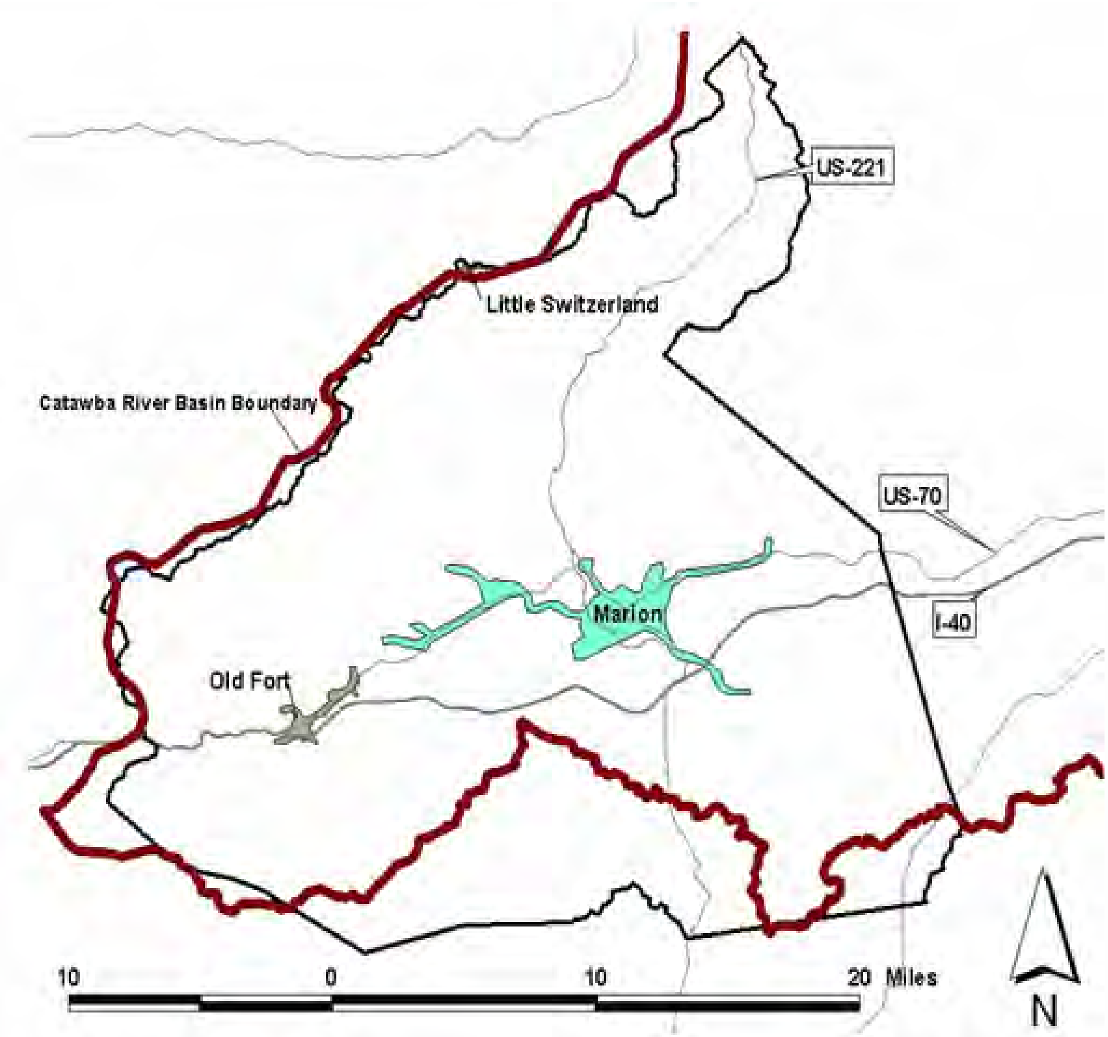

Figure 2-3: McDowell County 1997 Community Water System Service Areas

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[3] The North Carolina State Data Center (SDC) only calculated population projections through 2030. For a description of how they were extended, see Appendix B.

(b) Avery County

Avery County is located in the northeastern corner of the Catawba River Basin (See Figure 2-4). It is a rural county and has a population density of only 69.5 people per square mile (Avery – Banner Elk Chamber of Commerce). Avery County is fairly mountainous, boasting famous peaks such as Grandfather and Sugar Mountains, and claims both the highest county seat and the highest incorporated town in the Eastern United States (Avery – Banner Elk Chamber of Commerce). Banner Elk and Newland are the two largest towns in the county; however, in the year 2000, neither of their populations topped 1,000 (US Census Bureau 2000).

According to the 2002 Census of Agriculture, 30,614 acres of the County's 158,093 acres were considered farmland, with 9,963 acres of harvested cropland (NC Department of Agriculture and Consumer Services). Also, 28,369 acres of the Pisgah National Forest is within Avery County (U.S. Forest Service 2004).

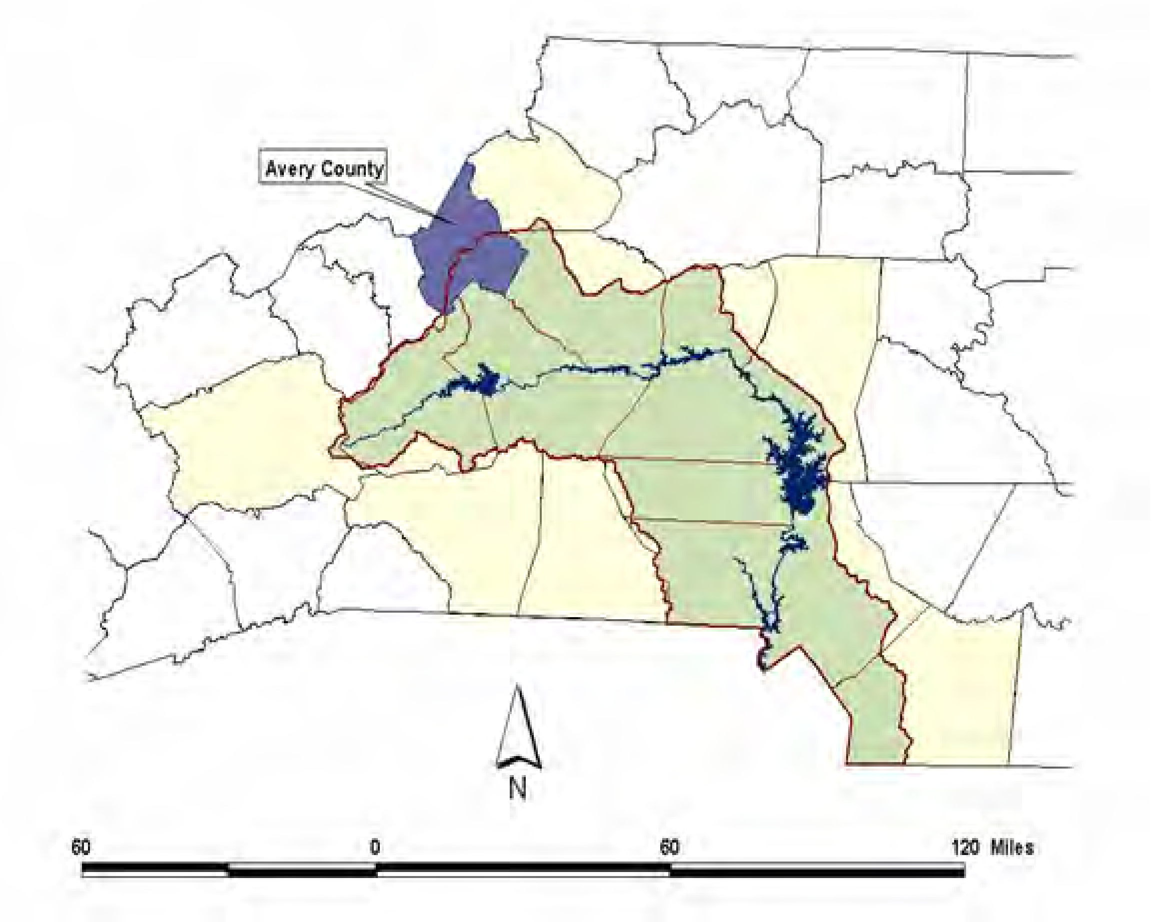

Figure 2-4: Avery County Location

Figure 2-5 compares the population growth projection by the State Data Center (SDC) for Avery County and the population growth projected for the only community water system (Linville Land Harbor) in the County that lies within the

Catawba River basin. The State Data Center projection for the county shows the population rising slightly and then beginning to fall between 2040 and 2050[4]. The Linville Land Harbor community water system's 2002 Local Water Supply Plan (LWSP) included two different population projections, one with the seasonal population and one without. The population projection represented in Figure 2-5 is the year-round population, which does not include the seasonal population. The service area population for this system is expected to remain constant: 440 persons year round, increasing seasonally to 2,340 people.

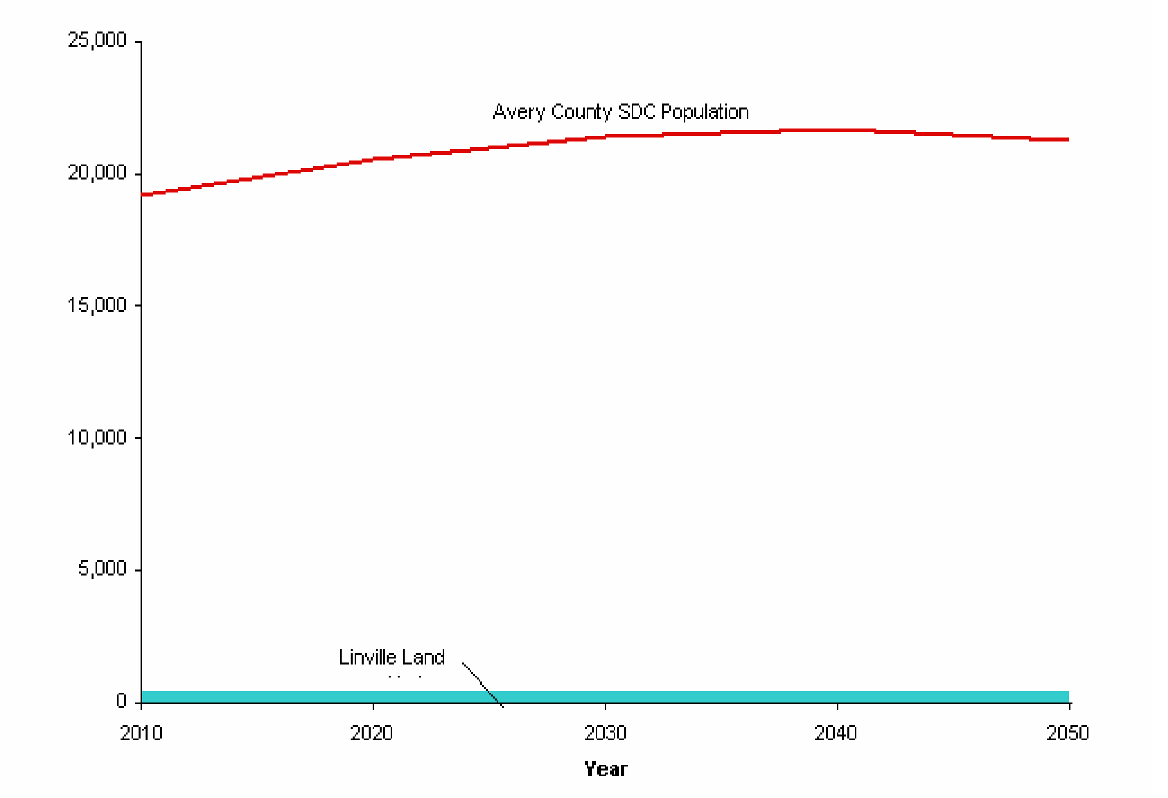

Figure 2-5: SDC Projection vs. LWSP Projection

In terms of industry, the two largest employment sectors in Avery County, as of the third quarter in 2005, were Health Care and Social Assistance at 19.1% and Accommodation and Food Services accounting for 13.5% of the County's employment (North Carolina Department of Commerce 2005).

Only 35% of Avery County is located within the Catawba River basin (North Carolina Division of Water Quality 1999), and only one community water system discharges into the basin. There are no systems in the County that withdraw water from the Catawba River basin. The Linville Land Harbor community water system withdraws groundwater and then discharges its wastewater to the Linville River, a tributary to the Catawba River.

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[4] The North Carolina SDC only calculated population projections through 2030. For a description of how they were extended, see Appendix B.

(c) Burke County

Burke County is one of only two counties that fall entirely within the Catawba River basin (Figure 2-6) (North Carolina Division of Water Quality 1999). Along with Alexander, Caldwell, and Catawba counties it forms part of the Hickory Metropolitan Statistical Area, also known as the Unifour Region. A portion of Lake James is located in the western part of the County. Lake Rhodhiss runs along the northeastern edge of the County and forms part of the boundary between Burke and Caldwell Counties. The City of Morganton, the County seat, is by far the largest city in the County with 17,310 residents estimated in 2004 (US Census Bureau). The towns of Valdese and Drexel are the next largest municipalities with estimated 2004 populations of 4,485 and 1,938, respectively (US Census Bureau). Other smaller towns in the County include Glen Alpine, Rutherford College, and Connelly Springs.

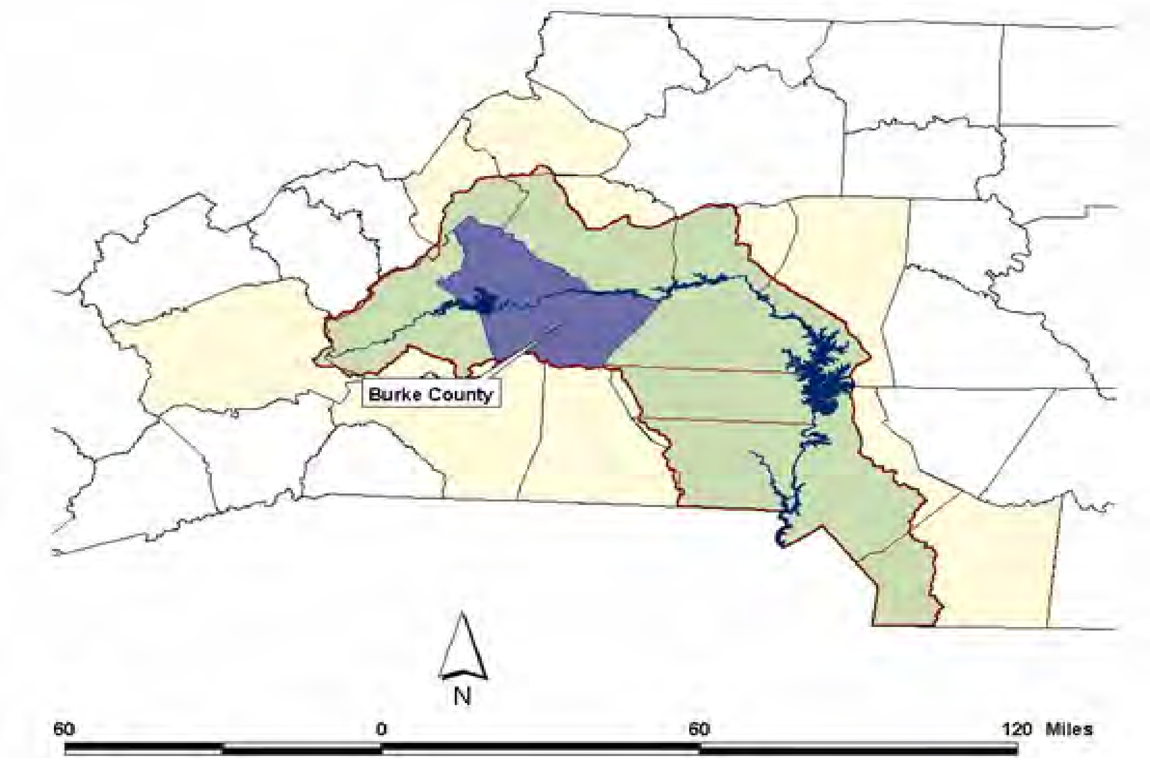

Figure 2-6: Burke County Location

The period between 1990 and 1999 was a dynamic decade for growth in the Unifour Region. Approximately 21,670 new jobs were created in the region, resulting in a large migration to the region and a shift in the focus of the regional economy. The 2002 report "Blueprint Burke" estimated that over 75% of the growth in Burke County alone "was the direct result of net in-migration". Burke County's growth rate of 18% during the 1990's was quadruple that of the 1980's, 4.5% (Burke County Strategic Planning Committee 2002, 2). Approximately 10 percent (32,037 acres) of Burke County's 324,320 acres were considered farmland in 2002 and, of that; 11,181 acres were harvested cropland (North Carolina Department of Agriculture and Consumer Services 2002).

Service producing jobs overtook goods producing jobs during the 1990's. In 1993 there were 1,392 more goods producing jobs than there were service jobs. By the year 2000, service producing jobs made up 56.7% of the County's workforce, surpassing the number of goods producing jobs by 5,670 (Burke County Strategic Planning Committee 2002, 3). As of July 2005, the manufacturing industry was the largest employment sector in the County with 10,663 employees accounting for 31.5% of the total workforce. The next largest employment sector was Health Care and Social Assistance, whose 6,903 employees make up 20.4% of the total workforce (North Carolina Department of Commerce 2005). Population projections from the North Carolina State Data Center (SDC) show population growth projections steadily rising through 2030 (North Carolina State Data Center 2005). An extension of these projections to the year 2050 show a leveling off of population growth after 2040, as the County's population approaches 140,000[5]. Local water suppliers, however, see the County's population continuing to grow, without any leveling off through the year 2050 (Figure 2-7). The population projections provided in the Local Water Supply Plans (LWSPs) do not come near to the SDC projections for the entire County.

As seen in Figure 2-8 the City of Hickory, The Town of Long View, The Town of Rhodhiss, and Baton Water Corporation also provided water to small portions of Burke County according to 1997 LWSP data. However, the service areas for each of these systems are located in more than one county and it is impossible to determine how much of their service population, reported in their LWSPs, is located in each county. For the purposes of this report, population numbers from the aforementioned seven water systems were not used for calculating the population served by local public water systems in the County. Instead, LWSP population figures are included in the sections of this report relating to the County in which the majority of a system's population resides. The Brentwood Water Authority and the Brentwood Water Corporation are not represented in Figure 2-8, because they did not submit Local Water Supply Plans for 1997.

Of all the public water supply systems in Burke County, only three (the City of Morganton, the Town of Valdese, and the City of Hickory) withdraw surface water directly from the Catawba River basin. The rest of the community water systems purchase water from at least one of the three. The City of Morganton, the Town of Valdese, and the City of Hickory also have the only community water systems that return wastewater through their own wastewater treatment plants. Burke County and the Town of Drexel return wastewater via the Town of Valdese and the City of Hickory's wastewater treatment facilities. The remaining water systems primarily rely on septic systems for wastewater disposal.

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[5] The North Carolina SDC only calculated population projections through 2030. For a description of how they were extended, see Appendix - B.

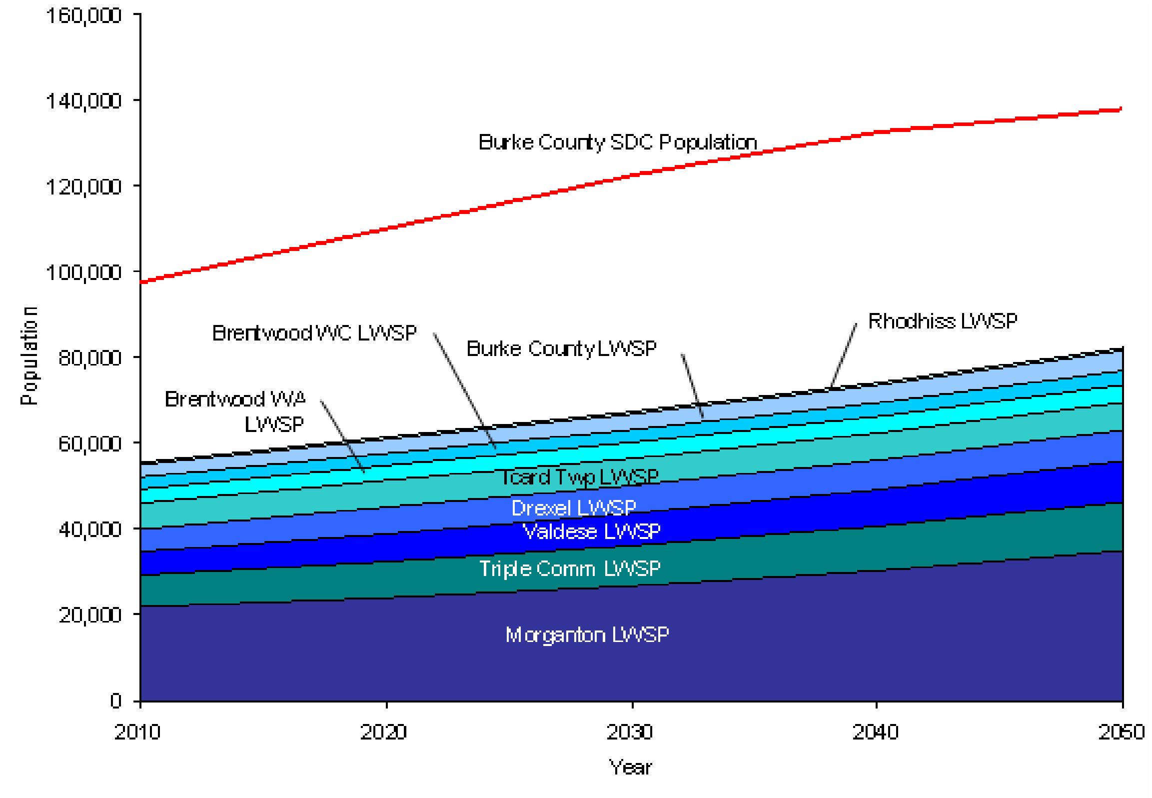

Figure 2-7: SDC Projection vs. LWSP Projections

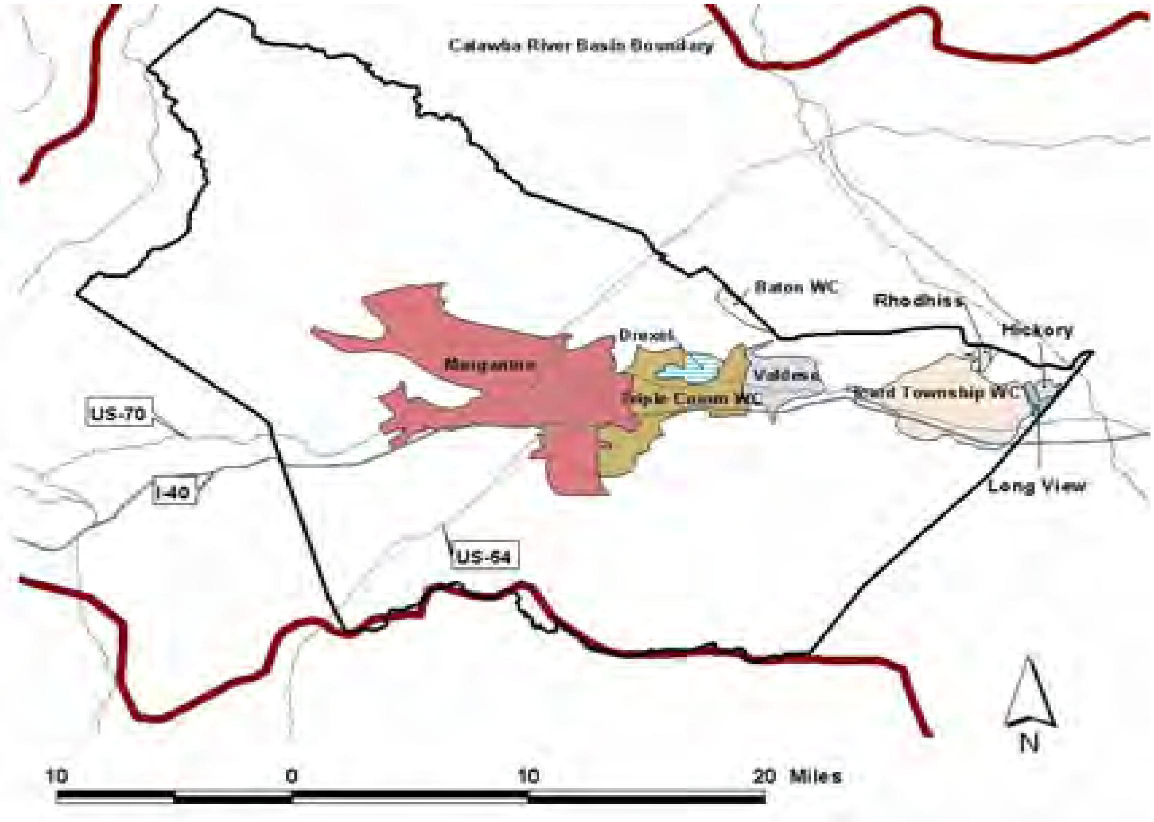

Figure 2-8: Burke County 1997 Community Water System Service Areas

(d) Caldwell County

Caldwell County is located in the north-central portion of the Catawba River basin (Figure 2-9). The river itself forms the southernmost border of the County, Lake Rhodhiss runs along its southwestern edge and Lake Hickory begins on southeastern edge of the County. According to the North Carolina Division of Water Quality's Catawba River Basinwide Water Quality Plan, approximately 75% of the County is located within the Catawba River basin (1999). The municipalities in Caldwell County are clustered in the southern and western portions of the County along US-321 and US-64, respectively. Of the seven municipalities in the County, only the City of Lenoir has a population of over 10,000 (17,943 (2004 estimate)); the next largest is the Town of Sawmills with a 2004 population estimate of 4,933 (US Census Bureau). Since the City of Hickory is adjacent to the southeastern border of Caldwell County, the County is considered part of the Hickory Metropolitan Statistical Area (MSA).

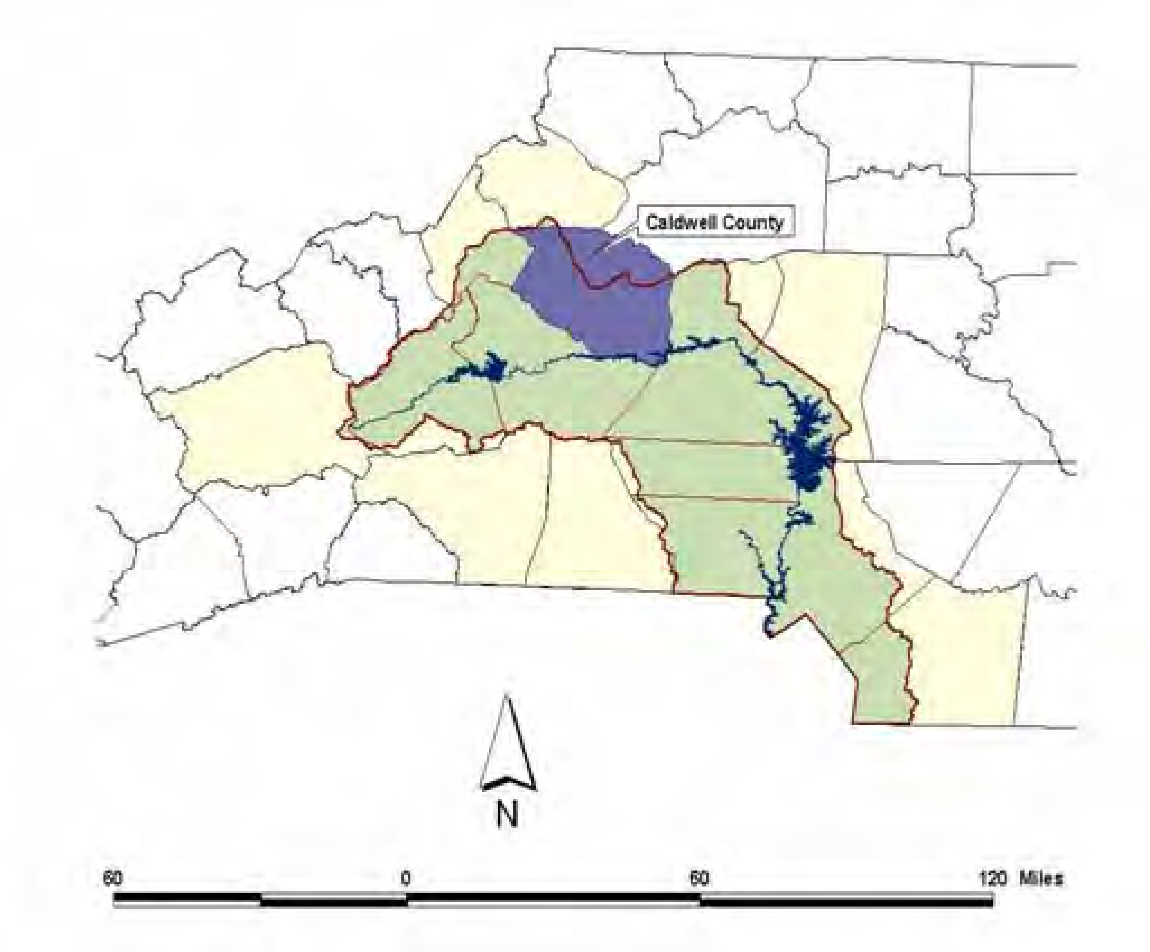

Figure 2-9: Caldwell County Location

The County, as a whole, encompasses 301,875 acres. In 2002, there were 411 farms covering 34,918 acres (North Carolina Department of Agriculture and Consumer Services 2002). According to the Western Piedmont Labor Area

Industry Growth Analysis, minimal industrial growth has been recorded; in fact, a net decline in industrial activities throughout the County has been noted (Western Piedmont Council of Governments 2004). In July of 2005, the North Carolina Department of Commerce estimated that only 352 employers in the County could be classified as goods producing, compared to the 1,102 service producing employers. However, even with fewer employers, the manufacturing industry employs the most people with 10,803 employees. Retail is the second largest industry in the County with 2,857 employees (North Carolina Department of Commerce 2005).

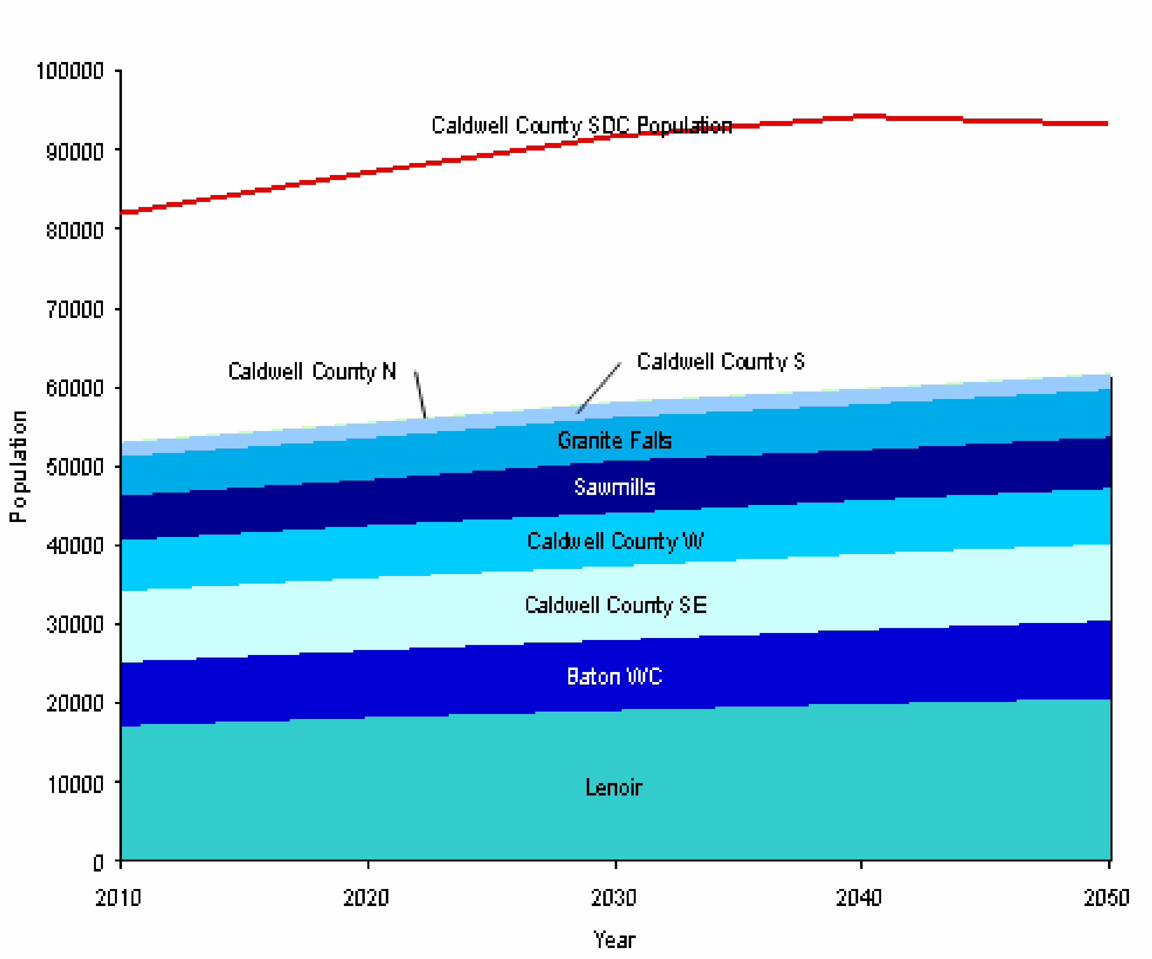

Figure 2-10: SDC Projections vs. LWSP Projections

From 1990 to 2000, population in the County increased from 70,809 to 77,415, and in July of 2005 population was estimated at 78,816 (North Carolina Department of Commerce 2005). Figure 2-10 is a chart comparing the projected service area populations in Local Water Supply Plans (LWSPs) to the projected County population from the North Carolina State Data Center (SDC). The LWSP population projections show a slow total increase in expected service area populations, while the total County population begins to level off around 2040 and actually decreases between the years 2040 and 2050, from 94,240 to 93,248[6] (North Carolina State Data Center).

Most of the community water system service areas are located in the County's southern half (Figure 2-11). A very small area in the northern portion of the County is served by the Town of Blowing Rock, which obtains its water from the New River. The remaining community water systems in the County obtain all of their water from within the Catawba River basin. It is significant to mention here that there has been some movement recently in the County to develop the Yadkin River as a potential future water supply source. A description of the Caldwell County Yadkin Reservoir Project, on the Caldwell County website, notes that "considering all of the existing and potential problems with the Catawba River, Caldwell County's current administration believes that it is prudent to begin the efforts to develop a second supply of drinking water for the county." The County has already received a $20,000 grant to complete the Environmental Assessment for the project. Plans for the project include the Yadkin River becoming the primary drinking water supply source for the part of the County that lies within the Yadkin River basin and for the river to also serve as a reliable backup supply of drinking water for the rest of the County (Caldwell County).

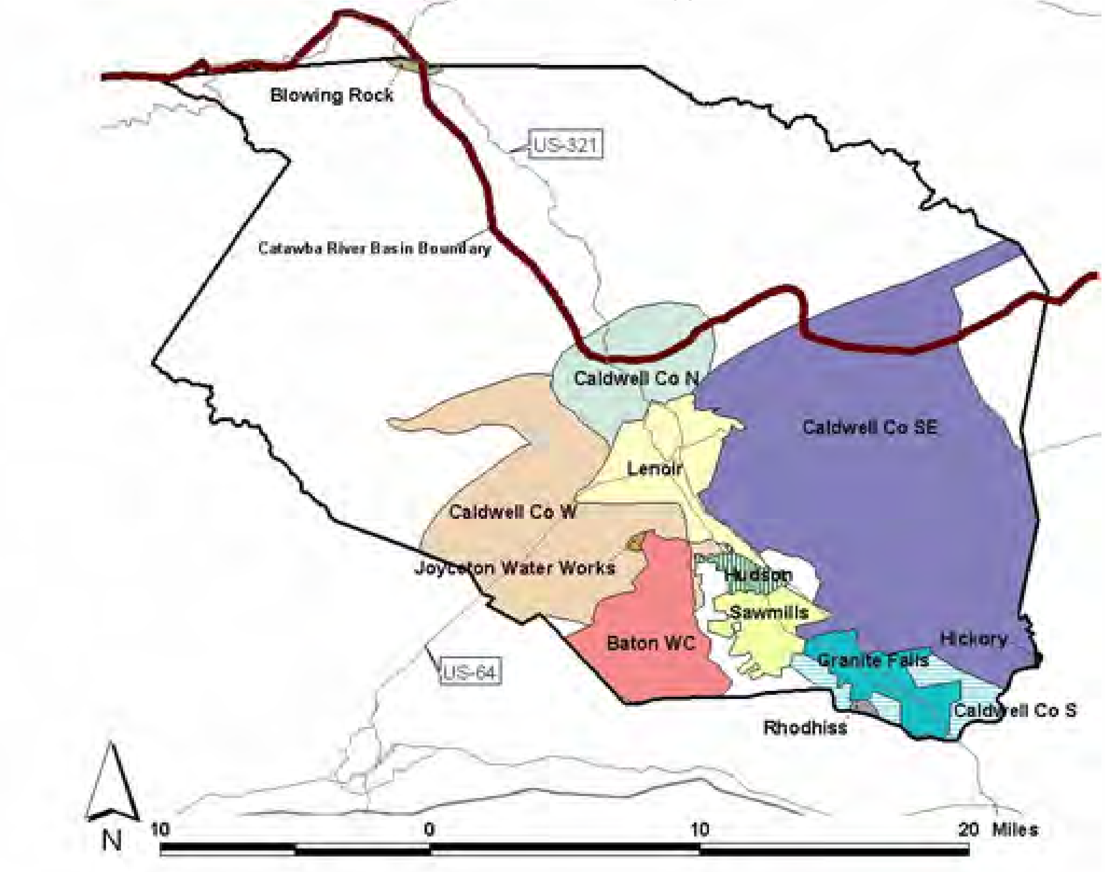

Figure 2-11: Caldwell County 1997 Community Water System Service Areas

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[6] The North Carolina SDC only projected populations to 2030. For a discussion of the methodology we used in extending these projections, please see Appendix B.

(e) Alexander County

Alexander County is positioned in the northwest corner of the Catawba River basin (Figure 2-12). According to the North Carolina Division of Water Quality Catawba River Basinwide Water Quality Plan, an estimated 68% of the County's land area falls within the Catawba River basin (1999). It is considered part of the Hickory Metropolitan Statistical Area (MSA) (along with Burke, Caldwell, and Catawba Counties) and is a member of the Western Piedmont Council of Governments. The Town of Taylorsville, situated in the center of the County, is the largest town in the County with a population of 1,837 in the year 2004 (US Census Bureau). Other small towns in the county include Bethlehem (located in the southwestern portion of the county), Hiddenite, and Stony Point (both located in the eastern central portion of the county).

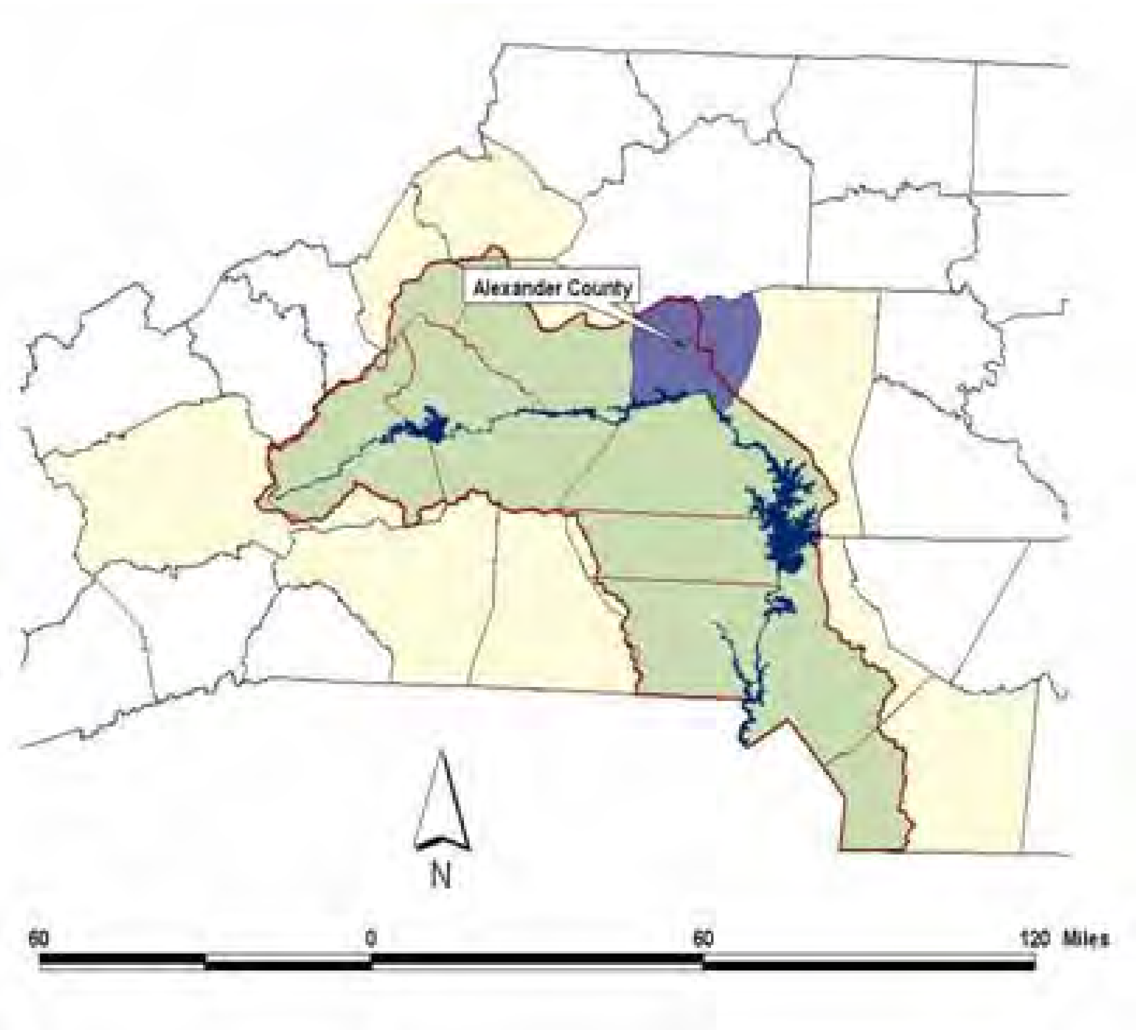

Figure 2-12: Alexander County Location

Alexander County could be considered rural, approximately two-thirds of its area is given over to agriculture, producing mainly “poultry, dairy, tobacco, apples, forestry products, grain crops, and beef cattle” (Charlotte Regional Partnership 2004). According to the 2002 Census of Agriculture, conducted by the North Carolina Division of Agriculture, 58,366 of Alexander County’s 166,611 acres were considered farmland, 17,436 acres of which were harvested cropland (North Carolina Department of Agriculture and Consumer Services 2002).

The County’s largest employment sector is manufacturing and includes textiles, furniture, apparel, paper products, electrical components, and lumber products (Charlotte Regional Partnership 2004). As of the third quarter of 2005, the manufacturing sector employed 570,924 people, 91,236 more than the next largest sector, Health Care and Social Assistance (North Carolina Department of Commerce 2005).

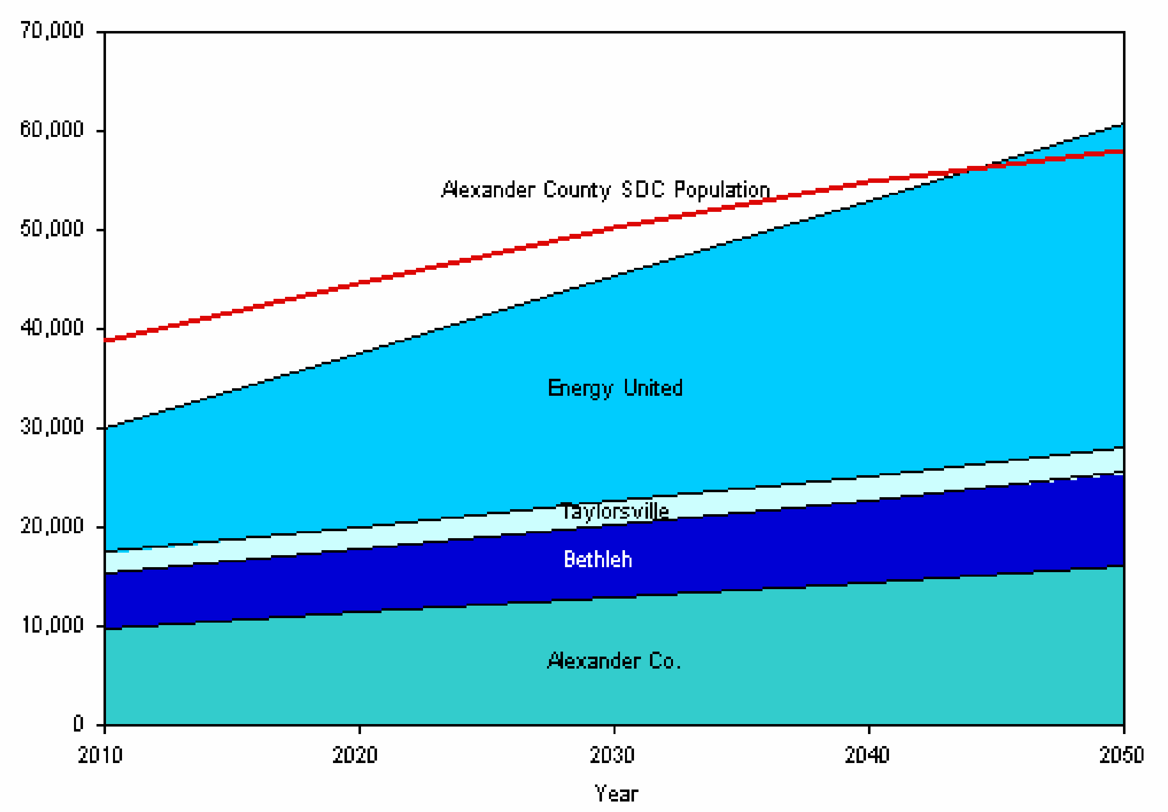

Figure 2-13: SDC Projection vs. LWSP Projections

In terms of population, the North Carolina State Data Center (SDC) portrays the County growing at a seemingly steady rate (Figure 2-13), reaching 50,223 by the year 2030. Extending this projection to 2050, Alexander County could potentially grow to a population of almost 62,000[7]. Figure 2-13 compares the SDC projections to the stacked population projections provided by community water

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[7] The North Carolina OSP only calculated population projections through 2030. For a description of how they were extended, see Appendix B.

systems in their Local Water Supply Plans (LWSPs). By the year 2050, the stacked population projections exceed those from the SDC, which is problematic in that the stacked population projections from the LWSPs are not meant to represent the entire County population, only those purchasing water from one of the community water systems. Also, the portion of the County served by the City of Hickory's water supply system is not included, since its service area straddles Alexander and Catawba Counties (Figure 2-14). It would be impossible to separate the number of people served in Alexander County from the majority of the City of Hickory's service population located in Catawba County.

In terms of industry, growth is more difficult to quantify. According to the Western Piedmont Council of Governments, employment in the 12 county region that it represents peaked in 1994 and has been declining ever since (Center for Regional Economic Competitiveness 2003, 3). Between January 2001 and December 2003, the four counties composing the Hickory MSA reportedly lost more than 20,000 jobs (Western Piedmont Council of Governments 2004, 13).

The Western Piedmont Labor Area (Hickory MSA) Industry Growth Analysis did identify several industrial sectors already present in the region that are predicted to grow nationally, including wood products (wood container and pallet manufacturing), plastics, and motor vehicle-related industries (2004, 5). Service sector industries are also projected to grow in the region, although these positions do not tend to pay as well as the manufacturing positions (3). More specifically, in June of 2005 it was announced that Paragon Films, "a major producer of plastic film", will be locating a new manufacturing operation in Alexander County (Herman 2005). The 40,000 square foot facility will initially create 25 new jobs, with more expected as the company moves through its planned expansions (Herman 2005).

Five community water supply systems that serve the residents of Alexander County submitted LWSPs indicating that all but one withdraw a portion of their water from the Catawba River. The Alexander County Highway 16 and Town of Bethlehem systems purchase all of their water from the City of Hickory, which draws all of its water from the Catawba River. The Town of Taylorsville system buys approximately half of its water supply from the City of Hickory and the rest is purchased from the Energy United system. The Energy United system withdraws all of its water from the South Yadkin River[8]. The City of Hickory system provides water to a small section of southwestern Alexander County.

The service areas for each of these systems have been mapped, as shown in Figure 2-14 (1997 LWSP data). The Sugar Loaf system shown in Figure 2-14 was not mentioned above, because they did not submit a LWSP in 2002.

The Town of Taylorsville currently has the only system that treats and disposes of its own wastewater. It is also the only system in Alexander County with a majority

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[8] It should be noted that in 2002 Energy United did purchase a small amount of its water from Alexander County, however it noted in its LWSP that this source would no longer be available due to high fees.

of customers (approximately 92%) connected to a sewer system. The Town of Bethlehem and Alexander County Highway 16 systems send their wastewater to the Hickory wastewater treatment plant, although most of their water customers utilize septic tanks.

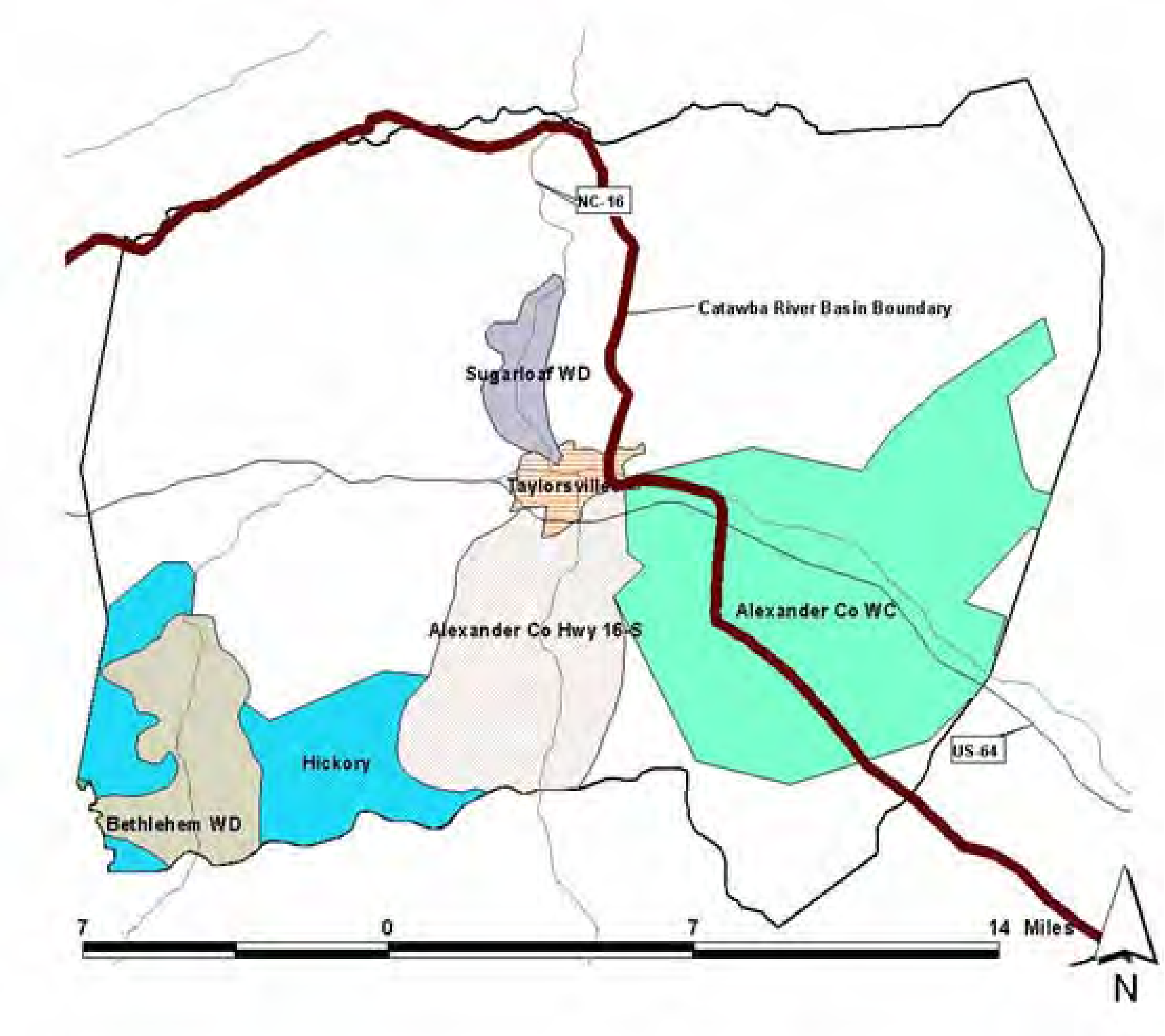

Figure 2-14: Alexander County 1997 Community Water System Service Areas

(f) Catawba County

Catawba County is one of two counties that falls entirely within the Catawba River basin (Figure 2-15) and is home to the City of Hickory. The City of Hickory is one of the largest cities in the basin and has become a regional hub, anchoring the four-county Hickory Metropolitan Statistical Area (MSA). It also has the largest population in the County, which in 2004 was estimated at 40,112. The second largest city in Catawba County is the City of Newton, with an estimated population in 2004 of 12,881 (U.S. Census Bureau 2004). The Catawba River serves as the County's northern and eastern borders with Caldwell, Alexander, and Iredell Counties. To its west and south, the County shares borders with Burke and Lincoln Counties, respectively. Lake Hickory is located along a portion of the border with Caldwell and Alexander Counties and the upper reaches of Lake Norman are located along the southeastern border with Iredell County (Figure 2.15).

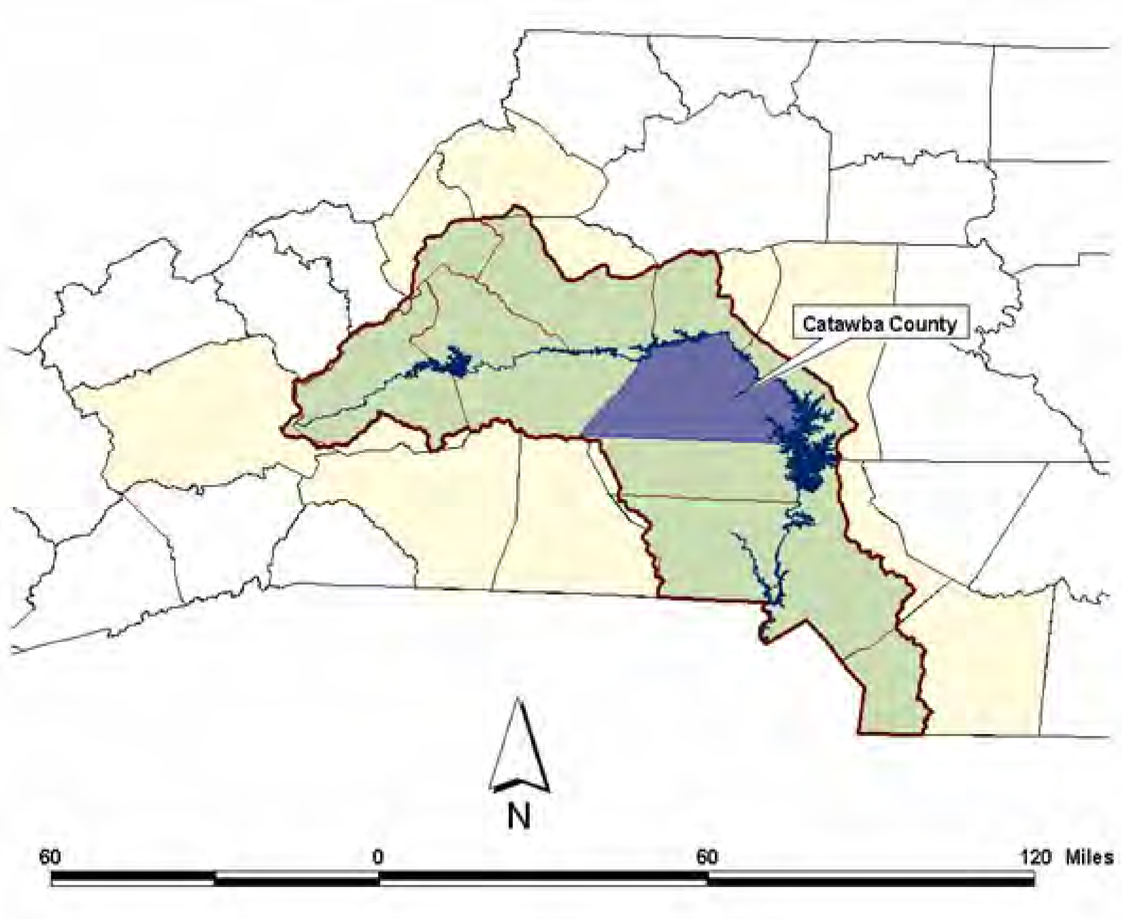

Figure 2-15: Catawba County Location

In the early 1990s, it was estimated that the County contained more than 20,000 acres of agricultural land and more than 115,000 acres of timberland (Benchmark

Incorporated 1999, 2). The North Carolina Department of Agriculture reported in 2002 that the County contained 78,516 acres of farmland, 26,949 acres of which were harvested cropland (North Carolina Department of Agriculture and Consumer Services 2002).

In terms of growth potential, in 1999, the Catawba County Strategic Growth Plan identified the southeastern portion of the County as its fastest growing region (Benchmark Incorporated 1999, 7). Much of this development was attributed to lakeside development along Lake Norman.

As with other counties belonging to the Hickory MSA, the 1990s were a period of economic growth that was followed by several years of economic decline. Between 1990 and 2001, Catawba County gained 16,679 new jobs throughout a variety of manufacturing and service sectors. Then, between 2001 and 2003, 12,601 jobs were lost (Catawba County 2004). Between April 2002 and December 2003, the manufacturing industry experienced the only mass layoff in the County, reporting 713 separations. Nevertheless, the manufacturing industry continues to have the most employees in the County, employing 29,838 people in 2005. The retail industry comes in second with 10,499 employees (North Carolina Department of Commerce 2005).

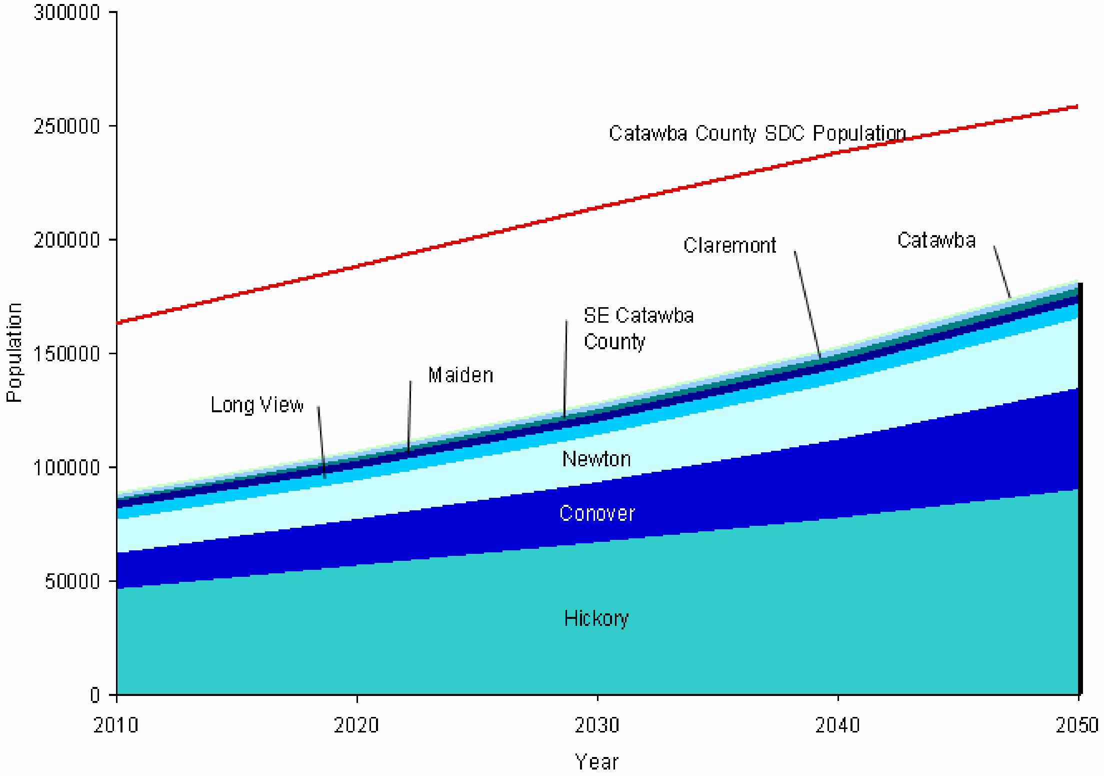

Figure 2-16: SDC Projections vs. LWSP Projections

The North Carolina State Data Center (SDC) is projecting relatively steady growth (Figure 2-16) for Catawba County[9]. Likewise, the Local Water Supply Plans (LWSPs) similarly project steady overall growth; although the larger community water systems in the County (the Cities of Hickory, Conover, and Newton) seem to be projecting more growth than the smaller systems.

The City of Hickory is by far the largest water supplier in the County. The 1997 map of service areas in Catawba County (Figure 2-17) shows that the City of Hickory's service area covers almost the entire western half of the County. It also covers small areas in Alexander and Caldwell counties[10]. In contrast, the southeastern portion of the County was, in 1997, virtually uncovered by community water systems.

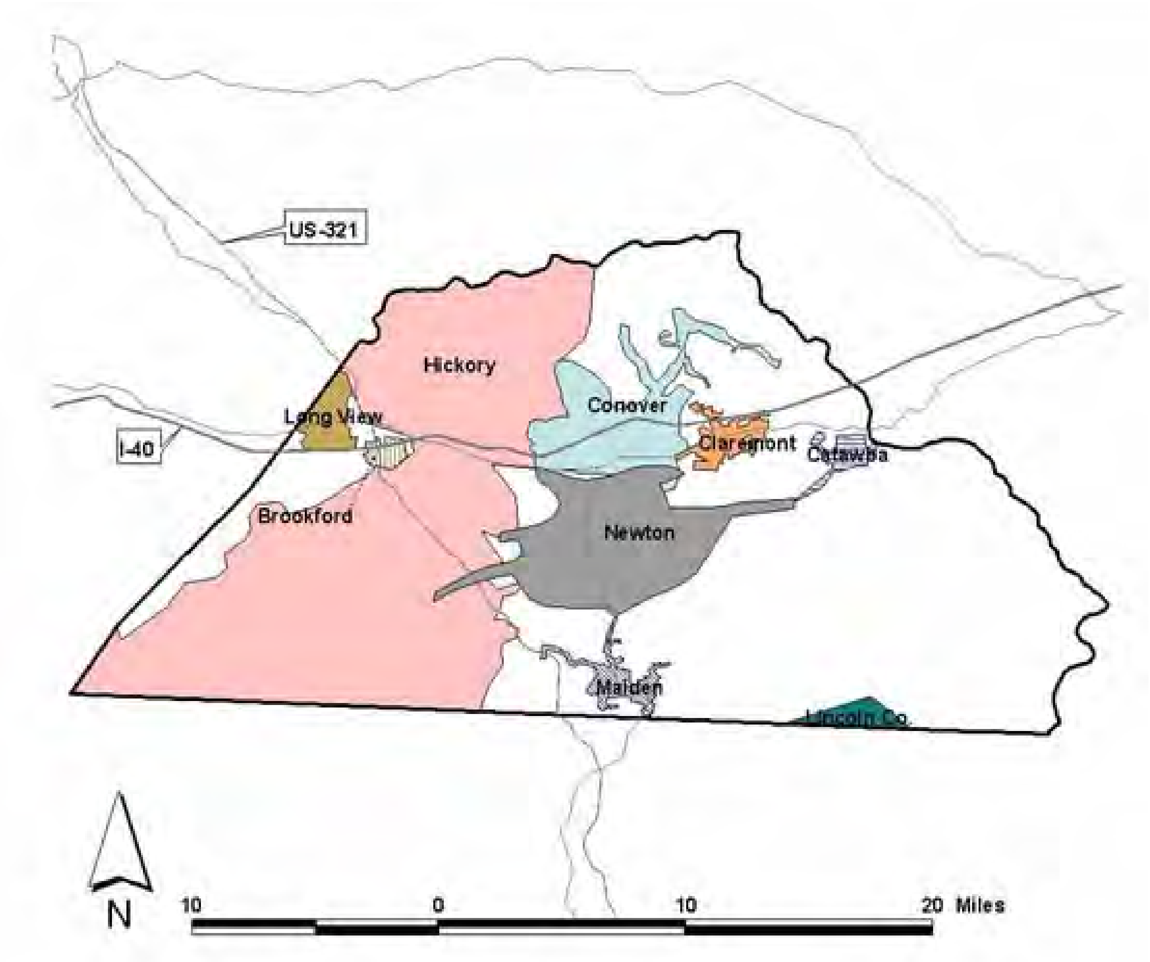

Figure 2-17: Catawba County 1997 Community Water System Service Areas

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[9] The North Carolina SDC only calculated population projections through 2030. For a description of how they were extended, see Appendix B.

[10] Please refer to the summaries of each of these counties for their coverage by community water systems.

(g) Iredell County

As seen in Figure 2-18, not much of Iredell County is actually located within the Catawba River basin. According to the North Carolina Division of Water Quality's Catawba River Basinwide Water Quality Plan, only about 22% of the County's land area falls within the basin (1999). However, all but one of the water systems serving Iredell County withdraw at least some of their water from the Catawba River basin. The Catawba River forms Iredell County's boundaries with Catawba and Lincoln Counties. Lookout Shoals Lake is located on the northernmost corner of the County's border with Catawba County and Lake Norman makes up a large portion of this border. There are only five municipalities located within the County: the City of Statesville and the Towns of Troutman, Mooresville, Love Valley, and Harmony. The City of Statesville and the Town of Mooresville are the two largest municipalities, with estimated 2004 populations of 24,489 and 20,122, respectively. The smallest municipality is the Town of Love Valley, located in the northwestern region of the County, with an estimated 2004 population of only 33 (U.S. Census Bureau 2004).

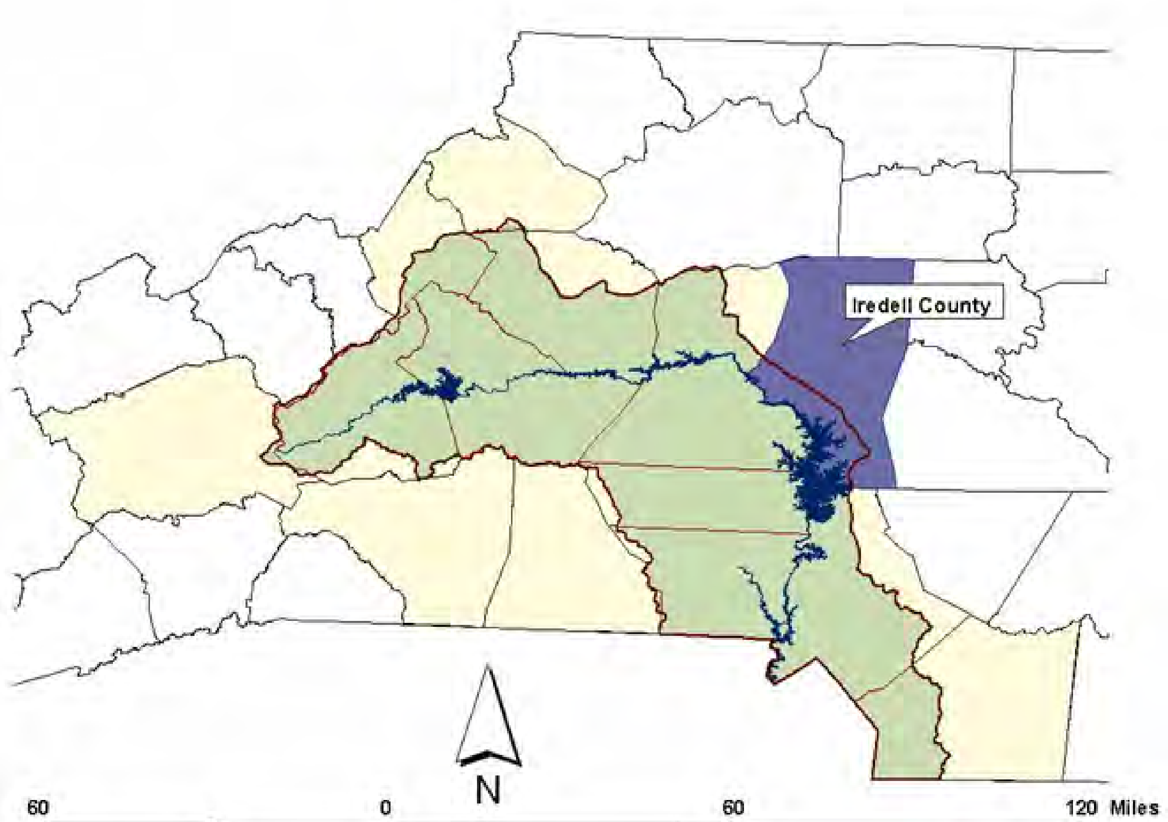

Figure 2-18: Iredell County Location

In its 2002 Census of Agriculture, the North Carolina Department of Agriculture reported that the County contained 146,556 acres of farmland and 55,846 acres of that were harvested cropland (North Carolina Department of Agriculture and Consumer Services 2002). An Economic Development Assessment completed for the Mooresville-South Iredell Chamber of Commerce in 2005 estimated that population in its region has increased annually by 4.5% since 1990 (Angelou Economics 2005, 8). Much of the growth was attributed to the expansion of the Charlotte metro area, a high quality of life, and the attractiveness of the region to businesses. Recently, the motor sports industry has expanded locally and Lowe's (the home improvement retailers) has chosen to locate their regional headquarters in the area (4).

The Town of Mooresville has been credited with being "responsible for nearly all the County's population growth over the past decade". Other areas in the County have not been growing as quickly. Below average growth has been projected for both the Town of Troutman and the City of Statesville during the same period (Angelou Economics 2005, 8). The Town of Troutman, however, anticipates growth in the near future. According to a 2004 article in the Charlotte Business Journal, the town has "plans for more than 1,250 homes in five subdivisions, a multimillion-dollar industrial expansion, anticipated development of 1,100 acres in nearby Barium Springs and talk of a separate, Birkdale Village-style project," referring to the mixed-use development in Huntersville, North Carolina (Elkins 2004).

As seen in Figure 2-19, the calculated population projections by community water systems are well below the North Carolina State Data Center (SDC) projection[11]. Most of the community water systems seem to be projecting moderate growth; the largest increase projected is, predictably, in the Town of Mooresville, where they plan to more than double their service area population from 24,660 in 2010 to 50,000 by 2050.

Manufacturing has continued to be the largest employer in the County. In the period between 1982 and 1993, while manufacturing was on the decline throughout the region (Iredell County 1997, 5), the diversity of manufacturing jobs in Iredell County enabled a 14 percent net increase in overall manufacturing positions, although employment in textile manufacturing fell by 2,160 (Iredell County 1997, 5). The 1997 Land Use Plan predicted that total employment would rise from 52,600 in 1990 to 69,820 in 2010, with major increases in retail, services, and manufacturing (10).

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[11] The North Carolina SDC only calculated projections through the year 2030. For information on how these were extended to the year 2050, please see Appendix B.

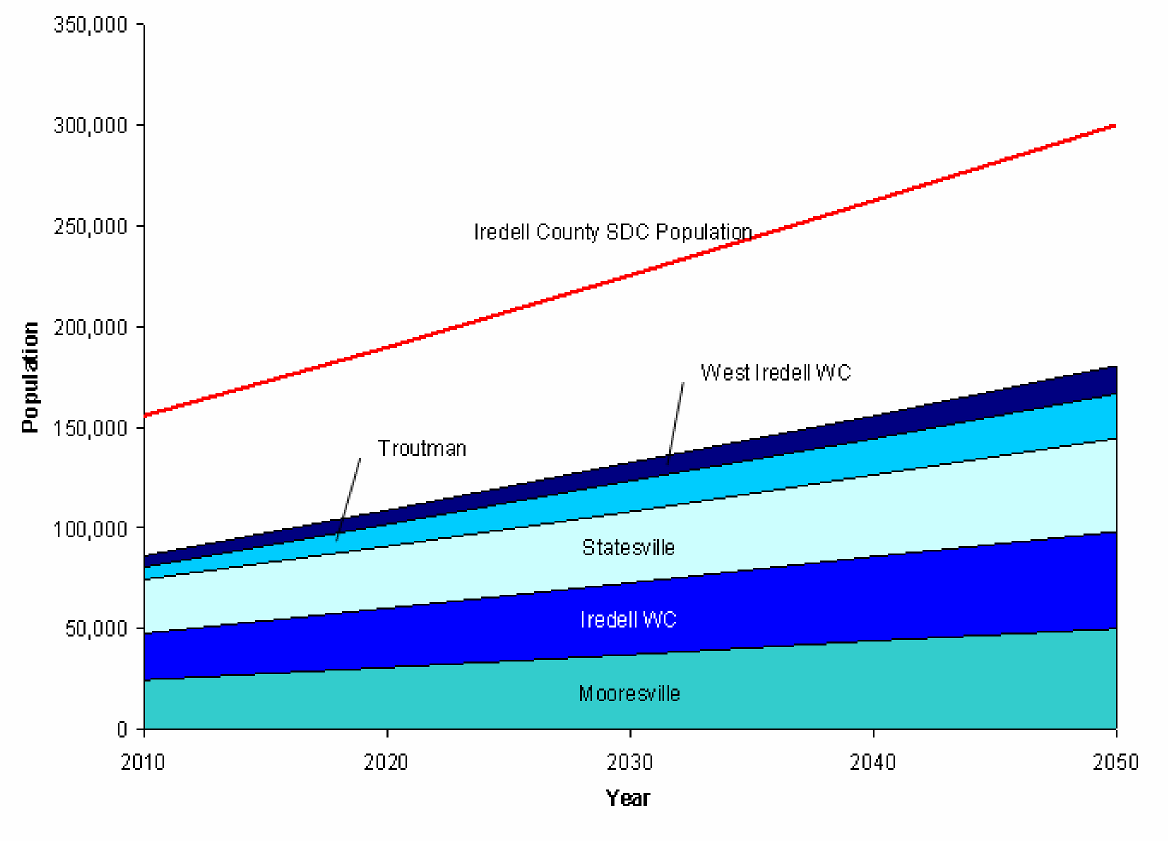

Figure 2-19: SDC Projections vs. LWSP Projections

In 1997, a small portion of Iredell County was served by community water supply systems (Figure 2-20). The Alexander County Water Company, the City of Statesville, the West Iredell Water Company, the Town of Troutman, and the Town of Mooresville all draw at least a portion of their water from the Catawba River basin. The City of Statesville only began drawing water from the Catawba River basin in 2004 and plans on increasing withdrawals from the basin in the future (HDR, Inc. Engineering of the Carolinas 2005, Appendix C). According to the South Iredell Small Area Plan, the Town of Mooresville has plans to expand their water system's service area in the near future; its 1998 water and sewer plan includes coverage for much of southern Iredell County (Iredell County 2004, 13).

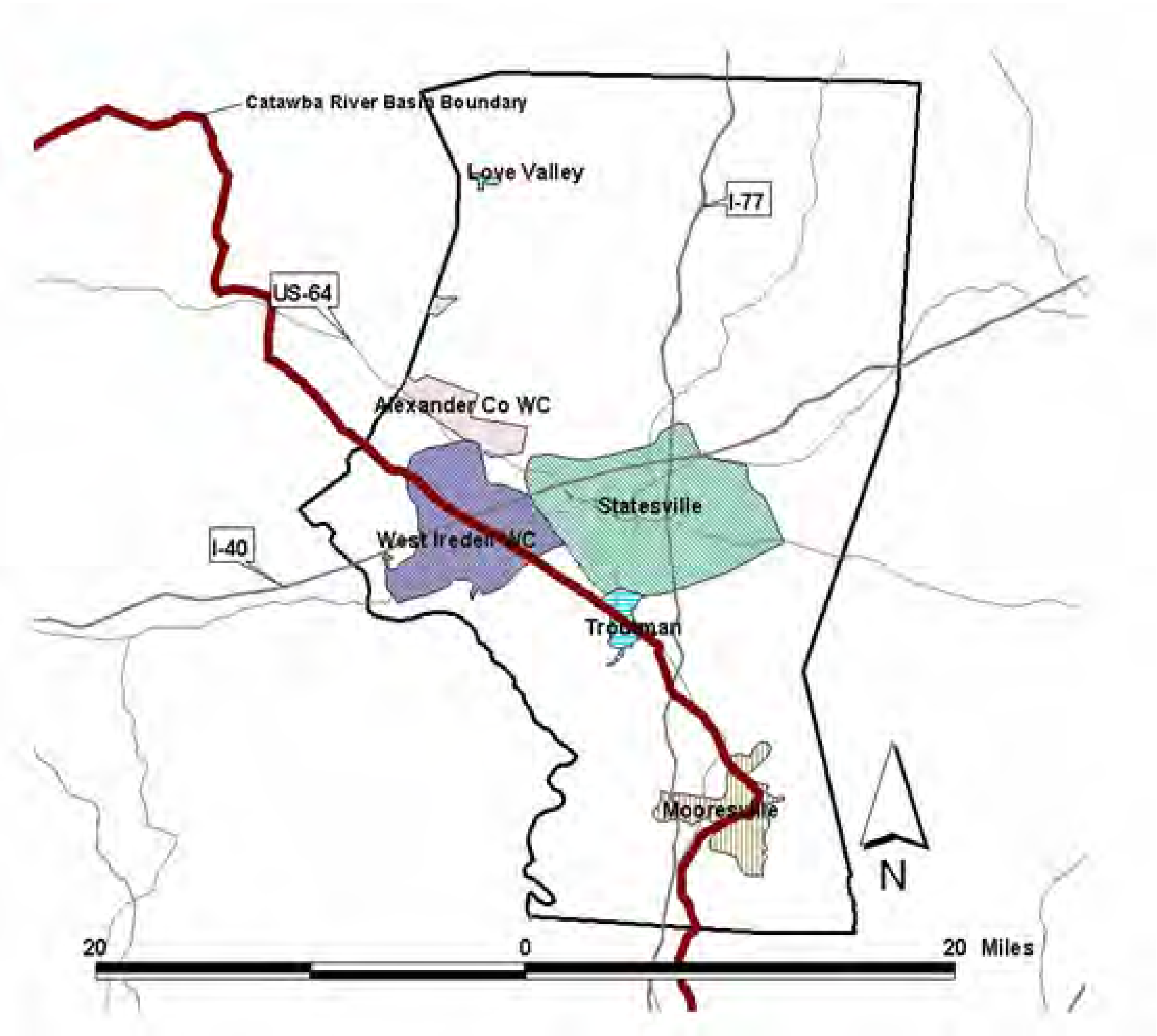

Figure 2-20: Iredell County 1997 Community Water System Service Areas

(h) **Lincoln County**

Lake Norman forms most of Lincoln County's eastern border between Mecklenburg and Iredell Counties (Figure 2-21). Most of Lincoln County is located in the Catawba River basin; the percentage of its land area within the basin was estimated at 93% (North Carolina Division of Water Quality 1999).

The City of Lincolnton is the only municipality in the County. It is centrally located in the County and, in 2004, was home to an estimated 10,194 people (U.S. Census Bureau). As of July 2005, the County's population was recorded at 69,145 people (North Carolina Department of Commerce 2005).

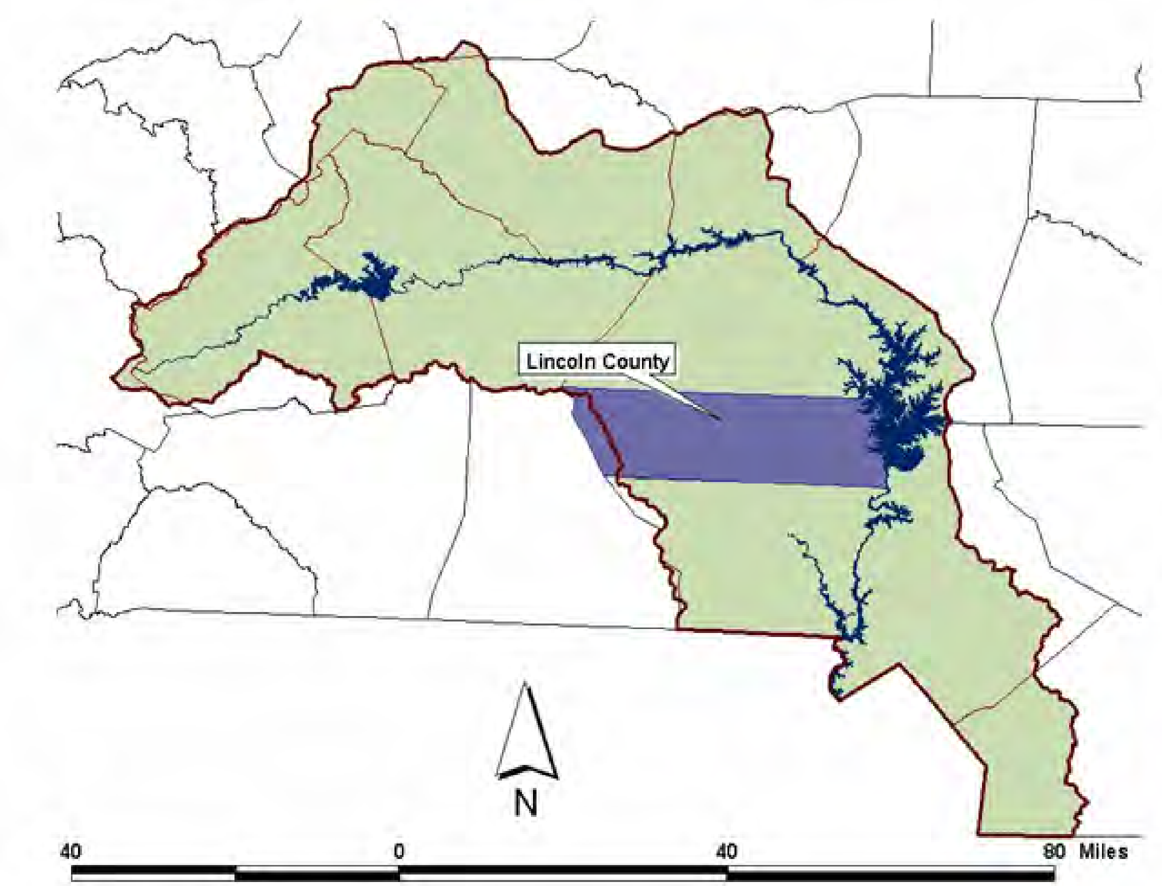

Figure 2-21: Lincoln County Location

The 2002 Agricultural Census reports that 57,777 acres of Lincoln County's 191,245 total acreage were considered agricultural. Of the 57,777 agricultural acres, 23,202 acres were harvested cropland (North Carolina Department of Agriculture and Consumer Services 2002).

As noted in the City of Lincolnton's 2003 land use plan, much of the growth expected for the County will occur toward the east, near Lake Norman and convenient to Charlotte (Centralina Council of Governments 2003, 2-2). In the

City of Lincolnton, growth has been increasing and is expected to continue to increase to the east and south, with less growth towards the north and west, away from Charlotte and Lake Norman (2-1).

Manufacturing and retail are the two largest employment sectors in the County. Manufacturing represents 29.9% of the County's total employment and retail employs an additional 11.6% of Lincoln County's workforce (North Carolina Department of Commerce 2005).

Figure 2-22 depicts two increasing population projections for the County, as calculated by the North Carolina State Data Center[12] (SDC) and community water systems. Most of the growth in the number of people in the County served by the two systems is due to the Lincoln County water system.

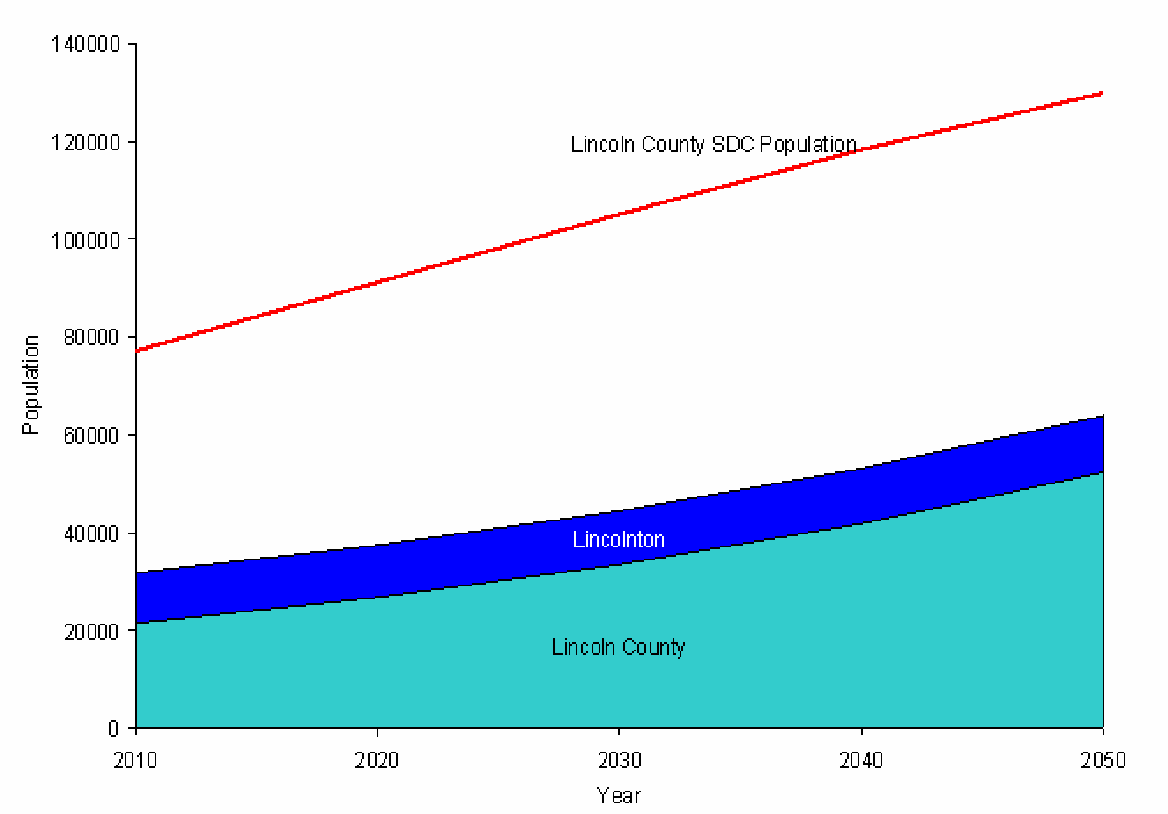

Figure 2-22**:** SDC Projections vs. LWSP Projections

The concentration of population in the southeastern portion of the County is visibly reinforced by the size of the service areas for the two community water systems in the County, as shown in Figure 2-23. In 1997, the Lincoln County water supply system extends out from the City of Lincolnton to the northeast and south, along Lake Norman. It is also interesting to note the lack of water system coverage in the western portion of the County. A possible reason for this is touched on in the

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[12] The Office of State Planning projections were given only through 2030. For a description of how these were extended, please see Appendix B.

Lincolnton's Land Use Plan, which identified the South Fork Catawba River as an impediment to extending water service to the western portion of the County (Centralina Council of Governments 2003, 2-1, 2-2).

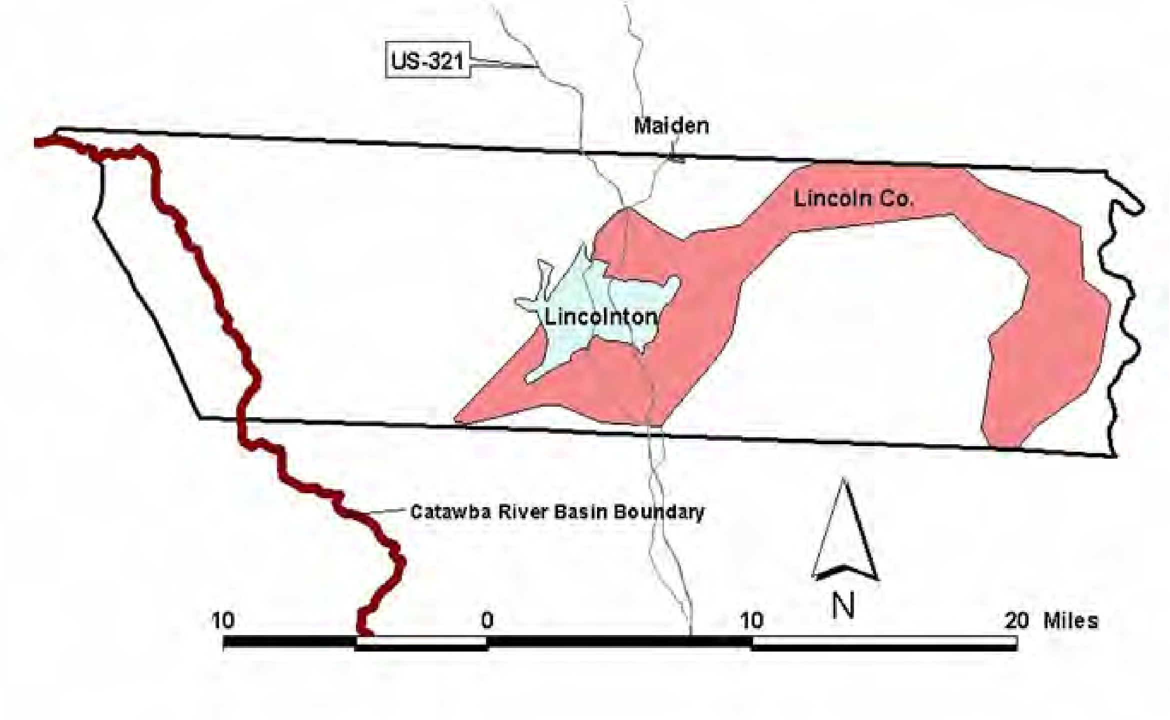

Figure 2-23: Lincoln County 1997 Community Water System Service Areas

(i) Gaston County

Approximately 97% of Gaston County's land area is located within the southwestern corner of the Catawba River basin (Figure 2-24) (North Carolina Division of Water Quality 1999). The Catawba River serves as the eastern border between Mecklenburg and Gaston Counties. The South Fork Catawba River runs diagonally through Gaston County and joins with the Catawba River in the County's southeastern corner.

There are 15 municipalities in Gaston County (Gaston County 2002, 1) and four have populations over 5,000. In 2004, the City of Gastonia was the largest municipality with an estimated population of 68,292. The next three largest municipalities, in order of their estimated 2004 population size, were the Cities of Mount Holly (9,639), Belmont (8,786), and Cherryville (5,430) (U.S. Census Bureau).

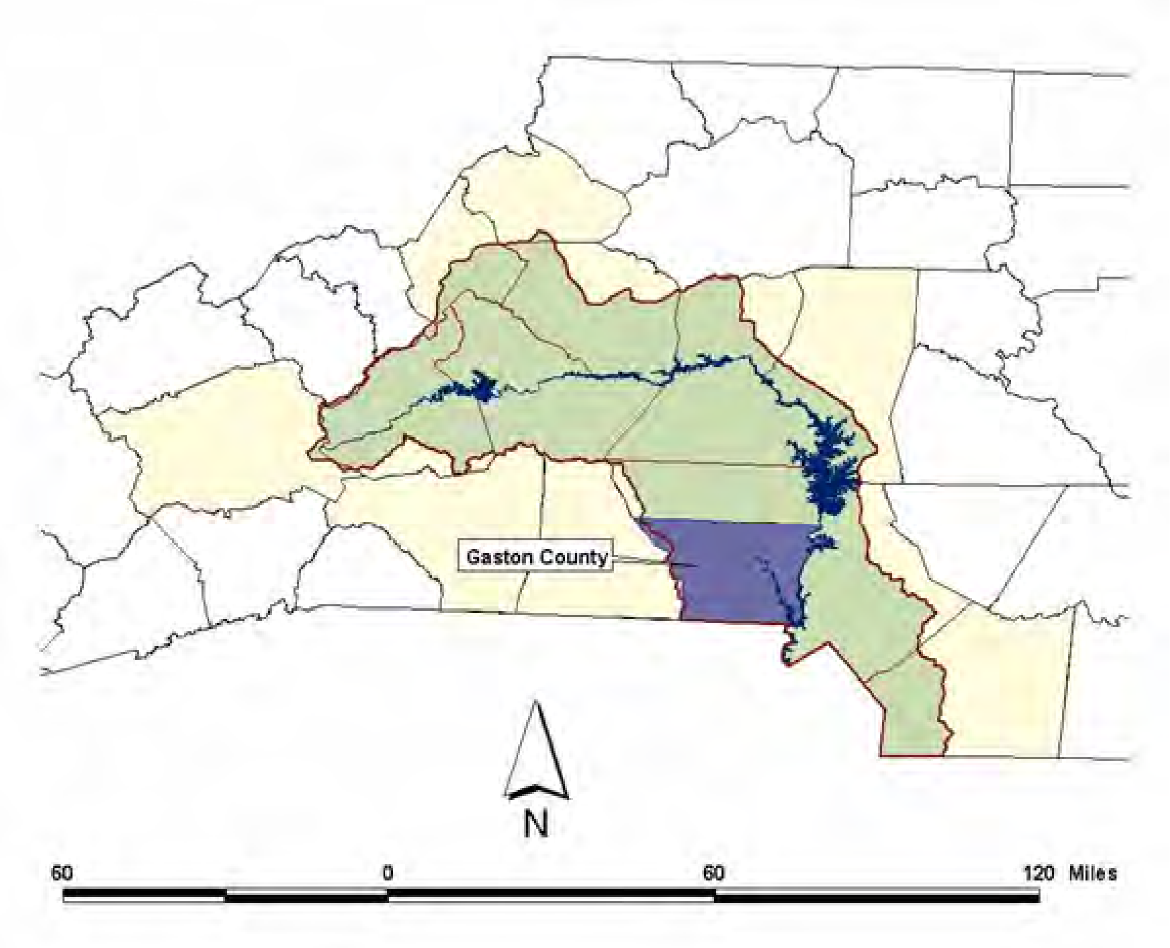

Figure 2-24: Gaston County Location

Development in Gaston County is closely tied to the development in the City of Charlotte and Mecklenburg County. According to the City of Cherryville's website (www.cityofcherryville.com), in the year 2000, approximately 37% of the County's resident workforce commuted to other counties for work. Of the 29,013 out-commuters, 23,101 were headed for jobs in Mecklenburg County (City of Cherryville 2004).

Population growth in Gaston County, however, occurred at a slower rate (18% from 1970 to 1990) than other areas in the vicinity of the City of Charlotte (over 50% in Union and York Counties from 1970 to 1990). This lower rate was attributed, in the City of Gastonia's *CityVision 2010* comprehensive plan, to the fact that during that period most of the growth from the City of Charlotte was extending towards the south and southeast, rather than to the west where Gaston County is located (City of Gastonia 1995, 23).

In its 2002 Comprehensive Plan, Gaston County reported that over 40% of the County's land was forested (3). According to the North Carolina Department of Agriculture, in 2002, there were 13,303 acres of harvested cropland in the County out of 41,827 total acres of agricultural land (North Carolina Department of Agriculture and Consumer Services 2002).

Many of Gaston County's textile mills have closed, leading to a decline in the textile industry in the region. During the 1970's and 1980's, textiles manufacturing declined from representing 64% of manufacturing jobs in the county to representing approximately half of manufacturing jobs in 1990 (City of Gastonia 1995, 44). The Gaston Urban Area Metropolitan Planning Organization's (MPO) 2005 Long Range Transportation Plan reported that this trend was slowing down; however, this may be attributed to the fact that the only remaining textile mills are essential to the companies that operate them and would only close if they should fail (41).

Employment projections from the Gaston Urban Area MPO transportation plan show a decline in employment in the manufacturing sector from 2000 to 2010. The manufacturing sector is expected to recover somewhat by 2030, while the textile industry is not anticipated to fully recover (Gaston Urban Area Metropolitan Planning Organization 2002, 42). Gaston County's 2002 Comprehensive Plan states that the services industry will provide most of the employment growth in the County, upward to 26.7% of total employment by 2010 (13). The manufacturing sector has already begun to recover with several companies making large investments in the County and creating new jobs. One of the most recent and highly publicized industrial investments in the County has been the announcement of Dole's intention to build a processing plant, creating 900 new jobs by the year 2016 (Gaston County Economic Development Commission 2005).

Figure 2-25 shows the comparison of the North Carolina State Data Center (SDC) population projections[13] to community water system service area population projections given in the 2002 Local Water Supply Plans[14] (LWSPs). The 2002 LWSP projections are more ambitious than the SDC projection. The SDC projected an increase in population between the years 2010 and 2050 of approximately 29,000, while the LWSP projections add up to a difference of more than 267,000 in the same timeframe. Unfortunately, it is practically impossible to pinpoint the reason(s) for this discrepancy, it can only be concluded that the SDC and the community water systems have different expectations for growth within the County.

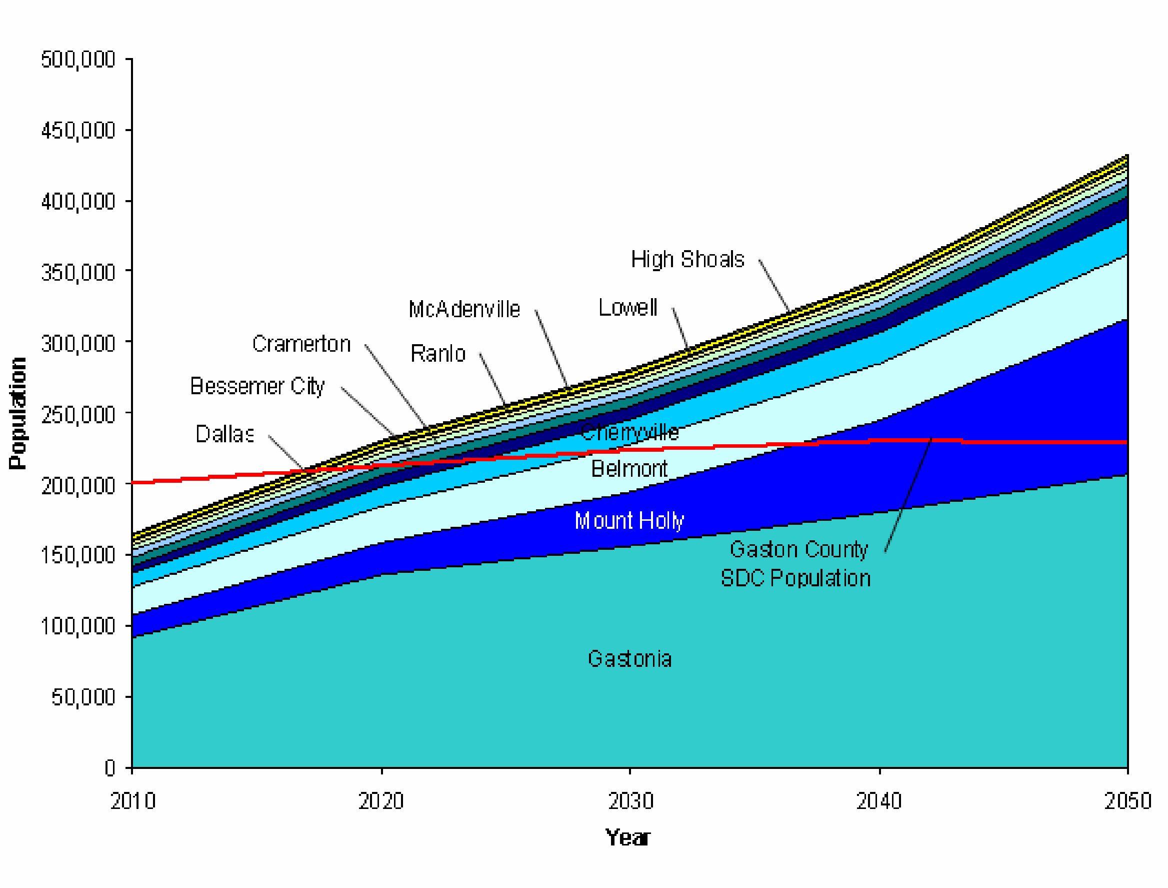

Figure 2-25: SDC Projection vs. LWSP Projections

As reported in the City of Gastonia's *CityVision 2010*, in 1995 Gaston County consumed water at that unusually high rate of 250-300 gallons per person per day. The reason given for this was the presence of high-volume industrial water users, the ten largest of which used approximately 41% of the total amount of water distributed by the City of Gastonia's community water system (City of Gastonia 1995, 82).

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[13] North Carolina SDC projections were only calculated through 2030, for an explanation of how they were extended to 2050, please see Appendix B.

[14] In their LWSP, Dallas only provided population projections through 2020. These were extended simply by fitting a linear expression to the given data points.

Most of Gaston County lies in a sub-basin of the Catawba River basin known as the South Fork Catawba River basin. The South Fork Catawba River cuts through the central eastern portion of the County, originating just west of the Town of Stanley and running southeast between the Town of Cramerton and the City of Belmont. Figure 2-26 shows community water systems' service area coverage in Gaston County during 1997. About half of the systems in the County draw their water from the South Fork Catawba River, while the other half withdraw from the Catawba River. The City of Gastonia, by far the largest water supplier in the County, withdraws its water from Mountain Island Lake. Only four community water systems in the County purchase water from other systems, three of which buy their water from the City of Gastonia's water system.

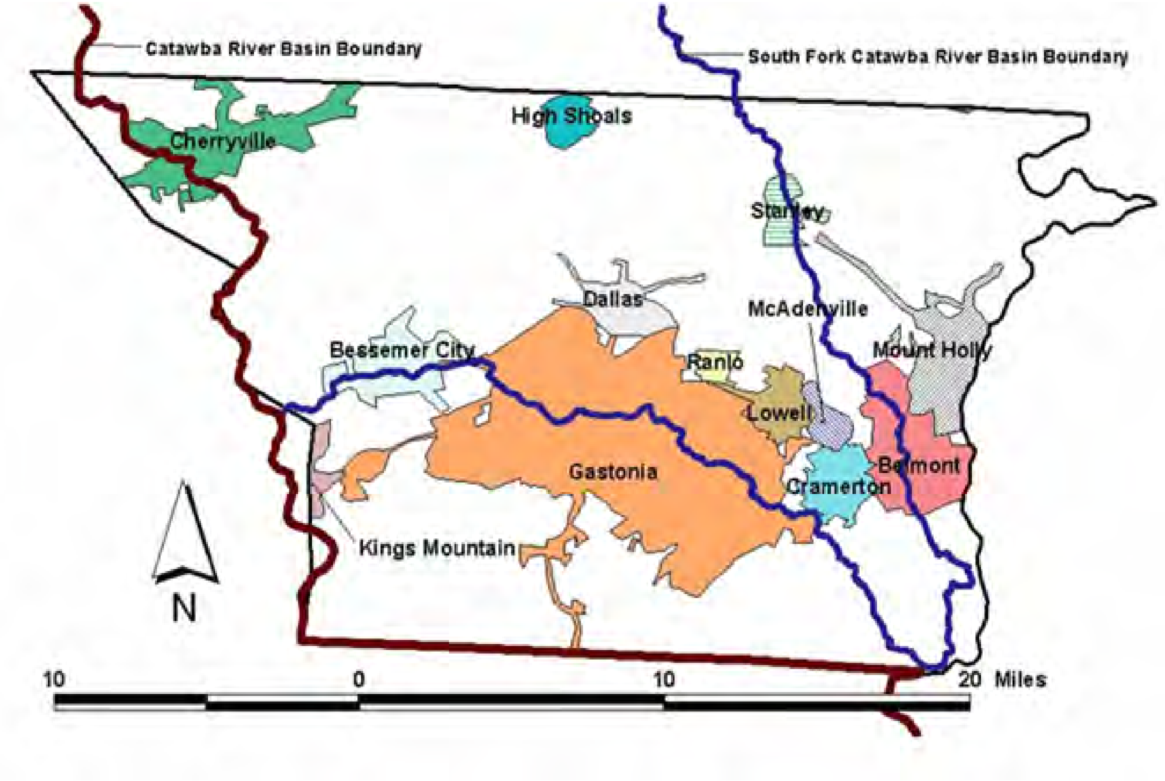

Figure 2-26: Gaston County 1997 Community Water System Service Areas

(j) Mecklenburg County

Mecklenburg County is considered the most influential county in the Catawba River Basin. It contains the City of Charlotte, which drives most of the growth in the basin. As can be seen in Figure 2-27, Mecklenburg County is located in the southeastern portion of the basin. Most of the County (74/%) is located within the basin (North Carolina Division of Water Quality 1999). Only a small portion of the County, along the eastern border, falls outside of the Catawba River basin.

In 2004, the City of Charlotte's estimated population was 594,359, more than three quarters of the entire County's population estimate of 771,617. The next largest municipality in the County is the City of Huntersville, with a 2004 estimated population of 34,332, while the smallest, in terms of population, is the Town of Pineville, with a 2004 estimated population of 3,643 (U.S. Census Bureau).

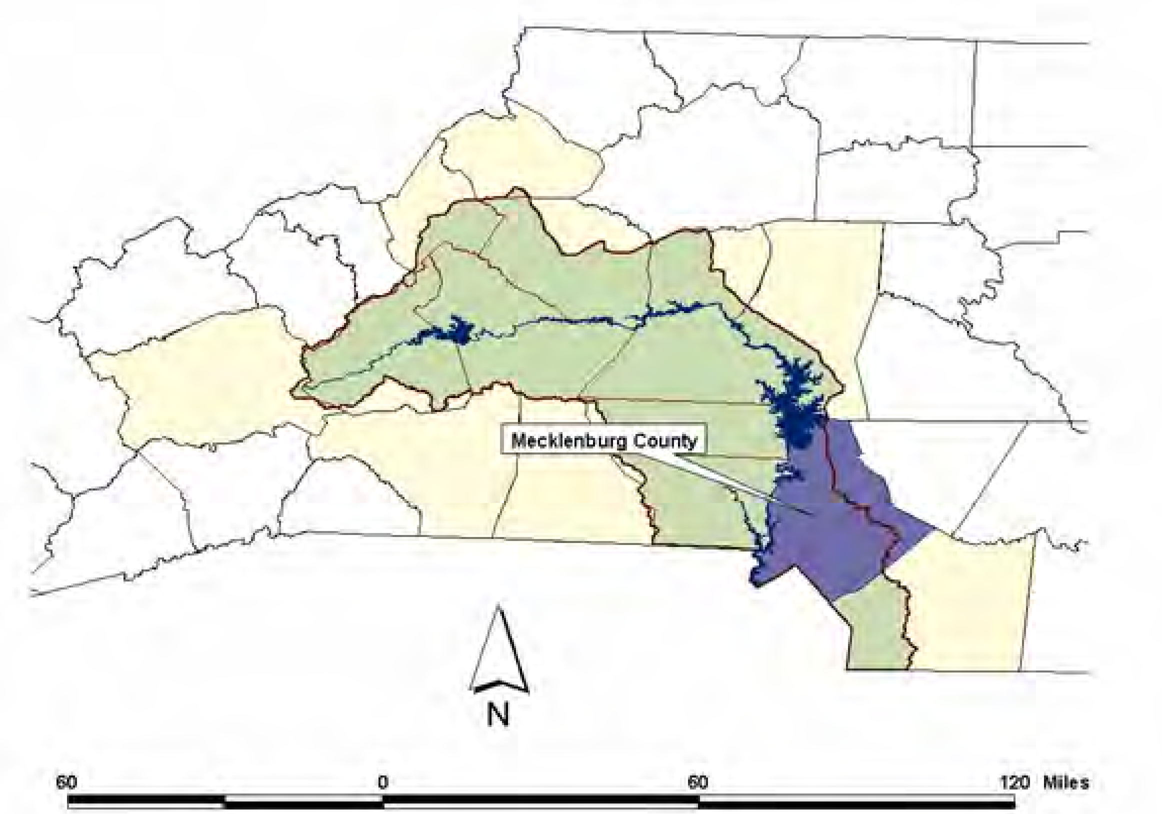

Figure 2-27: Mecklenburg County Location

Mecklenburg County is different from the other counties in the Catawba River basin in several areas. While many of the counties in the basin rely on the manufacturing industry as a major component of their local economy, manufacturing has never been a strong industry in Mecklenburg County. It has fallen from representing 8.3 percent of total employment in the County in 2000 (Advantage Carolina 2005, 12) to representing 6.9 percent of total employment in the County during the third quarter of 2005 (North Carolina Department of Commerce 2005). The Finance and Insurance sector is considered prominent in Mecklenburg County, although it was the second largest employment sector as of the third quarter of 2005 with 49,509 employees. Mecklenburg County's largest employment sector for this period was retail trade, with 53,553 employees (North Carolina Department of Commerce 2005).

Other differences include Mecklenburg County's higher population growth rates, higher average wages, and a population that is younger, more racially diverse, more educated, and wealthier than the populations of other counties in the basin (Advantage Carolina 2005, 86). Mecklenburg County's population, however, is expanding into neighboring counties, with 33% of the County's workforce commuting in from other counties (City of Charlotte Economic Development Office 2005, 6).

Figure 2-28 shows population in Mecklenburg County growing steadily through 2050. By 2020, the North Carolina State Data Center (SDC) is expecting the County to pass the one million mark, reaching 1,807,000 by 2050[15]. Charlotte-Mecklenburg Utilities' (CMU) service area encompasses the entire County; therefore, it is the only community water system to perform a population projection.

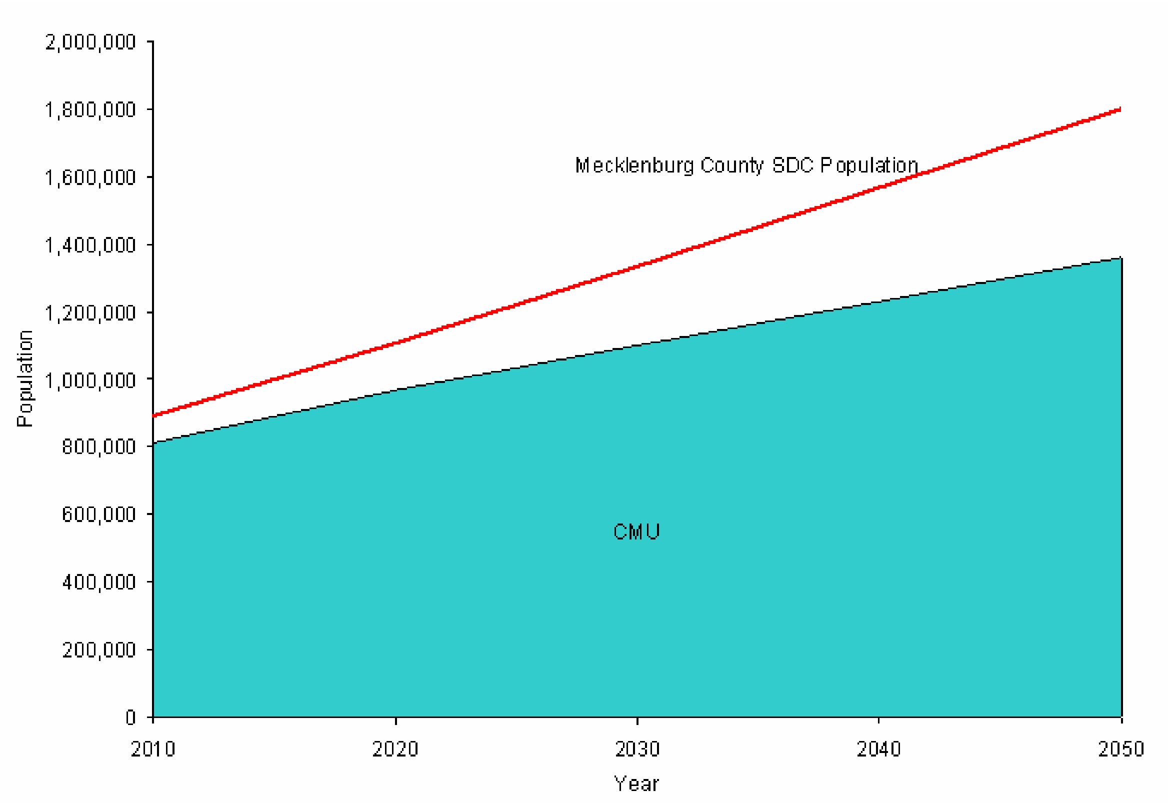

Figure 2-28: OSP Projections vs. LWSP Projections

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[15] The North Carolina SDC only provided population projections through 2030. For information on how these were extended, please see Appendix B.

(k) Union County

Union County is located in the southeastern corner of North Carolina's portion of the Catawba River basin. As shown in Figure 2-29, only a small part (25%) of the County is actually within the basin's boundaries (North Carolina Division of Water Quality 1999). However, through an interbasin transfer, much of Union County depends on the Catawba River basin for its water supply source. Union County contains 14 municipalities, 12 of which are located in the northwestern portion of the County, close to the border with Mecklenburg County. The County seat, the City of Monroe, is the largest municipality with an estimated 2004 population of 28,422 (U.S. Census Bureau).

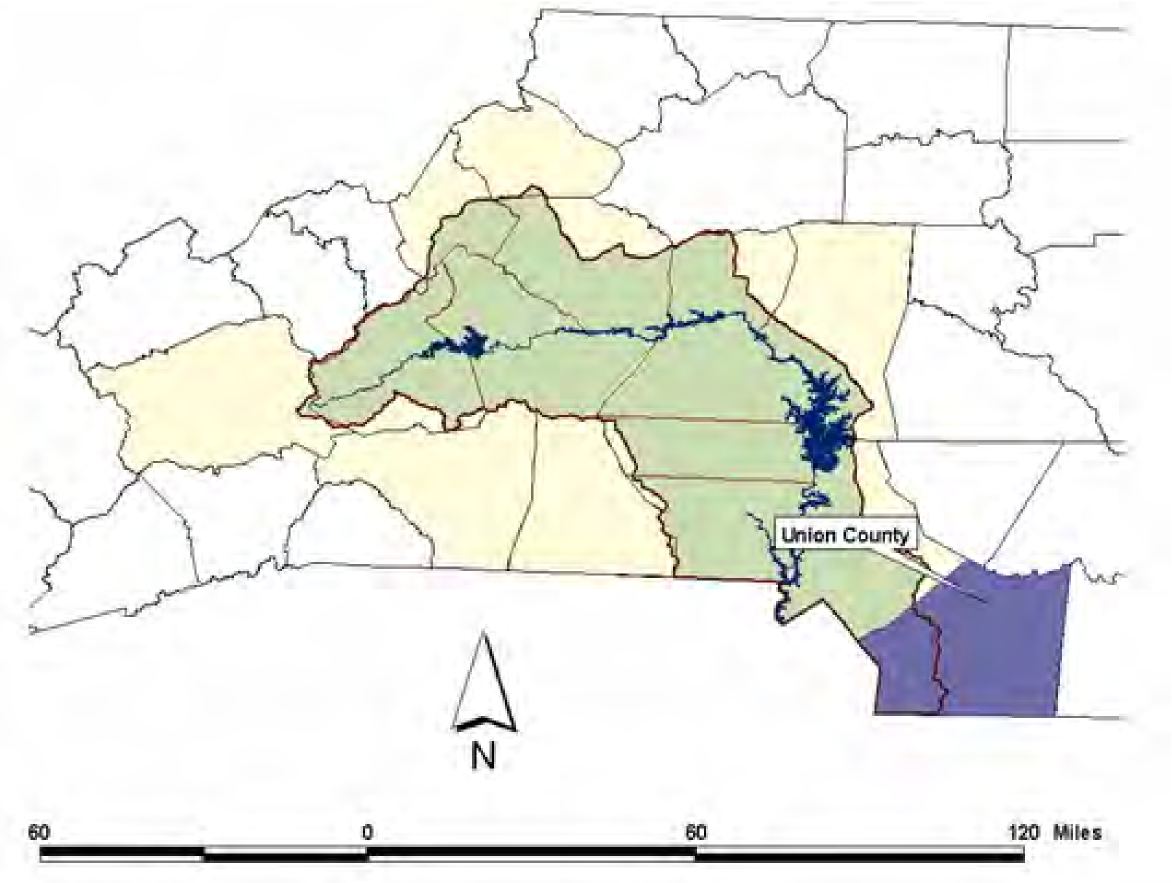

Figure 2-29: Union County Location

According to the Union County Chamber of Commerce, Union County has grown faster than any other county in the state (Union County Chamber of Commerce 2006). In fact, concerns over its rapid growth have compelled the County to institute a 12-month moratorium on "major residential development", beginning on the 15th of August, 2005 (Union County 2005).

In terms of business and industrial development, the City of Monroe's airport and the Monroe Corporate Center were both identified by the Union County Chamber of Commerce as potential attractions for new business (Union County Chamber of Commerce 2006). Another factor cited as a potential catalyst for economic growth, is the extension of sewer service to townships in the western portion of the County south of US-74 and the US-74 bypass (also known as the Monroe Bypass). Due to funding and environmental issues, the wastewater collection expansion project has yet to be constructed. The bypass project's start date is currently set for 2018; however, County officials are hoping to resolve funding and environmental issues and have the bypass finished by 2010 (Quirk 2005).

Currently, the number of people employed within the County is fewer than the number of Union County residents commuting to neighboring counties for work. Reversing this trend is a major goal of the County's economic development plans, as outlined in its Vision 2020 Long Range Plan (Union County 1999, 11).

As previously mentioned, Union County anticipates dramatic population growth (Figure 2-30). For the 20 year period between 2000 and 2030, the North Carolina State Data Center (SDC) projects that Union County's population will more than double. Of the community water systems serving the County, the Union County system is expected to expand the most, from a service area population of 133,470 in 2010 to one of 289,953 in 2050 (Figure 2-30).

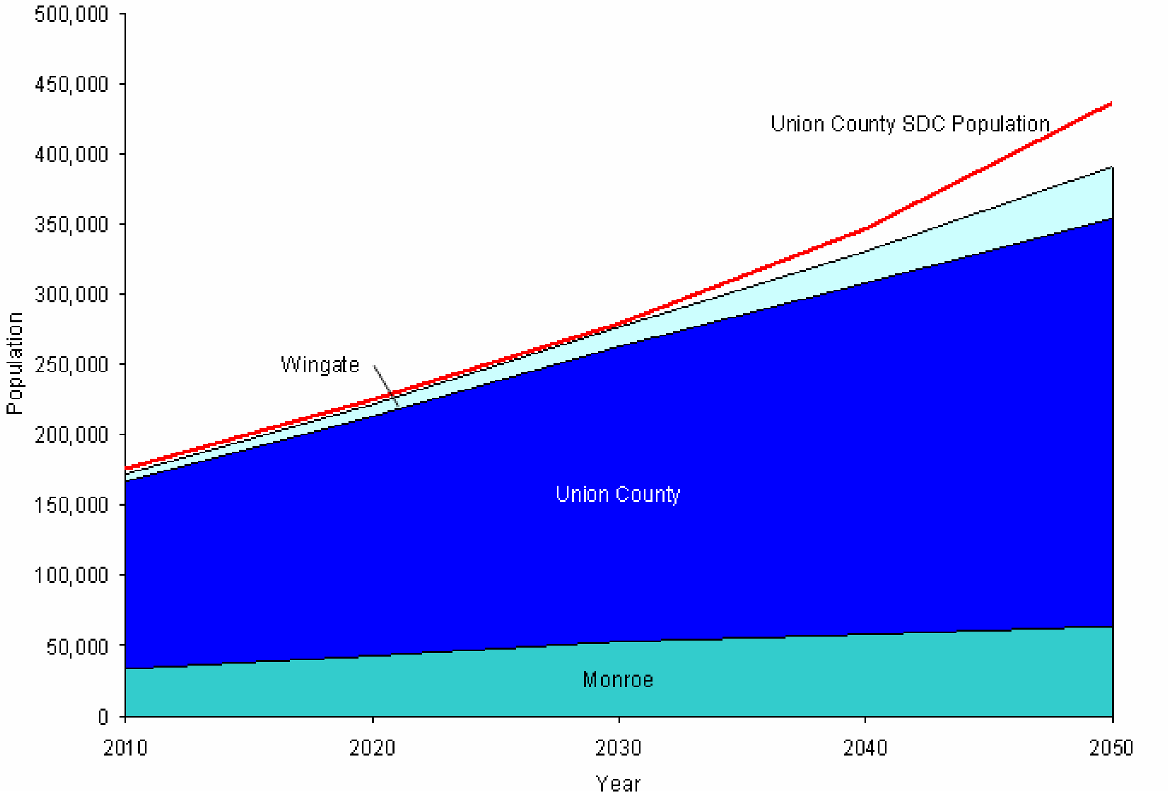

Figure 2-30: SDC Projections vs. LWSP Projections

The 1997 map of the community water system service areas in Union County (Figure 2-31) shows most of the western portion of the County receiving its water from the Union County water system. The City of Monroe, the Town of Wingate, and the Town of Marshville systems' service areas seem to cover their respective municipal areas. In 1997, much of the eastern portion of the County was not served by a community water system. Of the four systems in the County, the Town of Marshville is the only one, in 2002, that did not obtain any of its water from the Catawba River basin.

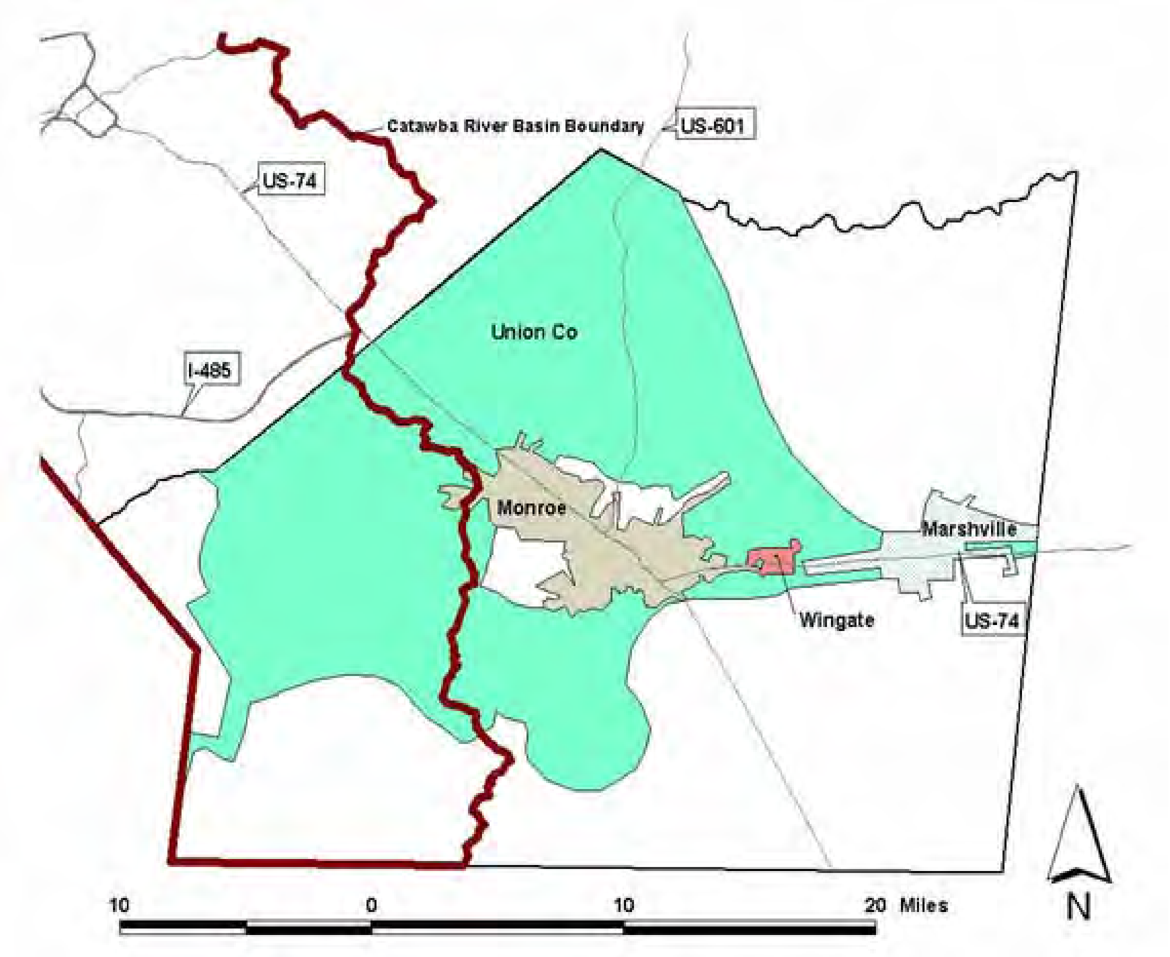

Figure 2-31: Union County 1997 Community Water System Service Areas

Section 2.2 Hydrology and Climatology

(a) Surface Water

(i) Basin Description

The Catawba is the eighth largest river basin in North Carolina covering 3,343 square miles. The Catawba River forms in the eastern slopes of the Blue Ridge Mountains at elevations of over 3,000 feet. The river flows approximately 3,004 miles (including tributaries) at first eastward into the piedmont, where it shifts to a more southerly direction at the Lookout Shoals Lake impoundment. It crosses the line into South Carolina near Charlotte and continues on to connect with the Broad River, becoming the Santee-Cooper River system, which then flows on to the Atlantic Ocean. The entire Catawba basin can be divided into four major sub-basins or hydrologic unit codes (HUC), shown in Table 2-1 pictured in Figure 2-32.

Table 2-1: Catawba River Basin HUCs

HUCs	**HUC Names/Sub-basins**	**States**	**Major Streams**
03050101	Upper Catawba	NC, SC	Linville Rv., Johns Rv., Catawba Main Stream, Long Cr. etc
03050102	South Fork Catawba	NC	South Fork Catawba, Henry fork, Jacob Fork etc
03020103	Lower Catawba	NC, SC	Catawba Main Stream, Irwin Cr., Sugar Cr., Briar Cr. Etc in NC & Rocky Cr. In SC
03020104	Wateree	SC	Wateree Rv., Colonels Cr. Etc in South Carolina

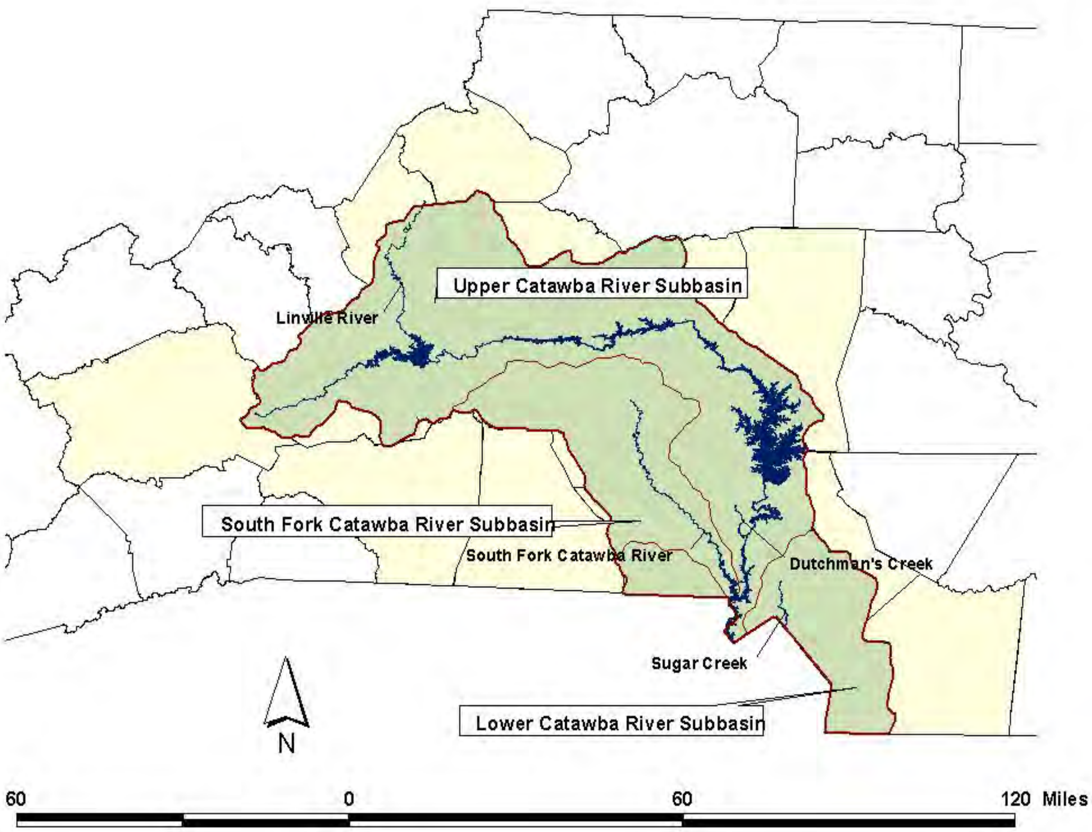

Figure 2-32: HUCS or Sub Basins in Catawba, North Carolina

The major tributaries to the Catawba River in North Carolina are the Linville River, Dutchman's Creek, the South Fork Catawba River and Sugar Creek (Figure 2-32). An important headwater stream is the Linville River, which flows through the Linville Gorge Wilderness Area, a section of the Pisgah National Forest, and into Lake James. The largest of these tributaries is the South Fork Catawba River which flows into Lake Wylie near the state line. It originates in the South Mountain area in southern Burke County. Its two major headwater tributaries are Jacob Fork and Henry Fork. Below Lake Wylie in South Carolina, the Catawba flows through Fishing Creek Reservoir and Wateree Lake before becoming the Wateree River. The Wateree, joined by the Congaree River, flows into Lake Marion, and the entire river system eventually drains to the Atlantic Ocean.

(ii) Major Flow Modifications:

- ***Reservoirs***

There are 11 impoundments commonly referred to as the Catawba Chain Lakes located along the main stem of the river in North Carolina and South Carolina. Hydroelectric operations on these lakes are owned and operated by Duke Energy. The lakes also provide the water supply needed for community water systems, industries and for agricultural and irrigation uses throughout the area from the mountains to the piedmont region, and are significant in terms of flood management in the basin. Approximately two-thirds of the main river stem and seven reservoirs are located in North Carolina. The names of the reservoirs and the corresponding project or plant names commonly used from upstream to downstream are listed in Table 2-2. Table 2-3 and Table 2-4 list the drainage areas and capacities of these reservoirs, respectively.

Table 2-2: Catawba Reservoirs / Plant Names

Reservoir Names	Project Names	Location (State)	Approximate Distance from Lake Wateree (miles)[16]
Lake James	Bridgewater	North Carolina	206
Lake Rhodhiss	Rhodhiss	North Carolina	170
Lake Hickory	Oxford	North Carolina	155
Lookout Shoals Lake	Lookout Shoals	North Carolina	143
Lake Norman	Cowan's Ford	North Carolina	108
Mountain Island Lake	Mountain Island	North Carolina	94
Lake Wylie	Lake Wylie	North Carolina/ South Carolina	65
Fishing Creek Reservoir	Fishing Creek	South Carolina	34
Great Falls Lake/ Dearborn Lake	Great Falls	South Carolina	26
Rocky Creek Lake/ Cedar Creek Lake	Rocky Creek	South Carolina	22
Lake Wateree	Wateree	South Carolina	-

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[16] Source: Figure 1.2-1, *First Stage Consultation Document, Catawba-Wateree Project, FERC # 2232,* by Duke Energy.

Table 2-3: Reservoir Watershed / Sub-basin Drainage Areas

Project	**Drainage Area**[17]
Bridgewater	380
Rhodhis	1,090
Oxford	1,310
Lookout Shoals	1,450
Cowans Ford	1,790
Mountain Island	1,860
Wylie	3,020
Fishing Creek	3,810
Great Falls/Dearborn	4,100
Rocky Creek/Cedar Creek	4,360
Wateree	4,750

Table 2-4: Reservoir Sizes and Capacities[18]

	Full Pond Storage (ac-ft)	**Critical Datum (ft)**	**Full Pond Elevation (ft)**	**Critical Elevation (ft)**	**Storage at Critical Elevation (ac-ft)**	**Normal Usable Storage (NUS) (ac-ft)**
Bridgewater	280,076	61	1,200	1,161	98,789	181,287
Rhodhiss	46,357	89.4	995.1	984.5	28,521	17,836
Oxford	126,990	94	935	929	103,76 7	23,223
Lookout Shoals	25,043	74.9	838.1	813	8,273.9	16,769.1
Cowans Ford	1,067,396	90	760	750	769,254	298,142
Mountain Island	59,618	94.3	647.5	641.8	44,669.3	14,948.7
Wylie	233,618	92.6	569.4	562	160,707	72,911
Fishing Creek	39,953	95	417.2	412.2	25,633	14,320
Great Falls	5,025	87.2	355.8	343	1,380	3,645
Cedar Creek	17,690	80.3	284.4	264.7	6,197.3	11,492.7
Wateree	256,196	92.5	225.5	218	171,749	84,448
Normal Usable Storage						739,022

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[17] Source: CHEOPS model input file for Inflow data

[18] Source: CHEOPS model interface and calculated storage at critical elevation

Withdrawals

According to 2002 Local Water Supply Plan (LWSP) data, 31% of the total demand for water was supplied by Mountain Island Lake. Fishing Creek Reservoir supplied 28%, and Lake Wylie, with the third largest contribution, supplied 15%. These three reservoirs are located near the cities of Charlotte and Gastonia in North Carolina and the City of Rock Hill in South Carolina, three of the major municipal communities located in the middle part of the basin, which are also responsible for some of the basin's largest surface-water withdrawals[19].

Surface water availability and reliability

The Catawba River stream flows are monitored at 46 United States Geological Survey (USGS) gage stations. Among these, 27 stations are at unregulated reaches of the river, where impoundments or any manmade disturbances do not impact the natural flow of the river. Of these 27, only 4 have good data over a significant drainage area for a considerable continuous time period. The list of the gage stations in North Carolina with record information is provided in Table 2-5[20]. Daily stream flow values at these four stations from the Upper Catawba River and the South Fork Catawba River have been analyzed. The locations of the four stations are shown in Figure 2-33.

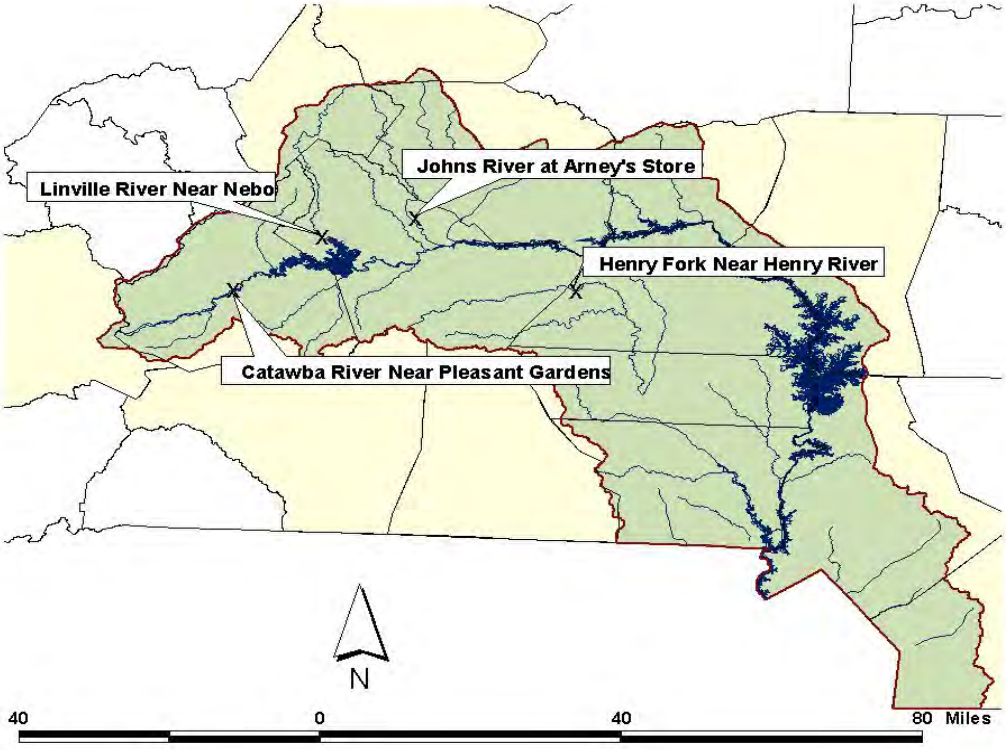

Figure 2-33: Unregulated USGS Gages

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[19] For more specific information on withdrawals in the Catawba River basin, please refer to Appendix D4-D6.

[20] Information gathered from USGS website

Table 2-5: Unregulated USGS Gage Stations in NC

USGS Site Number	Site Name	Huc Code	Huc Name	Drainage Area	Approximate Years of Record	Regulated or Unregulated
02137727	CATAWBA RIVER NEAR PLEASANT GARDENS, NC	03050101	Upper Catawba	126	24.01	U
02138500	LINVILLE RIVER NEAR NEBO, NC	03050101	Upper Catawba	66.7	82.31	U
02140991	JOHNS RIVER AT ARNEYS STORE, NC	03050101	Upper Catawba	201	19.43	U
02142000	LOWER LITTLE RIVER NEAR ALL HEALING SPRINGS, NC	03050101	Upper Catawba	28.2	51.78	U
0214253830	NORWOOD CREEK NEAR TROUTMAN, NC	03050101	Upper Catawba	7.18	20.85	U
0214266000	MCDOWELL CREEK NEAR CHARLOTTE, NC (CSW10)	03050101	Upper Catawba	26.3	7.00	U
0214295600	PAW CR AT WILKINSON BLVD NEAR CHARLOTTE, NC	03050101	Upper Catawba	10.8	10.01	U
02143000	HENRY FORK NEAR HENRY RIVER, NC	03050102	South Fork Catawba	83.2	79.22	U
02143040	JACOB FORK AT RAMSEY, NC	03050102	South Fork Catawba	25.7	43.03	U
02143500	INDIAN CREEK NEAR LABORATORY, NC	03050102	South Fork Catawba	69.2	53.12	U
02146300	IRWIN CREEK NEAR CHARLOTTE, NC	03050103	Lower Catawba	30.7	42.45	U
02146315	TAGGART CREEK AT WEST BOULEVARD NEAR CHARLOTTE, NC	03050103	Lower Catawba	5.38	6.25	U
02146348	COFFEY CREEK NEAR CHARLOTTE, NC	03050103	Lower Catawba	9.14	5.00	U
02146409	LTL SUGAR CR AT MEDICAL CENTER DR AT CHARLOTTE, NC	03050103	Lower Catawba	11.8	10.01	U
0214642825	BRIAR CREEK NEAR CHARLOTTE, NC	03050103	Lower Catawba	5.2	6.50	U
0214643860	BRIAR CREEK BELOW EDWARDS BRANCH NEAR CHARLOTTE, NC	03050103	Lower Catawba	14.22	1.17	U
0214645022	BRIAR CREEK ABOVE COLONY RD AT CHARLOTTE, NC	03050103	Lower Catawba	19	8.84	U
02146470	LITTLE HOPE CREEK AT SENECA PLACE AT CHARLOTTE, NC	03050103	Lower Catawba	2.63	21.85	U
0214655255	MCALPINE CREEK AT SR3150 NEAR IDLEWILD, NC	03050103	Lower Catawba	7.52	5.34	U
02146562	CAMPBELL CREEK NEAR CHARLOTTE, NC	03050103	Lower Catawba	5.6	5.25	U
0214657975	IRVINS CREEK AT SR3168 NEAR CHARLOTTE, NC	03050103	Lower Catawba	8.37	4.00	U
02146600	MCALPINE CREEK AT SARDIS ROAD NEAR CHARLOTTE, NC	03050103	Lower Catawba	39.6	42.53	U
02146670	FOUR MILE CREEK NEAR PINEVILLE, NC	03050103	Lower Catawba	17.8	7.25	U
02146700	MCMULLEN CREEK AT SHARON VIEW RD NEAR CHARLOTTE, NC	03050103	Lower Catawba	6.95	42.53	U
02146750	MCALPINE CR BELOW MCMULLEN CREEK NEAR PINEVILLE, NC	03050103	Lower Catawba	92.4	30.52	U
0214678175	STEELE CREEK AT SR1441 NEAR PINEVILLE, NC	03050103	Lower Catawba	6.73	6.42	U
02147126	WAXHAW CREEK AT SR1103 NEAR JACKSON, NC	03050103	Lower Catawba	35	2.42	U

The results from the statistical analyses for monthly stream flow values are presented in figures in the following few pages. The plots were arranged to show the mean, maximum and minimum flows for the water year for the available period of record. The period of records for the stations start from 1981 for *Catawba River Near Pleasant Garden*, 1922 for *Linville River Near Nebo*, 1985 for *Johns River at Arney's Store* and 1942 for *Henry Fork Near Henry River* and records end in 2004 water year[21] for these four USGS gage stations. These plots indicate that two significant peaks occur in the upper Catawba and South Fork Catawba River watersheds. The peak mean monthly flow occurs during the early spring, as shown in Figure 2-34. The annual drought occurs around late summer, shown in Figure 2-34 and Figure 2-36, balanced by seasonal heavy rain events producing a peak for maximum monthly flow during the same time frame, as shown in Figure 2-35.

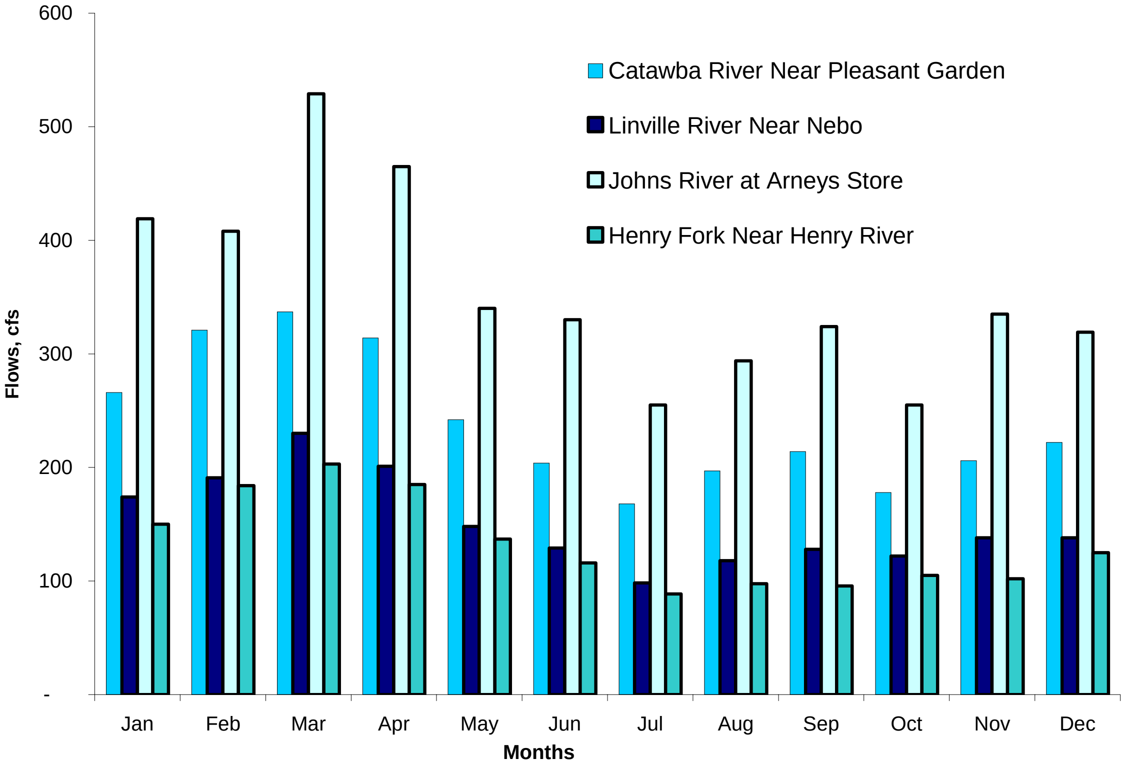

Figure 2-34: Mean Stream Flow Statistics

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[21] The USGS uses the 12-month period, October 1 through September 30 to designate the "water year".

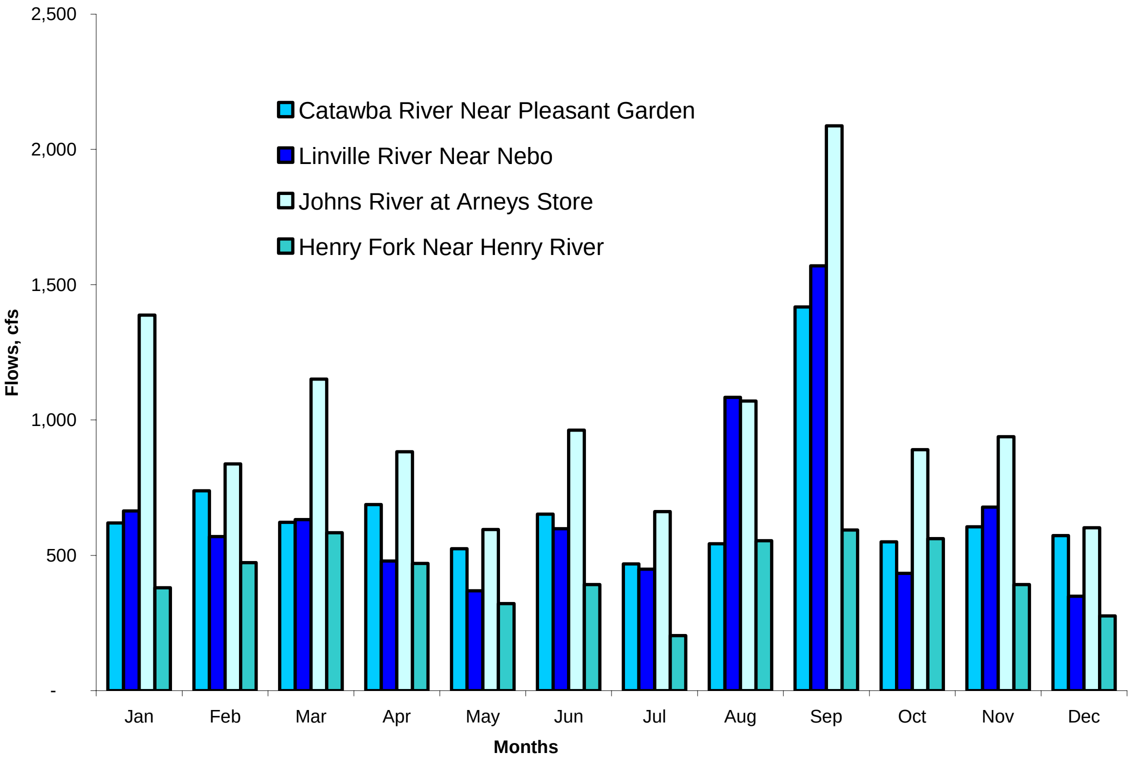

Figure 2-35: Maximum Stream Flow Statistics

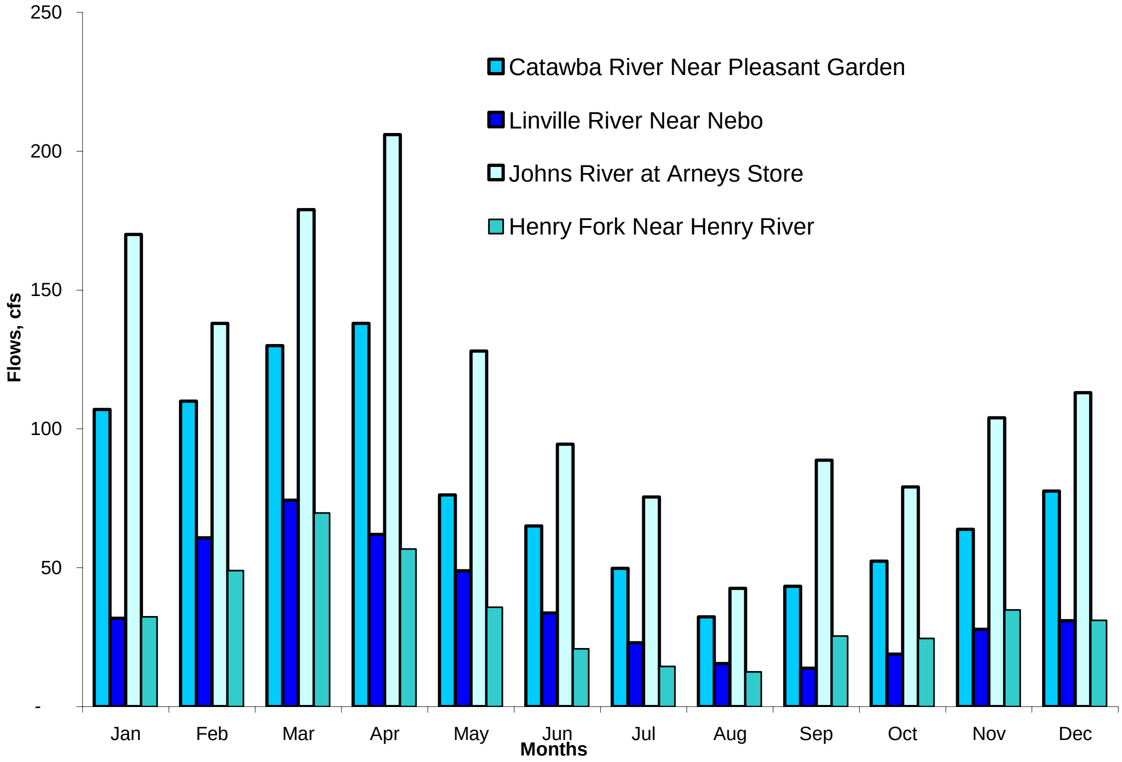

Figure 2-36: Minimum Stream Flow Statistics

The peak stream flow volumes are totally dependant upon the rainfall over the corresponding drainage areas. Thus the drainage area size as well as other factors such as geology, topography, vegetation, and temperature has a great influence over total runoff. The yield of a stream is calculated as the measured stream flow out of a unit area. Figure 2-37 through 2-39 show the mean, maximum and minimum unit stream flow measured as cubic feet per second (cfs) per square mile. These comparable unit flow plots are useful for decision-making in water resources management.

Compared to other gages, *Johns River Near Arney's Store* measured the highest stream flow in both wet and dry seasons as shown in figures 2-34 – 2-36 as it has the largest drainage area of 201 square miles. The second largest drainage area (126 square miles) is above the gage station at *Catawba River Near Pleasant Garden*. The stream flow statistics show that this station recorded about two-thirds of the volume measured at *Johns River Near Arney's Store*. However, unit flow volumes give a different picture. Even though the Linville area is the smallest of all four observed drainage areas, it is still the maximum producing stream (figures 2-37 – 2-38). One reason is that it includes the Linville Gorges and this topography influences the stream flow production.

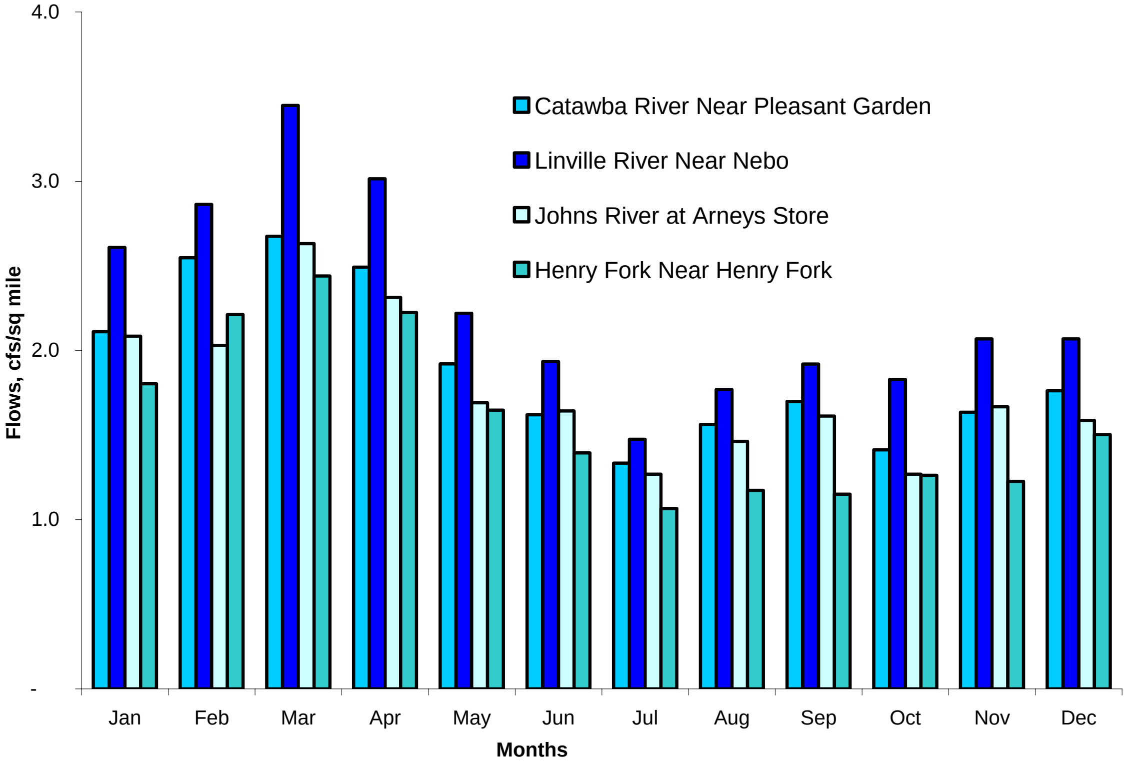

Figure 2-37: Unit Mean Stream Flow Statistics

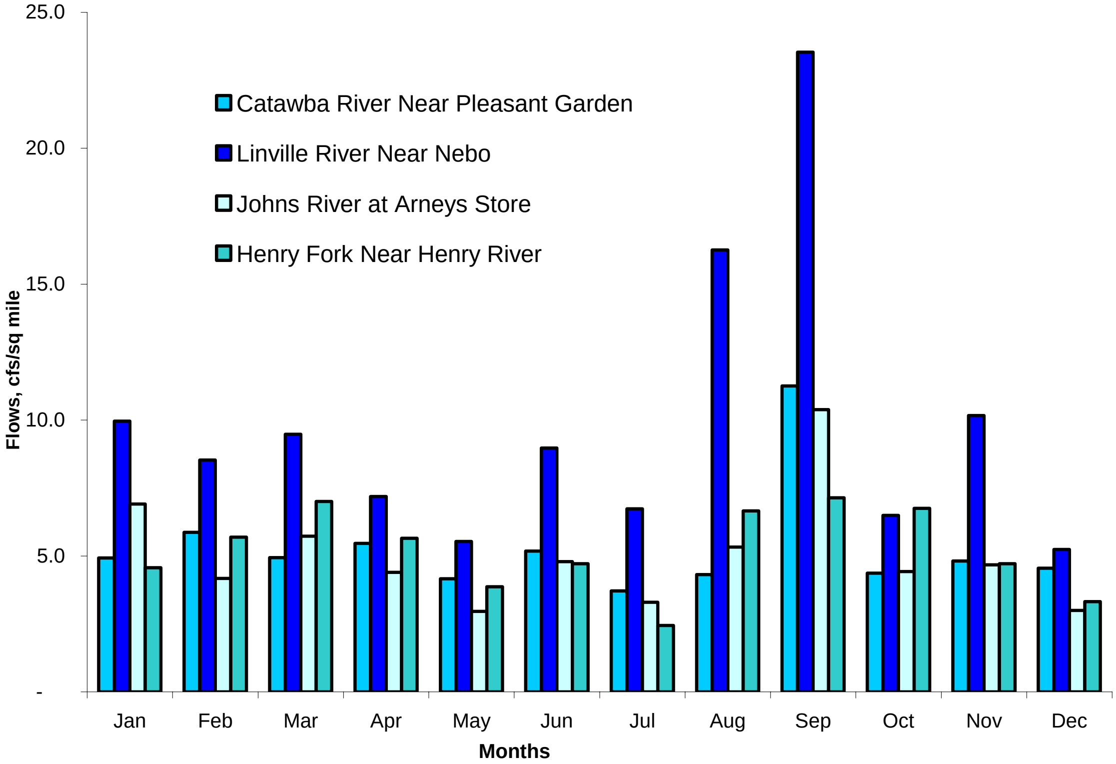

Figure 2-38: Unit Maximum Stream Flow Statistics

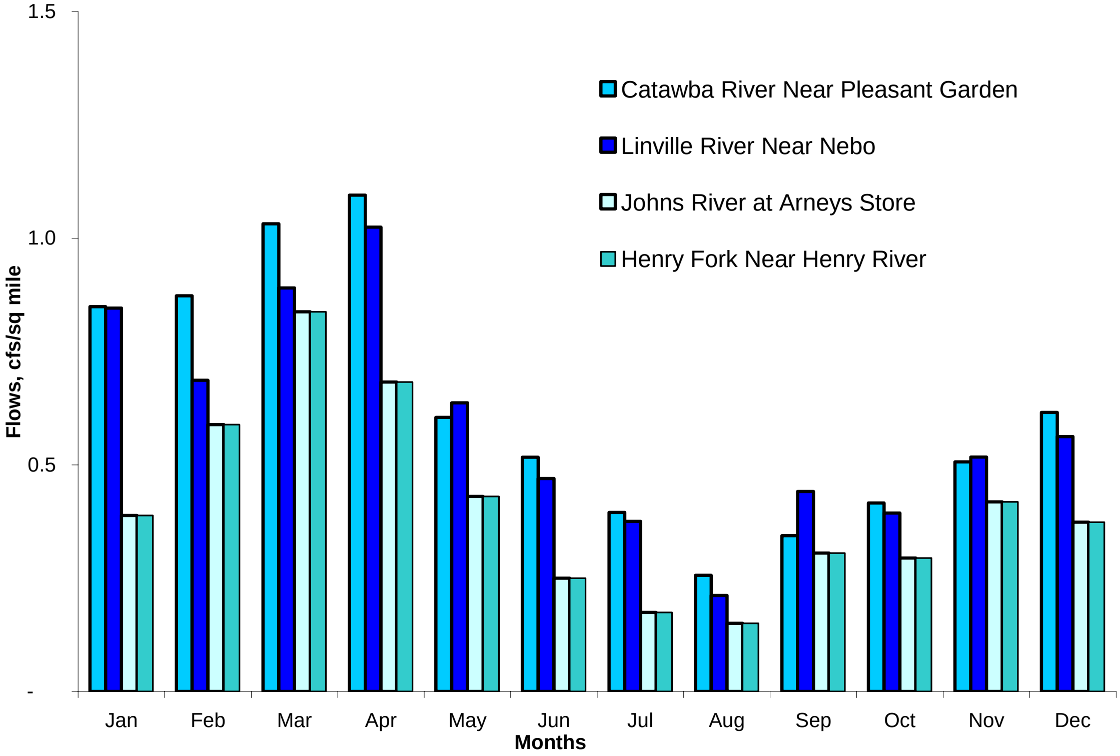

Figure 2-39: Unit Minimum Stream Flow Statistics

To supply certain quantity of water to the communities, a stream must be capable of producing that reliable quantity of water consistently throughout the year. The availability of that surface water throughout the year can be best presented in a duration plot. The stream flow duration plots for the above four stations are shown in Figure 2-40.

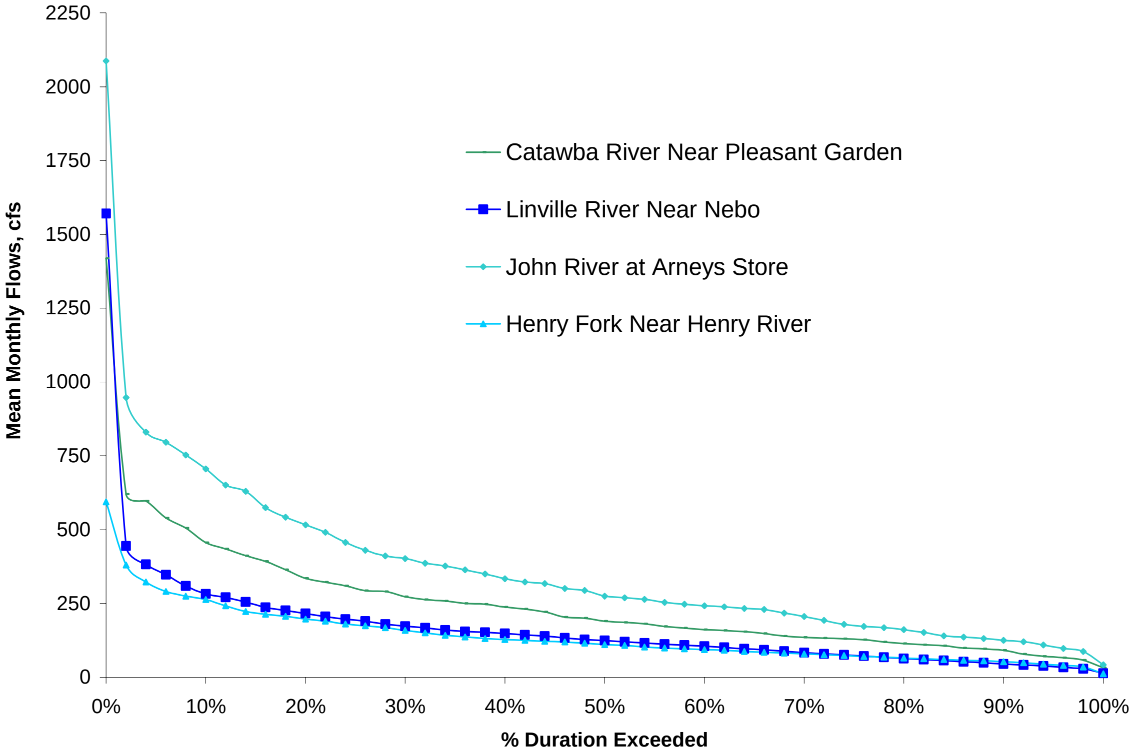

Figure 2-40: Mean Monthly Flow Duration Plot for four USGS gages for POR Water Years

These plots show that 50 percent of the time the flow varies at or below 110 cfs to 275 cfs at these four stations. Ninety percent of the time the flow varies at or below only 52 cfs to 125 cfs. The upper basin gage stations are more prone to flash floods than the lower basin stations such as *Henry Fork Near Henry River* as shown in the plot in Figure 2-40.

(b) Groundwater

Ground water occurs in the subsurface of the Catawba river basin in a similar fashion to other river basins in the Piedmont and Mountain provinces of North Carolina. In general, ground water flow boundaries are equivalent to the surface water drainage areas. Topographic highs form surface drainage and ground water divides and topographic lows form drainage avenues for both surface and ground water systems. Ground water flow tends to be of a local origin or contained within a watershed and not in a regional sense or between surface water basins which can occur in the Coastal Plain.

Rainfall infiltrates through soil horizons (if present) and into the weathered material overlying bedrock (saprolite) and into bedrock fractures, or into eroded and deposited weathered material (alluvium) and into bedrock fractures, or directly into bedrock where it is exposed at land surface. The water table is defined as the depth where the openings in the subsurface materials become saturated. Those openings may be joints or fractures in rock or pore spaces in unconsolidated rock material. The water table is a muted imitation of the topography; it is highest under hills and lowest in stream valleys. However, the water table is also closest to land surface in valleys. Ground water naturally discharges from the subsurface as base flow in streams and at springs (where the water table is higher than land surface). Base flow is the portion of stream flow made up of ground water. It is most easily measured when rainfall is negligible over a significant amount of time.

In Figure 2-41, the water table is represented by the solid line (the height water will reach in a well). When rainfall is scarce the ground water is not recharged and the water table declines (dashed line) as it is discharged from the subsurface via surface water drainage. Ground water would naturally follow theoretical flow lines as indicated, but would be restricted to flow through available openings or fractures. In this example, the stream would go dry without current runoff from rainfall into drainage.

In the diagram fractures in the bedrock illustrate some of the pathways in which ground water might flow. Fractures are shown as being more common in the valley and less common below the hill. In most cases topography is controlled by the fracture patterns. More highly fractured rock forms the valleys and draws and less fractured the hills and ridges. Often, fractures form conjugate pairs; fractures that are 60 to 90 degrees apart from one another. In some areas of the Catawba River Basin, the fracture patterns are obvious from the distribution and alignment of streams and topography. Ground water flow within saprolite and alluvium occurs in the porespaces.

Locating wells near lineations in topography or drainage patterns or at the intersection of such features usually increases the well yield. However, yields are dependent on many factors including depth of well, diameter of well, location (hill or valley), degree and orientation of fracturing of the rock unit, degree of weathering of rock (thickness of saprolite).

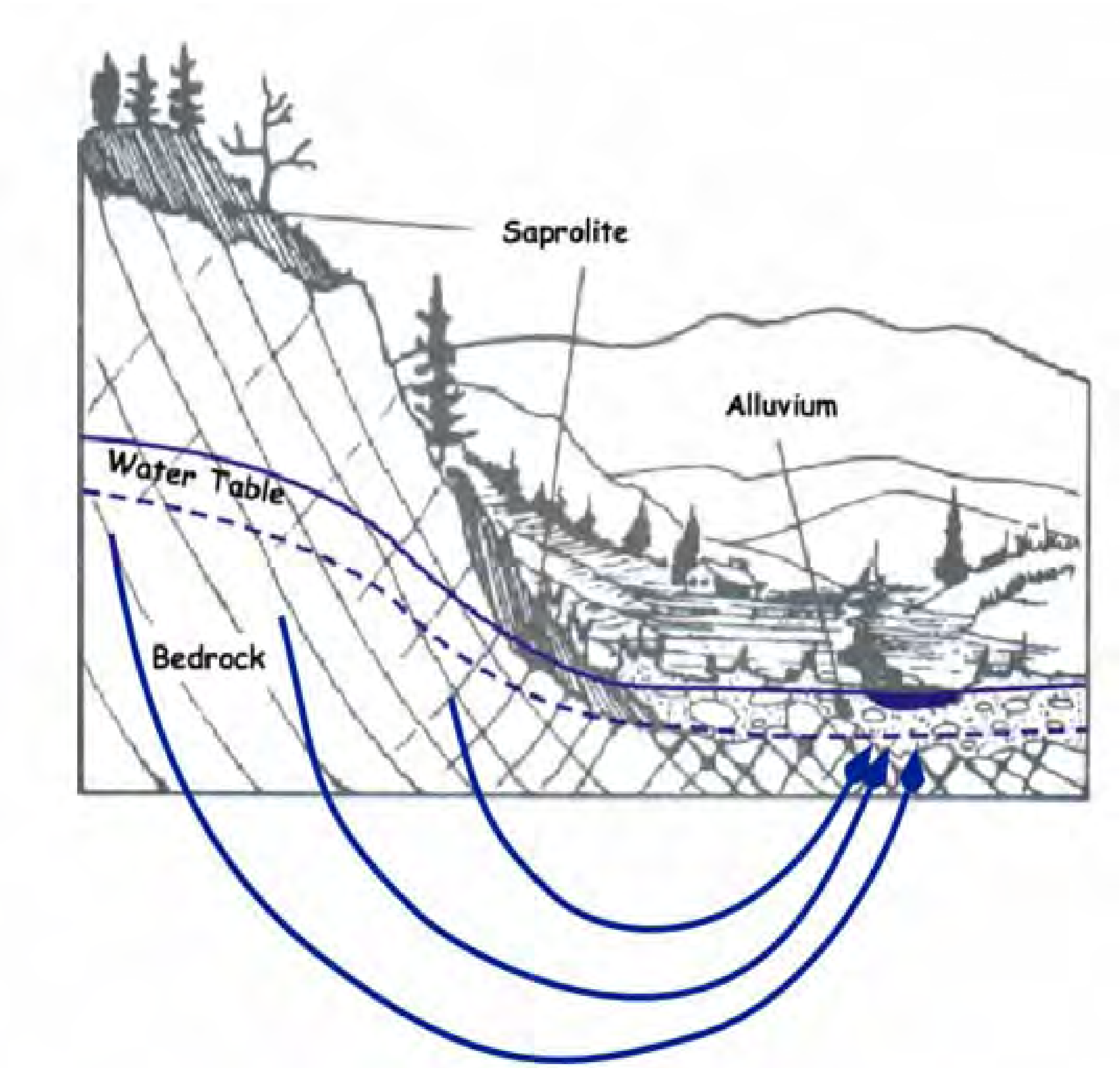

Figure 2-41: Adapted from USGS Water Resources Investigations 77-65, by M. D. Winner, Jr., figure 2. vertically exaggerated and generalized

Shallow wells, commonly dug or bored wells, tap the shallowest portion of the subsurface above the bedrock. They are usually a few tens of feet deep. They are most susceptible to going dry during drought conditions. Springs are also used for water supplies, but are also susceptible to going dry. Ground water reconnaissance studies identified many springs within the basin. Drilled wells are the most common method of extracting ground water. These wells are typically six inches in diameter and more than two hundred feet deep. Yields from all wells range from 0 to 500 gallons per minute and average about 18 gallons per minute within the Catawba River Basin based on ground water reconnaissance studies published between 1952 and 1967. Undoubtedly, yield averages have reduced if you factor in more recently constructed wells as homesites tend to be higher on the hillsides or ridgelines.

Although it is interesting to note the range of yield, differences in the methods used to collect this data and the variability of well construction and other factors make such comparisons unreliable. The best way to ensure a good yielding well is to drill it where it has the best chance to intersect as many bedrock fractures as possible. Often this is difficult to achieve. One may accomplish this by a review of topography and drainage patterns for the best locations. It is usually the case that a well should not be drilled in the most convenient location. Dug or bored wells should not be used as they are prone to pollution and drying up.

(c) Climate

The overall climate can be described as humid subtropical, consisting of long, hot, humid summers, and short, mild winters (USGS Report 2005). Temperature variations over the area are not very significant even though altitudes vary along the terrain, although climate changes can be observed between the mountains in the west and the piedmont in the east and south.

The rain is formed by the moisture carried mostly from the Atlantic and Gulf of Mexico. The highest rainfall amounts occur in the mountains of southwest just outside of the Catawba River basin and the lowest occur in the central mountains, to the west of the Catawba River basin, where the surrounding mountains apparently reduce the amount of rainfall reaching the area. Rainfall during the winter tends to be widely distributed and summer rainfall tends to be spotty with thunderstorms (USGS Report 2005).

Statistical analyses performed using the observed rainfall and temperature data from several weather stations[22], and Duke's reservoir evaporation data[23] are presented in the following sub-sections.

(i) Rainfall

The rainfall data were collected from the South East Regional Climate Center (SERCC) for seven stations: five in North Carolina and two in South Carolina. On average one station was selected from each county covering the length of the river basin. The selected stations are: Marion, Bridgewater, Morganton, Lookout Shoals, Lincolnton, Charlotte, Rockhill and Great Falls. All of these stations have at least 55 years of rainfall records with very few missing data points. The annual average rainfall plots for these stations are shown in Figure 2-42**.** This plot shows that the highest average annual rainfall of 54.5 inches was observed at Marion in the western portion of the basin. The rainfall amounts are relatively lower to the

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[22] Southeast Regional Climate Center, "Historical Climate Summaries for North Carolina" http://www.dnr.sc.gov/climate/sercc/climateinfo/historical/historical_nc.html

[23] CHEOPS model data

east, with the lowest being observed in Charlotte (42.7 inches). Figures 2-42 and 2-43 show that the stations in southern part of the basin in South Carolina measured slightly higher rainfall. In North Carolina, monthly rainfall varies from 3 to 5 inches depending on the season as shown in Figure 2-43. It also shows that during the summer the western stations experience higher amount of rainfall, and eastern/southern stations experience lower amount of rainfall.

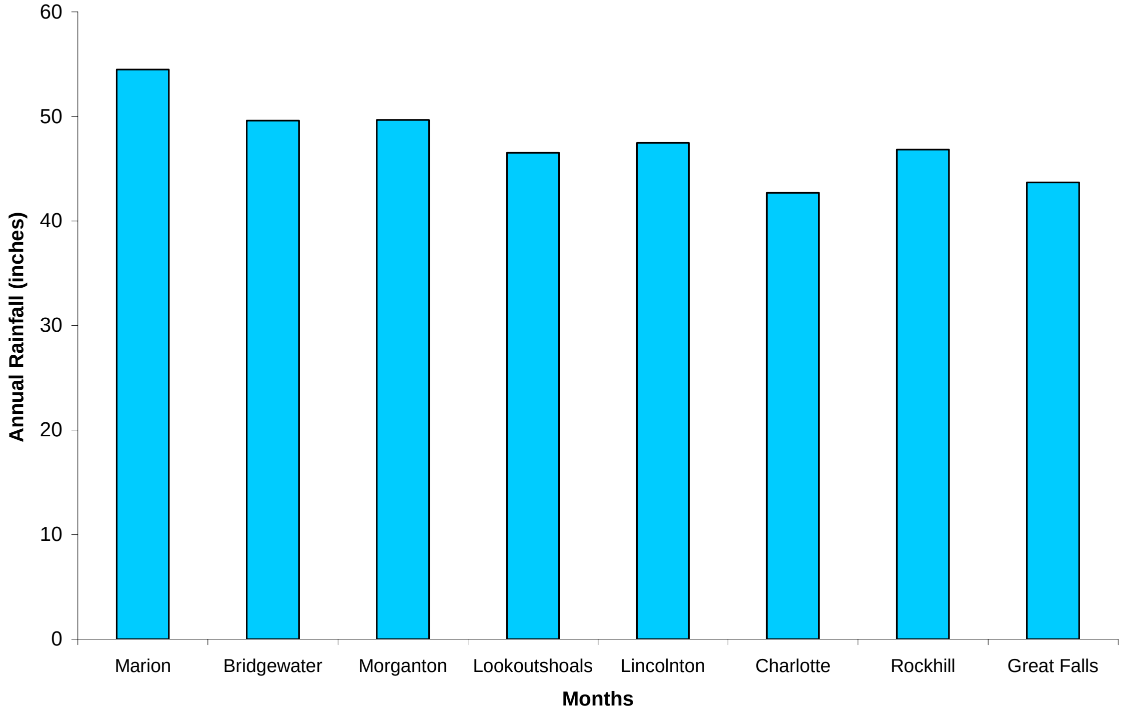

Figure 2-42: Average Annual Rainfall At Selected SERCC Stations

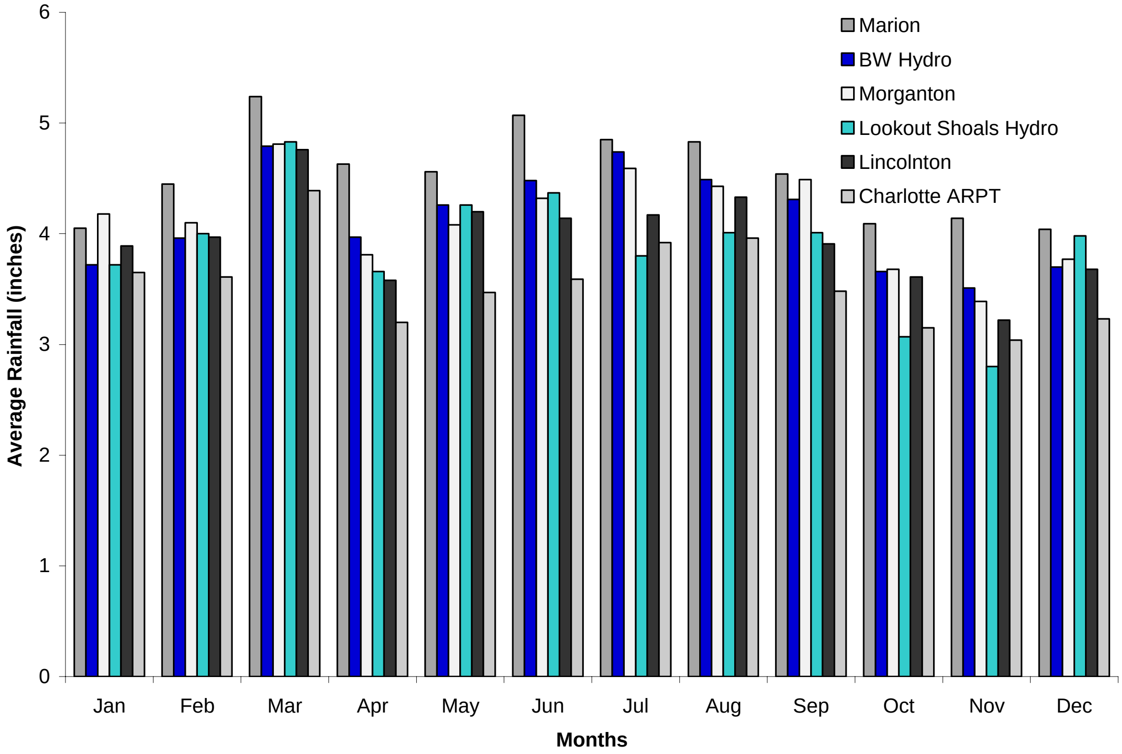

Figure 2-43: Average Monthly Rainfall At Selected SERCC Stations in the Catawba River Basin, North Carolina

(ii) Temperature

Temperature readings recorded at five SERCC weather stations (Marion, Morganton, Hickory, Lincolnton, and Charlotte) was analyzed. As mentioned above, temperature variations across the basin are relatively small. Figure 2-44 shows the average monthly temperature variation for the five stations. The region warms to the upper 70s in summer, falls to below 40 in winter and stays in the upper 50s during the spring (Figure 2-45).

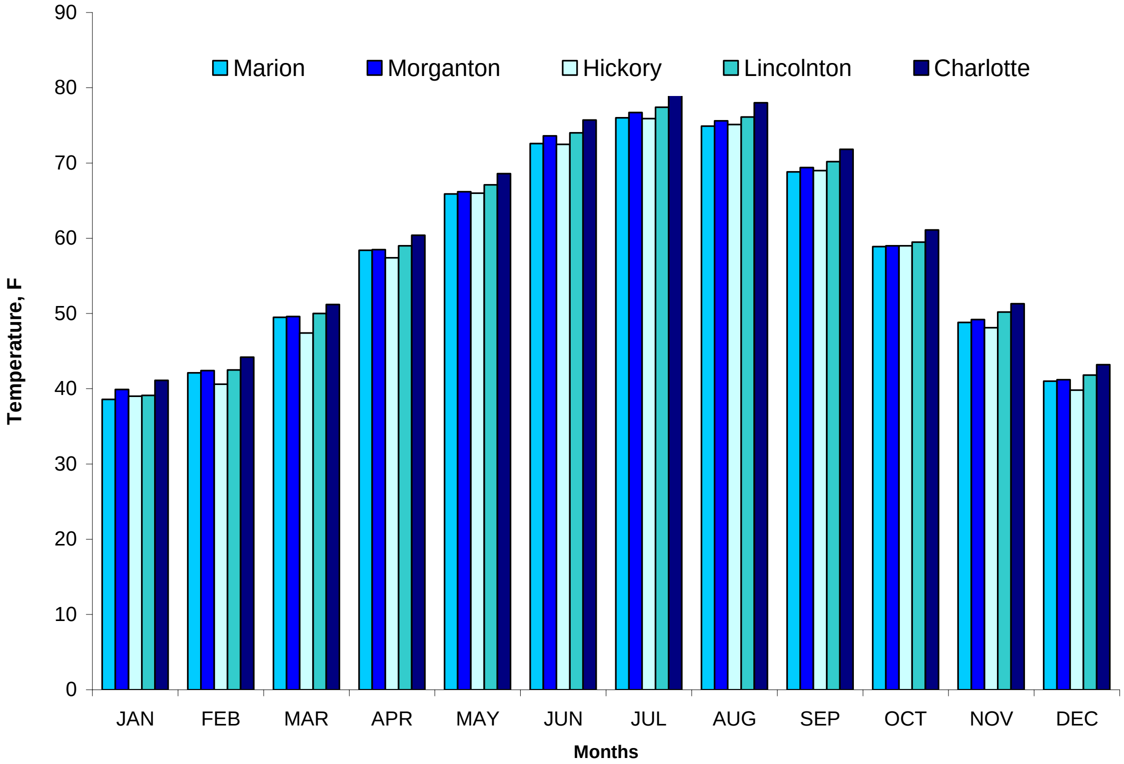

Figure 2-44: Average Monthly Temperature at Selected SERCC Stations in the Catawba River Basin, North Carolina

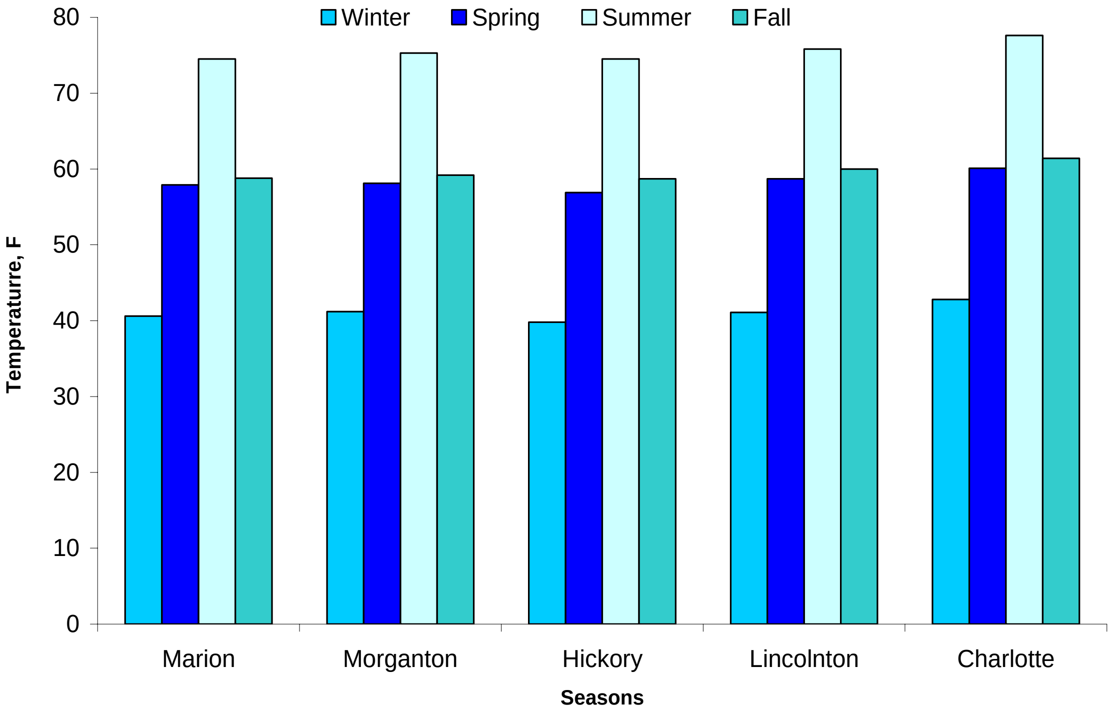

Figure 2-45: Seasonal Average Temperature at Selected SERCC Stations in the Catawba River Basin, North Carolina

(iii) Reservoir Evaporation

The eleven reservoirs along the main stem of the Catawba River create huge open surfaces of water that allow the loss of water through evaporation. The average daily reservoir evaporation rate is collected for eleven reservoirs from the data used in Duke Energy's CHEOPS reservoir operation model. The monthly patterns of these data are presented in Figure 2-46. This figure shows that the highest evaporation occurs in July, when it varies from .01 to .014 feet per acre of reservoir surface area per day.

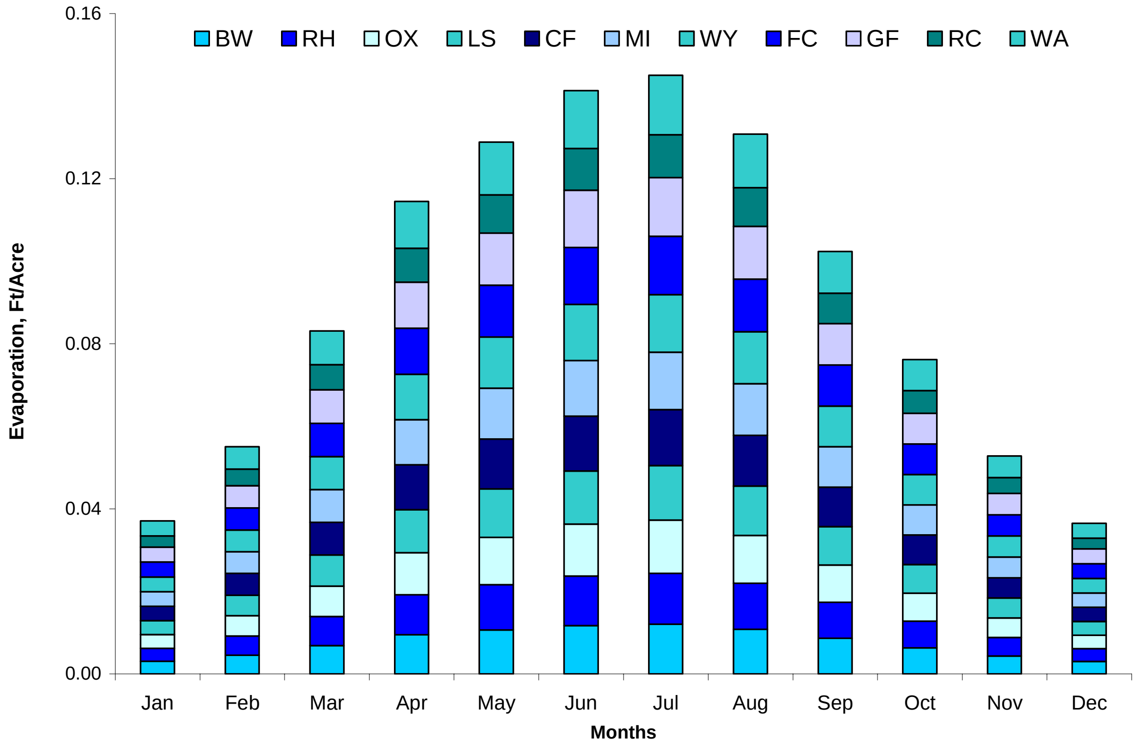

Figure 2-46: Monthly Pattern of Daily Reservoir Evaporation in the Catawba River Basin

(d) Drought

Drought conditions prevailed across much of North Carolina from 1998 to 2002, resulting in widespread record-low streamflow and groundwater levels in many areas (USGS Report 2005, 2). In general, it is believed to be the most severe drought in recent years.

The hydrology from USGS stream gage records show that much of the Catawba River basin experienced low flow conditions from 2000 to 2002 compared to the other low flow periods. The report, *"The Drought of 1998 – 2002 in North Carolina – Precipitation and Hydrologic Conditions*" published by USGS also shows the variability of the drought throughout the state from 1998 to 2002 (USGS Report

2005). Daily mean discharges before and after the drought were compiled and minimum 7-day average discharges at six selected gaging stations with long term records were compared by USGS. At three of the six sites, all located in the Blue Ridge and Piedmont areas, the minimum 7-day average discharges during the 1998 to 2002 drought became the minimum flows of record (USGS Report 2005, 40). These comparisons confirmed that the deepest drought occurred in the streams near the Catawba basin.

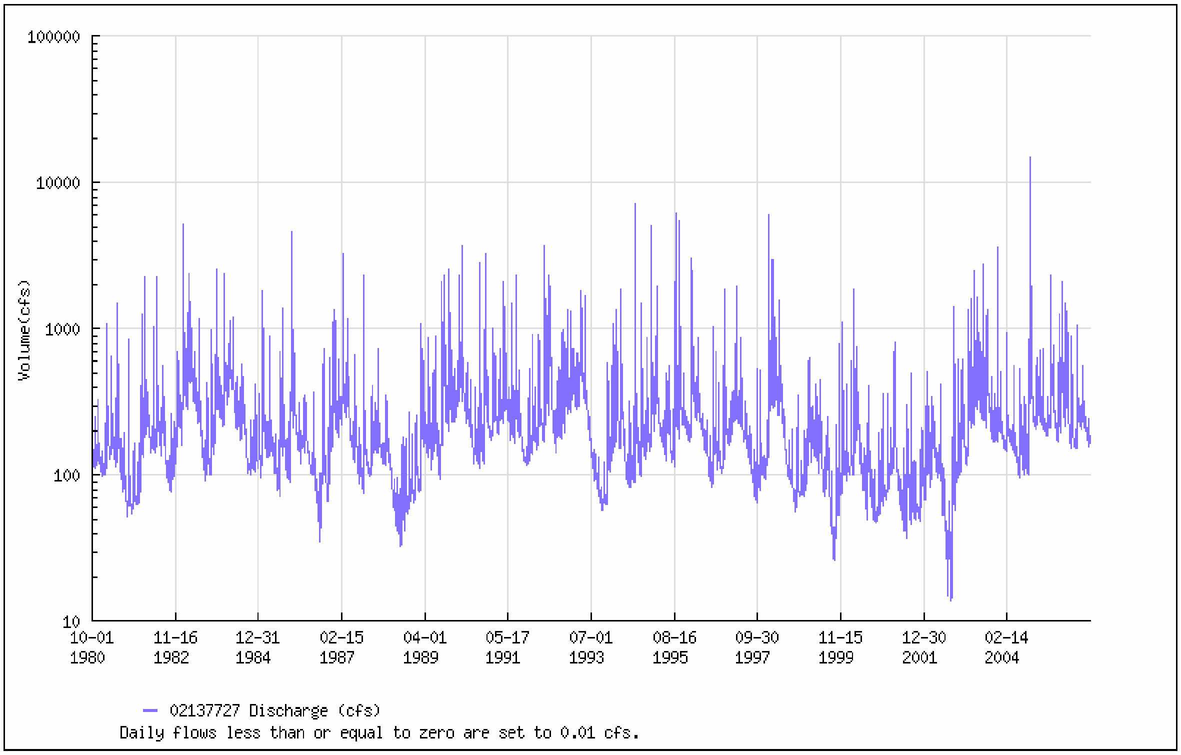

Figure 2-47: Hydrograph of Stream flow in Catawba River Near Pleasant Garden

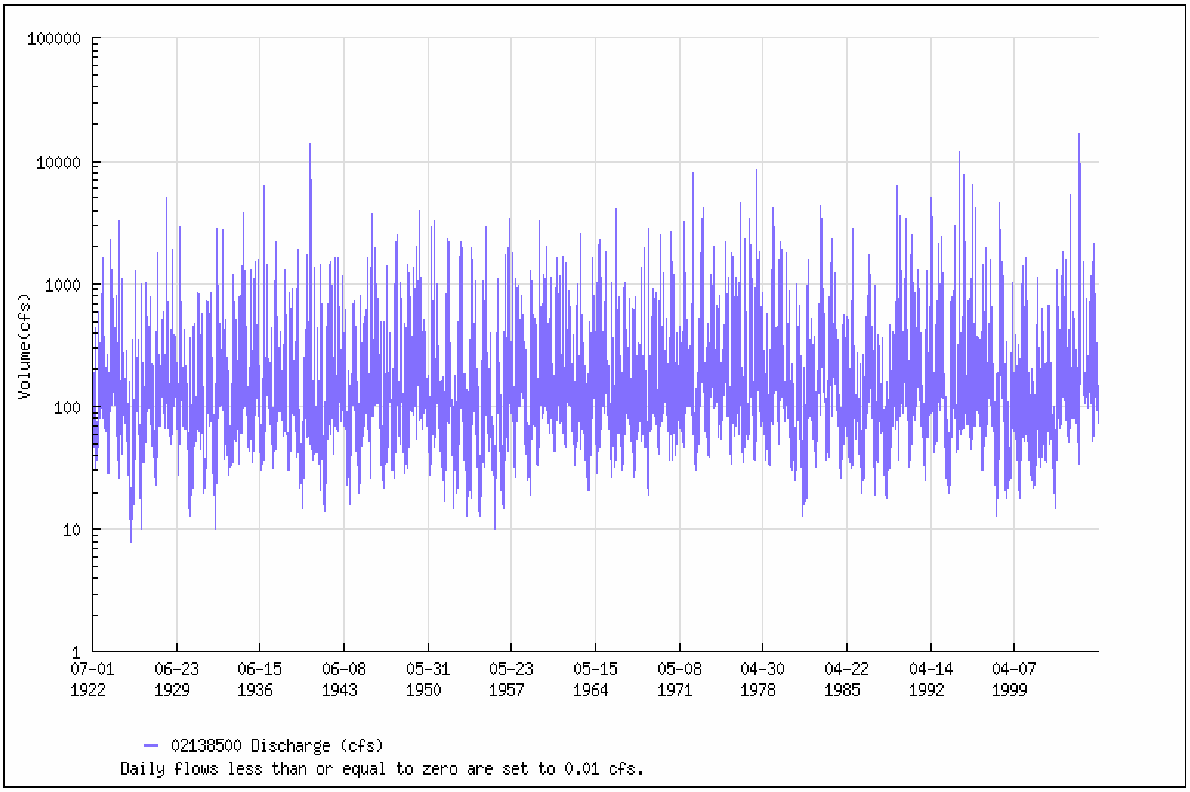

Figure 2-48: Hydrograph of Stream flow in Linville River Near Nebo

Also for further comparison, stream flows for four of the Catawba USGS gage stations were downloaded from USGS website and hydrographs were plotted in time series and are presented in figures 2-49 through 2-52. Gage stations at *Catawba River Near Pleasant Garden*, *Johns River Near Arney's Store* and *Henry Fork Near Henry River* in figures 2-49, 2-50 and 2-51 show that the flows gradually declined in 2002 from previous year. The flow statistics are also presented in figures 2-53 through 2-56 for those stream flows from the same gages. Monthly stream flow averages are compared with drought period's flows, especially for 2002. Only Linville River had the driest period in mid 1920s as shown in figure 2-54, whereas the other three locations show the minimum flows recorded during 2001 and 2002.

The USGS report also noted that precipitation records in two stations within Catawba River basin (Hickory and Charlotte), the average monthly deficit for the 1998 to 2002 drought exceeded the values computed for the other drought periods. The largest cumulative precipitation deficit (66.7 inches below normal) occurred in Hickory during the 1998 to 2002 (USGS 2005).Thus, these rainfall deficits also illustrate how much the basin was affected by this recent drought.

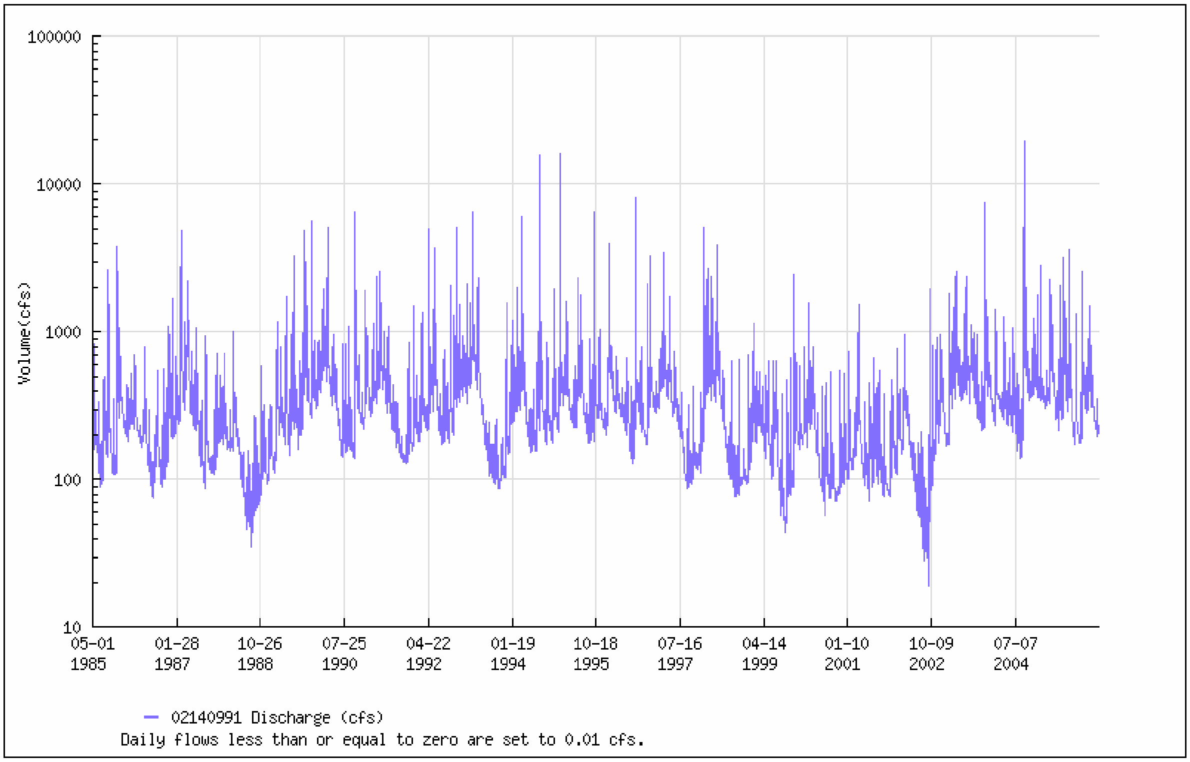

Figure 2-49: Hydrograph of Stream flow in Johns River At Arney's Store

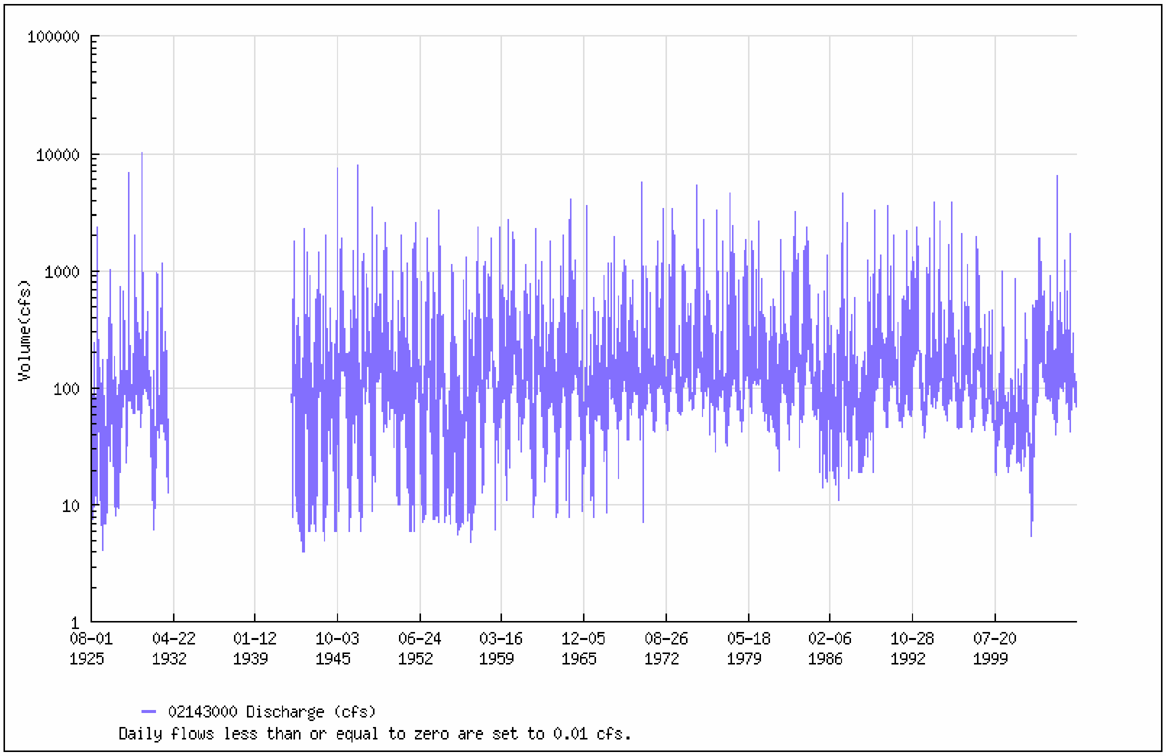

Figure 2-50: Hydrograph of Stream flow in Henry Fork Near Henry River

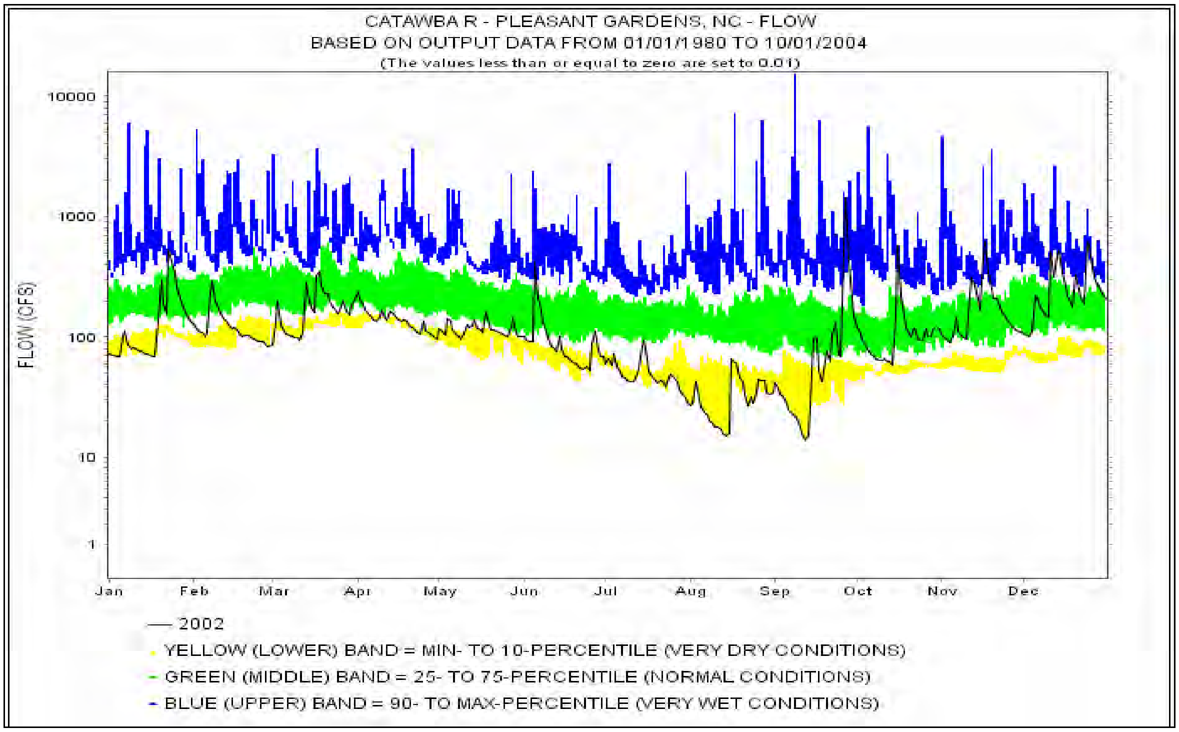

Figure 2-51: Statistics of Stream flow in Catawba River Near Pleasant Garden

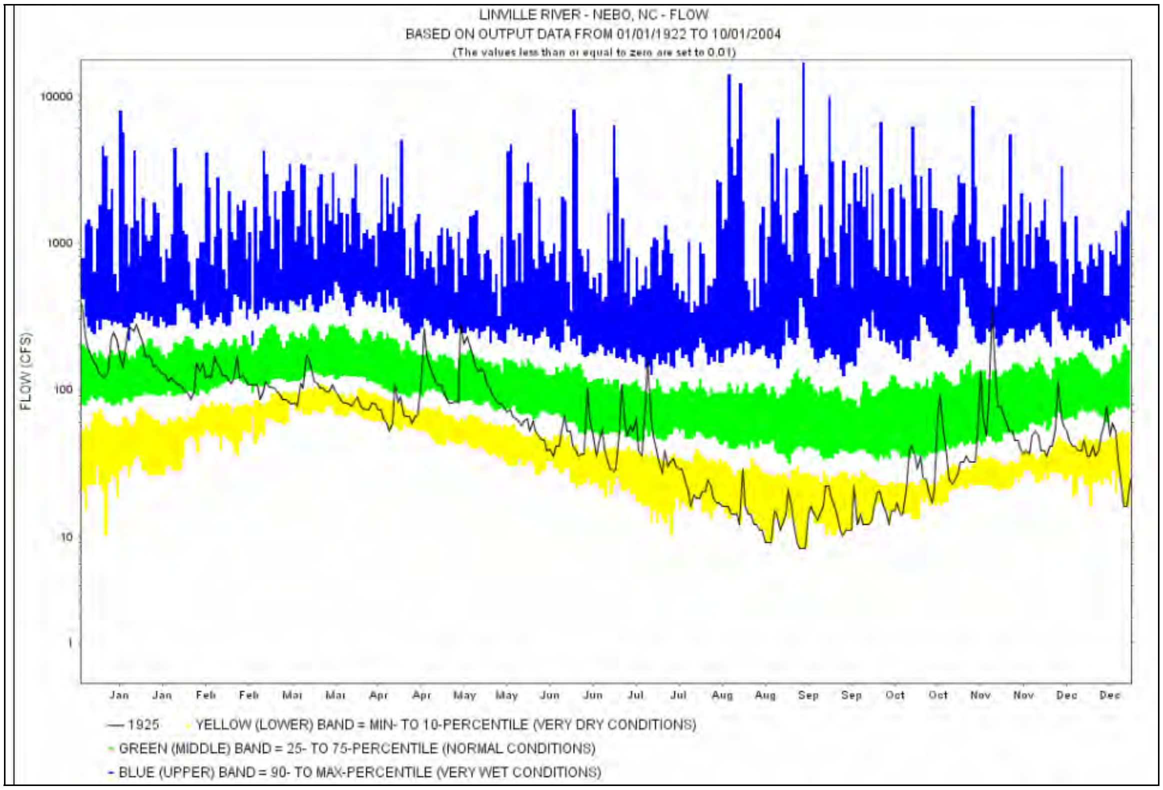

Figure 2-52: Statistics of Stream flow in Linville River Near Nebo

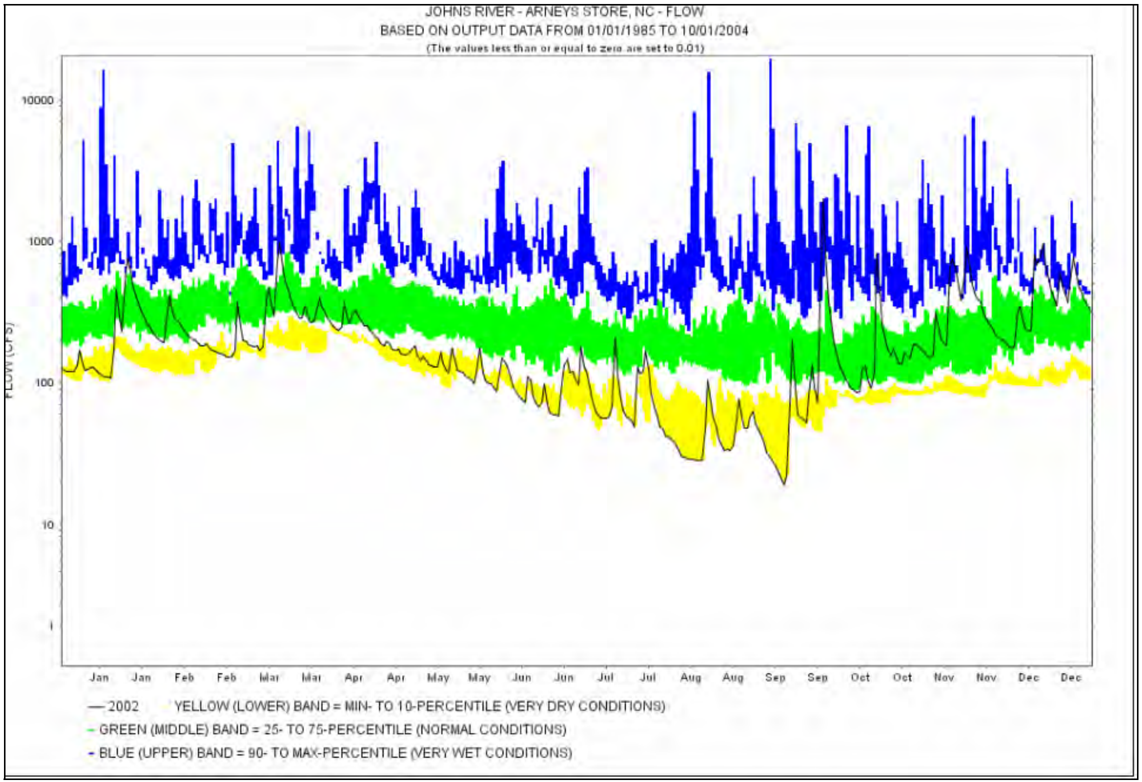

Figure 2-53: Statistics of Stream flow in Johns River At Arneys

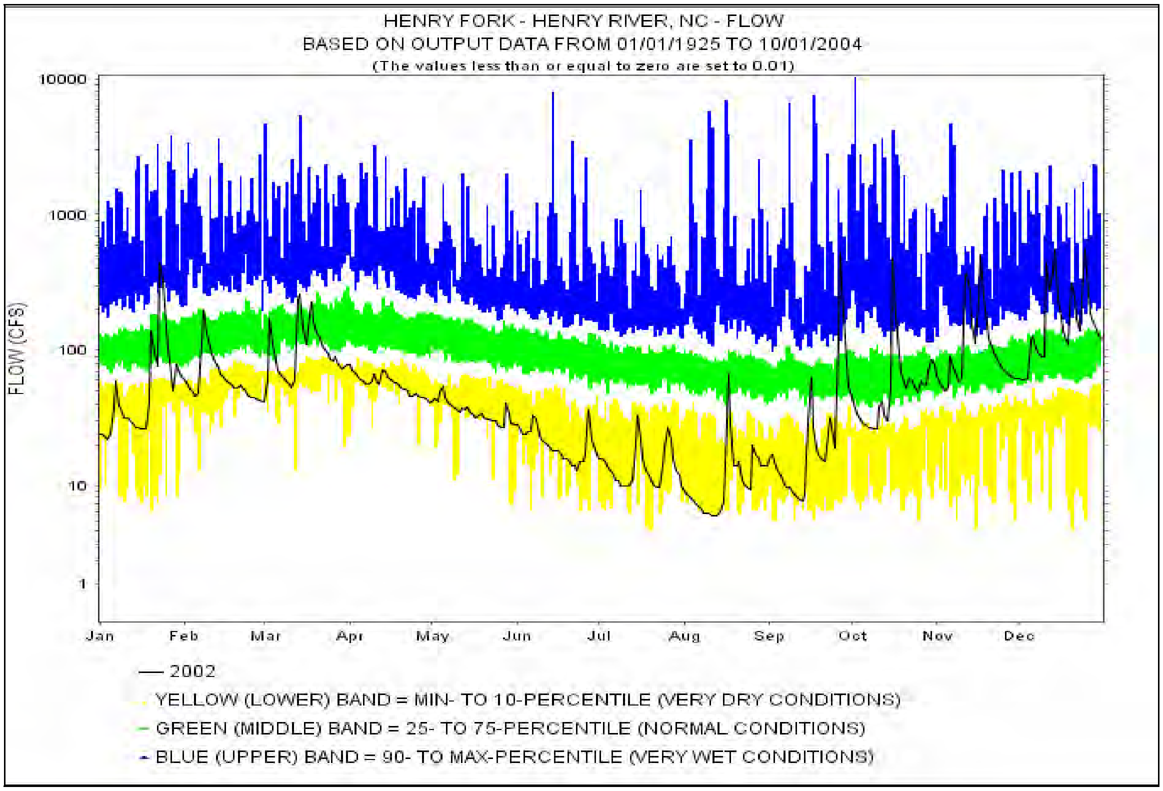

Figure 2-54: Statistics of Stream flow in Henry Fork near Henry River

Ground water levels have been measured on a recurring basis in 15 wells located in the Catawba River Basin between 1968 and present day. Currently, four wells continue to be measured. The four current stations and their beginning year of record are Glen Alpine in Burke County (1970), Linville in Avery County (1972), Hornets Nest Park in Mecklenburg County (1984), and Troutman in Iredell County (1972). The water level records from all 15 wells reveal four distinct periods of drought. The time period from 1970 through 1972 was dry for four wells, 1986 through 1989 was dry for seven wells, 1999 through 2002 was dry for four wells (only four wells were being monitored at this time), and 2005 was dry for one of the four wells. The magnitude of the decline in water levels was largest for the 1999 through 2002 time period.

Beyond the water levels measured in the monitoring wells, the 1999 through 2002 drought could be measured in the number of phone calls received and the reports from county health departments about well failures. Most of these well failures were dug or bored well owners getting information about new well construction and permits.

Above normal rainfall amounts began to occur in August and September of 2002. However, the stream flows and groundwater levels did not begin to increase across most of North Carolina, including the Catawba River basin, until the spring of 2003, thereby ending the hydrological drought (USGS Report, 2005).

This recent drought not only dried out the streams and wells within the basin, this dry condition impacted the public water supply systems also. These systems responded to drought through various forms of water conservations. Table 2-6 shows the water conservation status of the public water supply systems during 1998 – 2002 droughts. The numbers in the table show that many systems were in emergency water conservation condition for many months in 2002. Granite Falls, Bessemer City and Charlotte Mecklenburg Utilities had the highest cumulative impact of emergency condition for four months in 2002.

Table 2-6: Number of months the Public Water Supply Systems under Conservation measures during 1998- 2002 Drought

PWSID	Water System	WC Public Education Program	V98	V99	V00	V01	V02	M98	M99	M00	M01	M02	E98	E99	E00	E01	E02	Pub Education02	Voluntary	Mandatory	Emergency
01-02-010	Taylorsville	No	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	No	1	0	2
01-02-020	Alexander County WD	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Yes	0	0	0
01-02-035	Bethlehem WD	No	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	Yes	6	0	0
01-06-104	Linville Land Harbor	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-12-010	Valdese	Yes	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	Yes	2	0	0
01-12-015	Morganton	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Yes	0	0	0
01-12-040	Triple Community WC	Yes	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	Yes	8	0	0
01-12-045	Drexel	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-12-060	Icard Township WC	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-12-065	Burke County	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-12-103	Brentwood WA	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-12-104	Brentwood Water Corp	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-14-010	Lenoir	No	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	No	6	0	0
01-14-025	Baton WC	No	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	Yes	5	0	0
01-14-030	Granite Falls	No	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	Yes	4	0	4
01-14-035	Rhodhiss	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-14-040	Sawmills	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-14-045	Caldwell County W	No	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	No	3	0	0
01-14-046	Caldwell County S	No	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	No	3	0	0
01-14-047	Caldwell County SE	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-14-048	Caldwell County N	No	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	No	3	0	0
01-18-010	Hickory	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Yes	0	0	0
01-18-015	Newton	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-18-020	Conover	No	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	Yes	3	0	0
01-18-025	Longview	No	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	No	5	0	0
01-18-030	Maiden	Yes	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	Yes	5	0	0
01-18-035	Claremont	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-18-040	Catawba	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-36-010	Gastonia	No	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	Yes	2	0	0
01-36-015	Belmont	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-36-020	Mount Holly	Yes	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	Yes	4	0	0
01-36-025	Bessemer City	No	1	2	2	1	2	0	1	0	0	0	0	0	1	2	4	Yes	8	1	7
01-36-030	Cherryville	Yes	5	5	5	6	6	0	0	0	0	6	0	0	0	0	0	Yes	27	6	0
01-36-034	Ranlo	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-36-035	Stanley	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-36-040	Cramerton	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Yes	0	0	0
01-36-045	McAdenville	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-36-060	Lowell	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	0
01-36-065	Dallas	No	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	No	1	0	0
01-36-075	High Shoals	No	0	0	0	0	3	0	0	0	0	1	0	0	0	0	2	No	3	1	2
01-49-015	Mooresville	Yes	0	0	0	0	3	0	0	0	0	0	0	0	0	0	2	Yes	3	0	2
01-55-010	Lincolnton Water System	Yes	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	No	3	0	0
01-55-035	Lincoln County	Yes	0	0	0	0	3	0	0	0	0	0	0	0	0	0	2	Yes	3	0	2
01-56-010	Marion	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Yes	0	0	0
01-56-025	Old Fort	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Yes	0	0	0
01-60-010	Charlotte Mecklenburg Utilities	Yes	0	0	6	12	8	0	0	0	0	0	0	0	0	0	4	Yes	26	0	4
01-90-413	Union County	No	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	Yes	2	0	1
20-18-004	Southeastern Catawba County WD	No	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	No	6	0	0

Section 2.3 Water Supply – Drainage Area Summaries

(a) Lake James Drainage Area

Lake James is the westernmost lake in the Catawba River basin. The Lake James drainage area includes the headwaters for the Catawba River, just west of the Town of Old Fort, and is comprised of 380 square miles of largely forested land. In fact, approximately half of the drainage area is located within the Pisgah National Forest (North Carolina Department of Environment and Natural Resources 2001, 6). Major tributaries within the Lake James drainage area include the North Fork of the Catawba River and the Linville River. The largest portion of the drainage area is located in McDowell County, with smaller portions located in Burke and Avery Counties (Figure 2-55). It is located in the foothills of the Blue Ridge Mountains and the landscape is dominated by rolling hills (North Carolina Division of Water Quality 1999, 3).

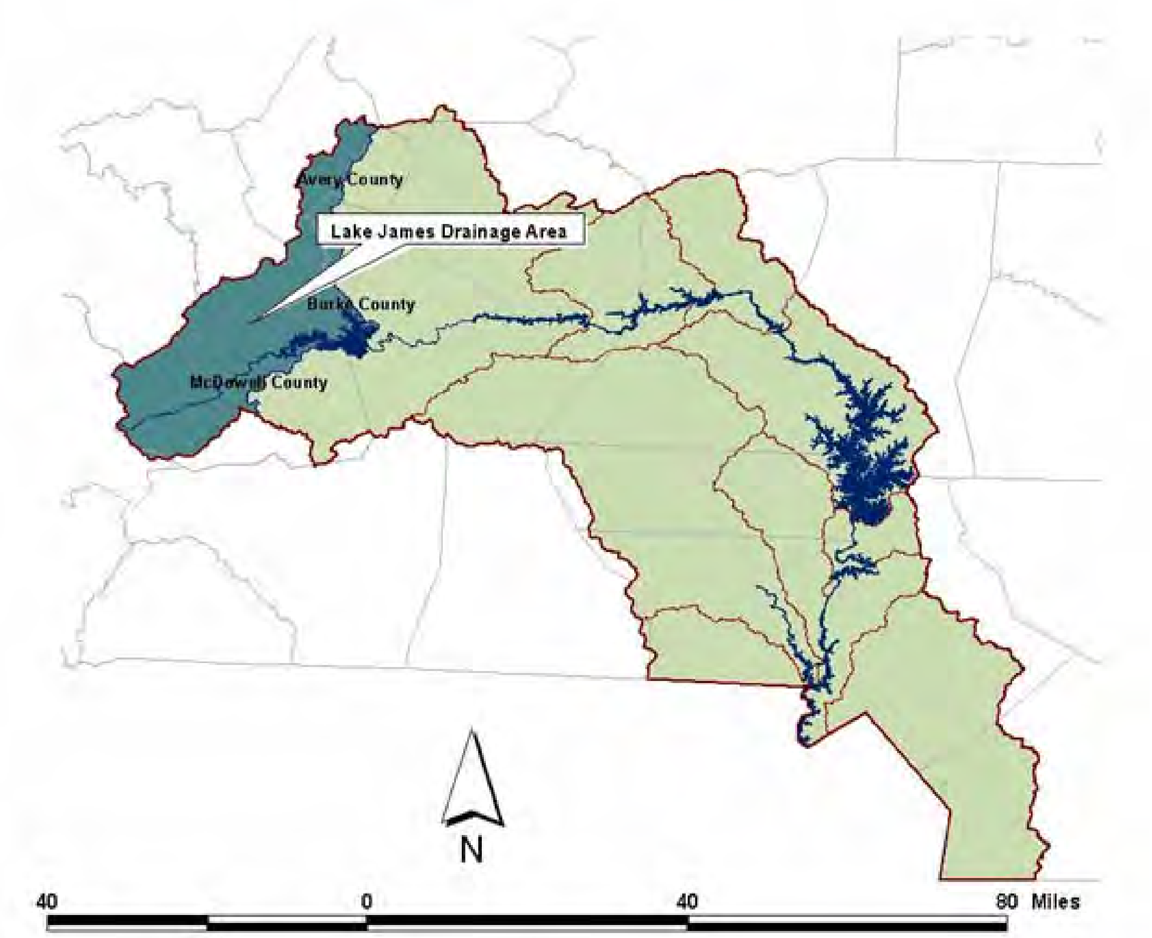

Figure 2-55: Lake James Drainage Area Location

The three counties in this drainage area are relatively rural. The largest municipality is the City of Marion, located in McDowell County, which also operates the only community water system to withdraw surface water from the drainage area. Other surface water withdrawals in the drainage area are made by Coats American, two trout farms, several fish hatcheries, and for use in agriculture and irrigation, including golf courses. A Duke Energy facility is also projected to withdraw water from Lake James beginning in 2048; although, specific plans for this facility do not, as of yet, exist (HDR, Inc. Engineering of the Carolinas 2005, 14).

Table 2-7 shows the City of Marion's projected demand (2002 Local Water Supply Plan (LWSP)). As seen in **Figure 2-56**[24], of the demand projections calculated for this report[25], the LWSP projections (blue line) and the Duke Water Supply Study projections (red line) (HDR, Inc. Engineering of the Carolinas 2005, Appendix C) both fall near the bottom of the projection range. In between 2040 and 2050, projected demand in the Lake James Drainage Area seems to jump drastically; however, this is only due to the aforementioned future Duke Energy facility, which is projected to use 15.3 MGD on average. The lowest and highest projections begin only 0.717 MGD apart in 2010 and finish 4.346 MGD apart in 2050. The lowest projections, the LWSP projections, and the Duke projections all rise between 2010 and 2050 by approximately 22 MGD (21.97, 21.8, and 21.94 MGD respectively) (HDR Engineering of the Carolinas 2005, Appendix C). The highest projections rise by 25.6 MGD for the same period.

Table 2-7: 2002 Local Water Supply Plan Service Area Demand Projections (in MGD)

	2002	2010	2020	2030	2040	2050
Surface Water Systems						
City of Marion	1.51	1.717	1.983	2.243	2.542	2.889
Total	1.51	1.717	1.983	2.243	2.542	2.889
Groundwater Systems						
Town of Old Fort	0.38	0.418	0.469	0.525	0.582	0.648
Linville Land Harbor	0.29	0.292	0.292	0.292	0.292	0.292
Total	0.67	0.71	0.761	0.817	0.874	0.94

In terms of wastewater, the City of Marion, the Linville Harbor Private Owners Association and the Town of Old Fort are all community water systems that discharge into the drainage area through their own wastewater treatment plants. The Linville Harbor Private Owners Association and the Town of Old Fort rely solely on groundwater as their water source. While the City of Marion discharges some of its wastewater to Lake James, a small portion of it is also discharged to the Lake Rhodhiss drainage area through Marion's Corpening Creek Wastewater Treatment Plant. **Table 2-8** shows projections for wastewater discharges in the

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[24] Figure 2-58 represents the range of withdrawal projections calculated for the Lake James drainage area. The highest and lowest projections for each year were selected from all projections calculated, and so do not always represent just one projection method. For a table of all of the projection values calculated, please see Appendix C.

[25] For information on how these projections were calculated, please see Appendix B.

Lake James drainage area based on the 2002 LWSPs and projections from the Duke Energy Water Supply Study (HDR, Inc. of the Carolinas 2005, Appendix C)[26].

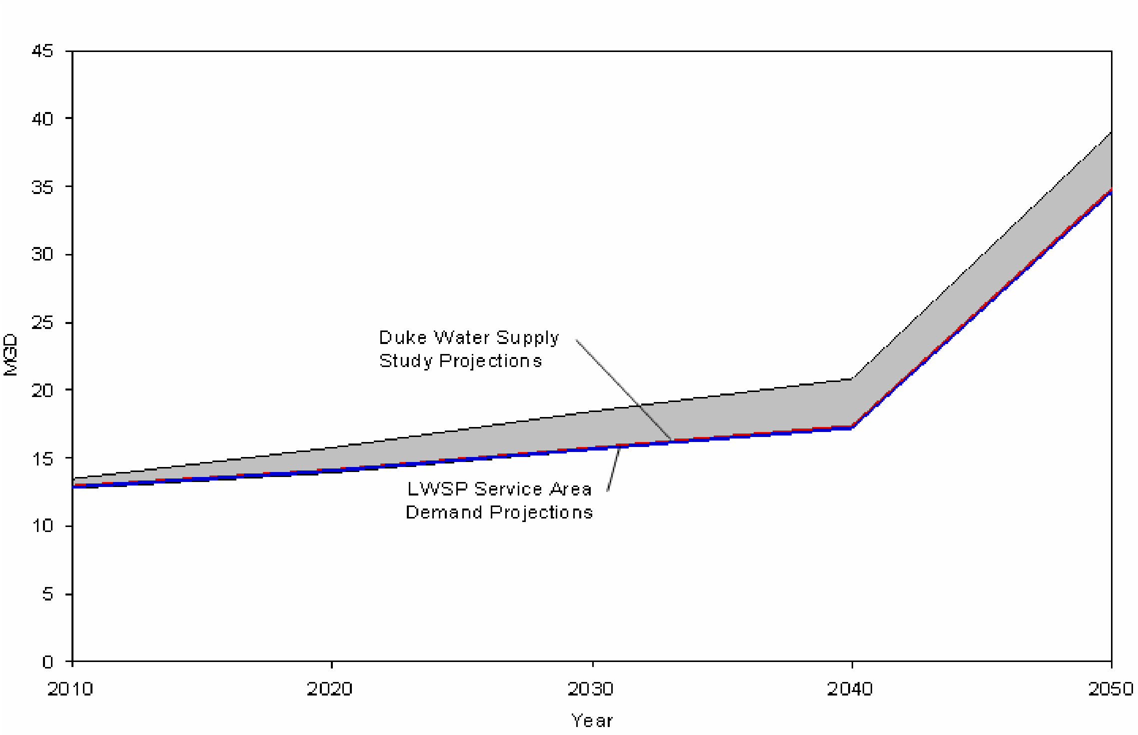

Figure 2-56: Lake James Drainage Area Water Demand Projections Range

Table 2-8: Discharge Projections – Lake James Drainage Area (in MGD)

	2002	**2010**	**2020**	**2030**	**2040**	**2050**
Discharge to Lake James						
Withdrawn from Lake James	7.969	8.780	9.401	10.085	10.832	11.736
Withdrawn from Groundwater	0.635	0.670	0.719	0.719	0.826	0.889
Withdrawn from Unknown Source	1.110	1.360	1.660	1.960	2.260	2.560
Total	9.714	10.810	11.780	12.764	13.918	15.185
Discharge to Other Drainage Areas						
Discharge to Lake Rhodhiss	0.621	0.636	0.725	0.838	0.948	1.221
Total Discharge From Lake James Drainage Area	**10.335**	**11.446**	**12.505**	**13.601**	**14.866**	**16.405**

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[26] For information about how these projections were calculated, please see Appendix B.

(b) **Lake Rhodhiss Drainage Area**

Based on the streamflow direction, Lake Rhodhiss is the second of seven lakes on the Catawba River in North Carolina. Its 710 square miles cover portions of McDowell, Avery, Burke and Caldwell Counties (Figure 2-57). According to the Division of Water Quality Catawba River Basinwide Water Quality Plan, approximately three quarters of the Lake Rhodhiss drainage area is forested (1999), as much of the northwestern portion of the drainage area lies within the Pisgah National Forest (North Carolina Department of Environment and Natural Resources 2001).

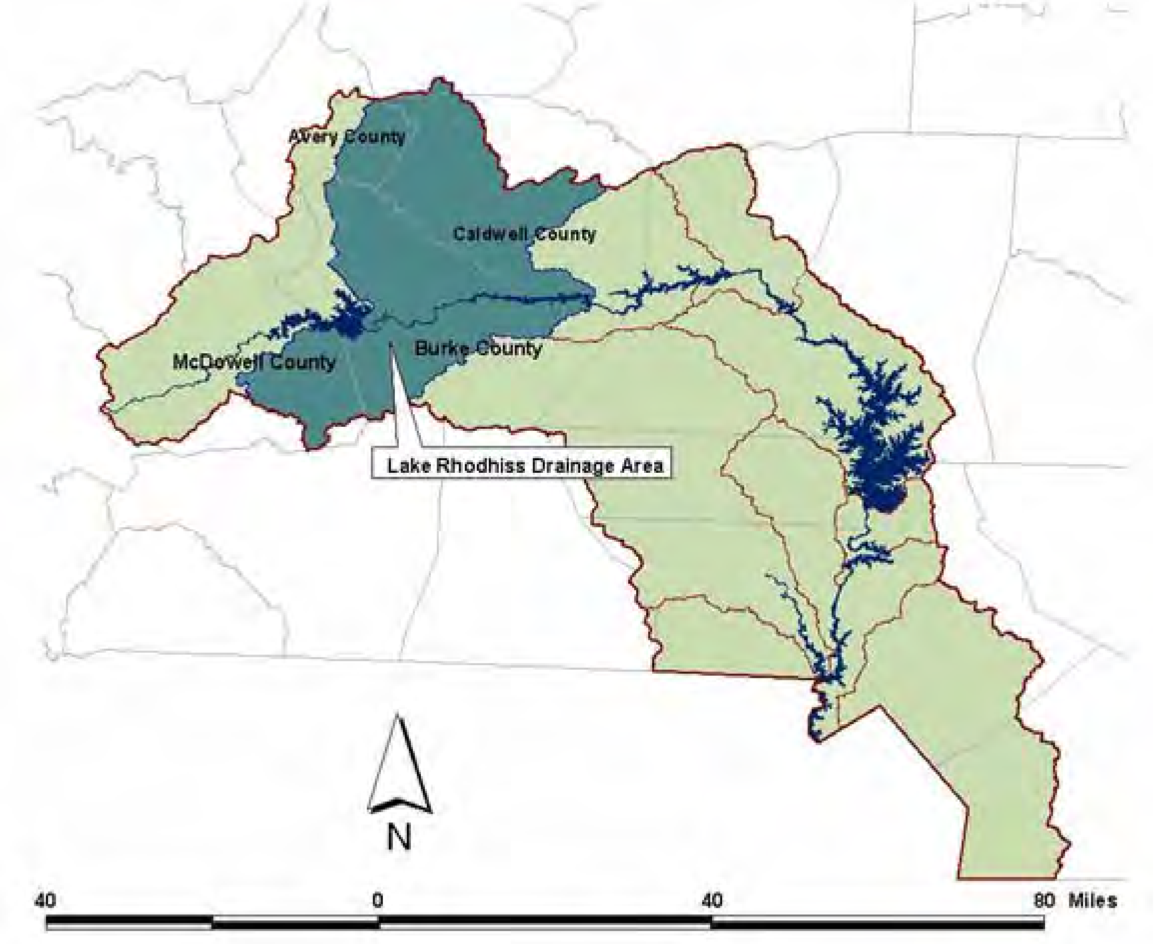

Figure 2-57: Lake Rhodhiss Drainage Area Location

Twenty community water systems depend on surface water from the Lake Rhodhiss drainage area. For seventeen of these systems, the Lake Rhodhiss drainage area is their only source of water. Icard Township, Burke County, and the Town of Rhodhiss only partially rely on this portion of the Catawba River basin as their water source. Four water systems in the Lake Rhodhiss drainage area withdraw their water directly from the Catawba River and its tributaries: the Town of Granite Falls, the City of Lenoir, the City of Morganton, and the Town of Valdese. The remaining sixteen systems purchase water from one of these four.

Non-municipal withdrawals in the basin consist of a fish hatchery, agricultural uses, and irrigation (including golf courses) (HDR, Inc. Engineering of the Carolinas 2005, Appendix C). **Table 2-9** shows the projected demand of all public water supply systems that rely on the Lake Rhodhiss drainage area for water, as presented in their Local Water Supply Plans (LWSPs).

Table 2-9: 2002 Local Water Supply Plan Service Area Demand Projections (in MGD)

Surface Water Systems	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
Granite Falls	0.906	0.996	1.113	1.241	1.385	1.549
City of Lenoir	4.041	4.152	4.357	4.554	4.747	4.938
City of Morganton	7.055	7.266	7.506	7.796	8.146	8.566
Town of Valdese	4.851	5.112	5.514	5.842	6.600	7.187
Caldwell County S	0.511	0.441	0.450	0.459	0.468	0.477
	2002	**2010**	**2020**	**2030**	**2040**	**2050**
Icard Township[b]	0.428	0.477	0.507	0.600	0.696	0.715
Burke County[b]	0.164	0.177	0.202	0.227	0.256	0.289
Rhodhiss[b]	0.044	0.045	0.045	0.048	0.048	0.048
Caldwell County N	0.300	0.311	0.315	0.319	0.323	0.328
Caldwell County SE	0.410	0.353	0.360	0.366	0.374	0.384
Caldwell County W	0.599	0.532	0.542	0.552	0.563	0.574
Sawmills	0.282	0.288	0.301	0.309	0.320	0.330
Baton WC	0.529	0.673	0.591	0.615	0.641	0.667
Joyceton[a]						
Triple Comm WC	0.487	0.568	0.645	0.721	0.801	0.881
Rutherford College[a]						
Drexel	0.240	0.336	0.400	0.464	0.523	0.582
Brentwood WA	0.760	0.795	0.831	0.871	0.912	0.955
Brentwood WC	0.342	0.354	0.371	0.388	0.407	0.426
Burke Caldwell[a]						
Total	21.949	22.877	24.050	25.371	27.209	28.896

[a] No 2002 LWSP submitted

[b] Only the amount of water withdrawn from the Lake Rhodhiss Drainage area is represented, based on the percentage of the total amount withdrawn from all sources in 2002

Figure 2-58[27] shows the lowest and highest service area water demand projections[28] in the Lake Rhodhiss drainage area. The blue line represents a compilation of the Local Water Supply Plan (LWSP) service area demand

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[27] Figure 2.60 represents the range of withdrawal projections calculated for the Lake Rhodhiss drainage area. The highest and lowest projections for each year were selected from all projections calculated, and so do not always represent just one projection method. For a table of all of the withdrawal projections calculated, please see Appendix C.

[28] For information on how these projections were calculated, please see Appendix B.

projections and the red line represents a compilation of the Duke Energy Water Supply Study projections (HDR, Inc. Engineering of the Carolinas 2005, Appendix C). Both are near the bottom of the range and follow the slope of the low end of the range fairly closely. The lowest projections rise only by 7.81 MGD, from 22.223 in 2010 to 30.034 in 2050. The LWSP projections increase by a combined 8.632 MGD and the Duke Energy projections by a combined 11.748 MGD. The highest projections show an increase from 45.895 in 2010 to 143.345 in 2050 (HDR, Inc. Engineering of the Carolinas 2005, Appendix C). The difference between the highest and lowest projections in 2050 is 113.28 MGD.

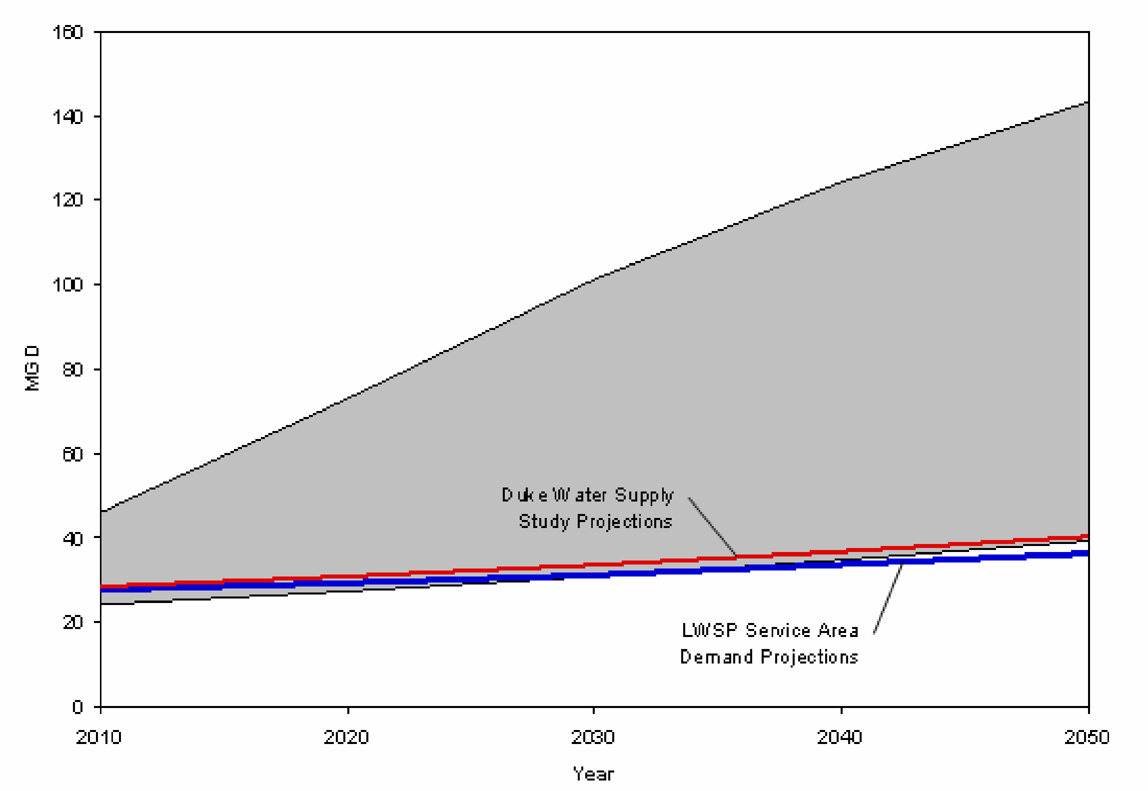

Figure 2-58: Lake Rhodhiss Drainage Area Water Demand Projections Range

The Cities of Marion, Lenoir, Morganton and the Town of Valdese return wastewater through their own treatment plants to the Lake Rhodhiss drainage area. Of the four, only the latter three withdraw water from the Lake Rhodhiss drainage area. Marion withdraws its water from the Lake James drainage area. In 2002, approximately 61% of the water withdrawn from Lake Rhodhiss was discharged as wastewater and about 88% of that was discharged back into Lake Rhodhiss. Table 2-10 summarizes current and future discharge projections based on LWSP service area demand projections to and from the Lake Rhodhiss drainage area[29].

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[29] For information about how these projections were calculated, please see Appendix B.

Table 2-10: Discharge Projections – Lake Rhodhiss Drainage Area (in MGD)

	2002	2010	2020	2030	2040	2050
Discharge to Lake Rhodhiss						
Withdrawn from Lake Rhodhiss	11.862	12.517	13.280	13.889	15.149	16.190
Withdrawn from Lake James	0.621	0.636	0.725	0.838	0.948	1.221
Withdrawn from Lake Hickory	0.122	0.133	0.152	0.170	0.192	0.217
Withdrawn from Unknown Source	1.700	0.920	1.020	1.140	1.320	1.440
Total	14.305	14.206	15.177	16.037	17.609	19.068
Discharge to Other Drainage Areas						
Discharge to Lake Hickory	1.446	2.618	2.787	2.869	3.136	3.325
Discharge to Lake Wylie	0.081	0.088	0.100	0.112	0.127	0.143
Discharge to Lake Norman	0.027	0.029	0.033	0.037	0.042	0.048
Total	1.554	2.735	2.920	3.018	3.305	3.516
Total Discharge from Lake Rhodhiss Drainage Area	**13.416**	**15.252**	**16.200**	**16.907**	**18.454**	**19.706**

(c) Lake Hickory Drainage Area

The largest portion of the Lake Hickory drainage area[30] is located in the eastern part of Caldwell County and the remainder of the reservoir resides in Alexander, Catawba, and Burke Counties (Figure 2-59). The City of Hickory is the largest municipality in the Lake Hickory drainage area (North Carolina Department of Environment and Natural Resources 2001). The Division of Water Quality Catawba River Basin Plan estimated that roughly half of the drainage area is forested and approximately a third is agricultural (1999). The reservoir's drainage area is approximately 220 square miles (North Carolina Department of Environment and Natural Resources 2001); its major tributaries include the Catawba River, the Middle Little River, and Gunpowder Creek (North Carolina Division of Water Quality 1999).

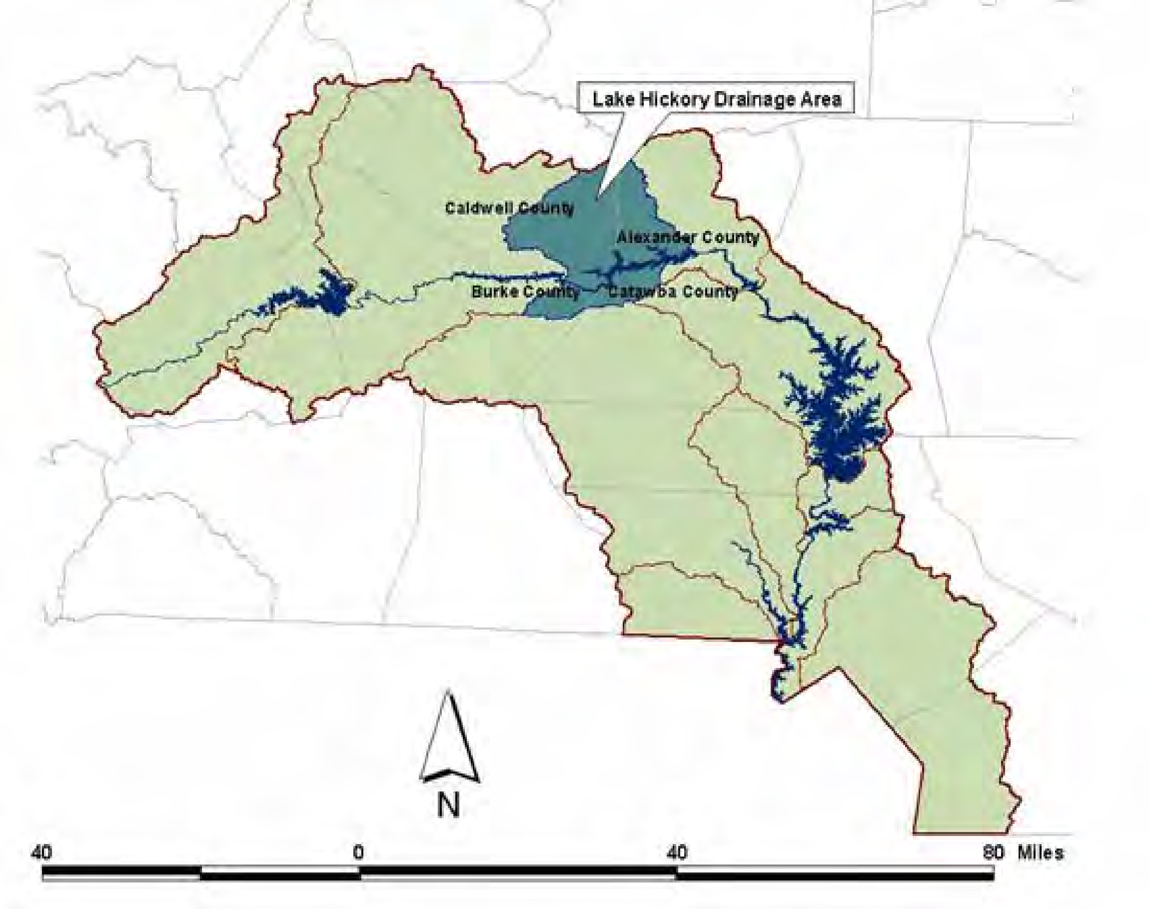

Figure 2-59: Lake Hickory Drainage Area Location

Of the eleven community water systems that depend on surface water in the Lake Hickory drainage area, only two, the City of Hickory and the Town of Longview, have their own intakes in the drainage area. The remaining nine systems purchase water from one of these two community water systems. Table 2-11

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[30] Drainage area boundaries were determined by HDR, Inc. Engineering of the Carolinas for the Duke Energy Water Supply Study (2005).

shows the projected withdrawals from each system's Local Water Supply Plan (LWSP). The only other surface water withdrawals in the lake Hickory drainage area are for agriculture and irrigation (including golf courses); there are no direct industrial withdrawals (HDR, Inc. Engineering of the Carolinas 2005, Appendix C). No community water systems in this drainage area rely on groundwater.

Table 2-11: 2002 Local Water Supply Plan Service Area Demand Projections (in MGD)

Surface Water Systems	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
City of Hickory	8.944	9.531	10.540	11.760	12.980	14.510
Town of Longview	1.036	1.140	1.184	1.211	1.484	1.551
	2002	**2010**	**2020**	**2030**	**2040**	**2050**
Bethlehem	0.447	0.520	0.608	0.693	0.778	0.876
Alexander County	0.730	0.742	0.962	1.086	1.215	1.360
Conover	1.553	1.617	2.101	2.731	3.550	4.616
Claremont	0.233	0.300	0.427	0.625	0.930	1.421
Icard Township	0.350	0.391	0.415	0.491	0.569	0.585
Burke County	0.055	0.059	0.067	0.076	0.085	0.096
Rhodhiss	0.013	0.013	0.013	0.013	0.013	0.014
SE Catawba County	0.096	0.137	0.206	0.268	0.321	0.071
Taylorsville	0.403	0.264	0.269	0.274	0.279	0.284
Total	13.859	14.713	16.792	19.228	22.205	25.384

Figure 2-60[31] shows the lowest and highest service area water demand projections calculated in the Lake Hickory drainage area[32]. The line showing the Local Water Supply Plan (LWSP) service area projections starts out closely following the bottom of the range of projections (see Appendix B). Around 2030, the LWSP water demand projection crosses below the line representing the lowest projection in the range and continues below the projection range, indicating a slower projected growth rate. The lowest water demand projection in this range rises from 15.309 MGD in 2010 to 31.863 MGD in 2050, while the LWSP projection rises from 16.503 MGD in 2010 to only 27.964 in the same timeframe. The highest water demand projection in the range begins at 30.525 MGD in 2010 and escalates to 121.287 MGD in 2050.

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[31] Figure 2.62 represents the range of withdrawal projections calculated for the Lake Hickory drainage area. The highest and lowest projections for each year were selected from all projections calculated, and so do not always represent just one projection method. For a table of all of the withdrawal projections calculated, please see Appendix C.

[32] For information on how these projections were calculated, please see Appendix B.

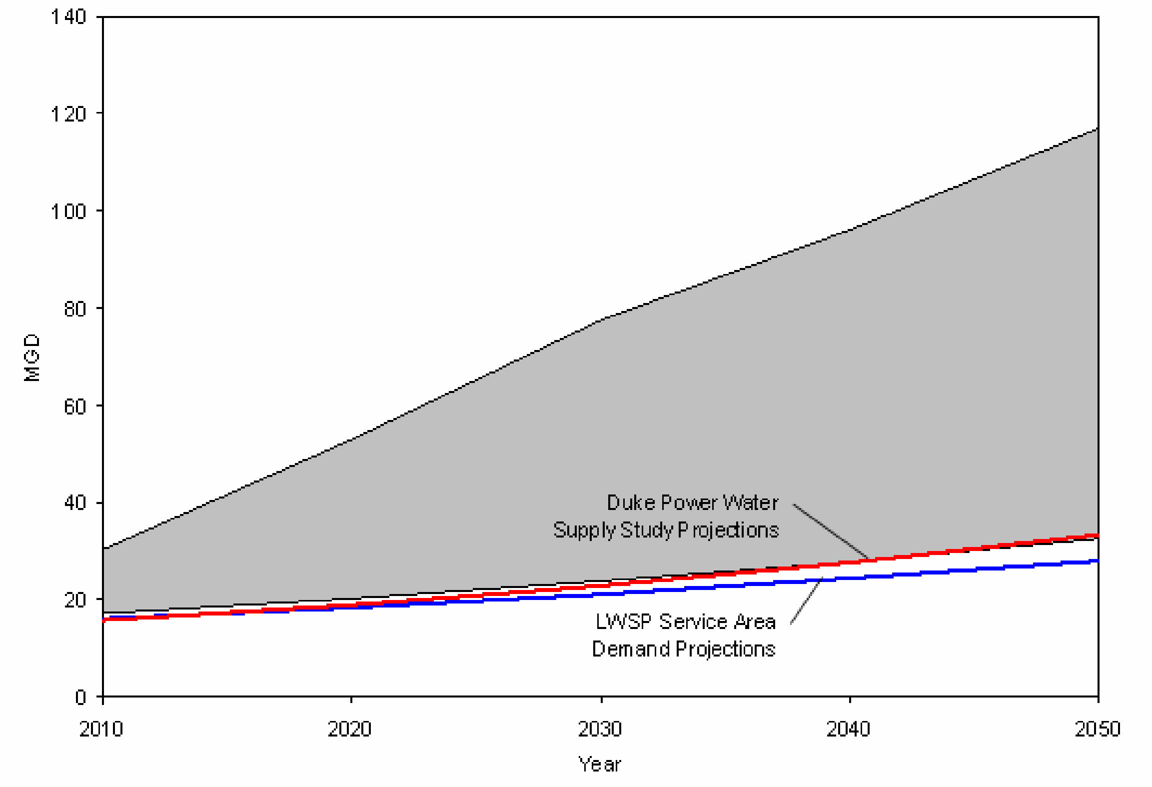

Figure 2-60: Lake Hickory Drainage Area Water Demand Projections Range

Fourteen public water supply systems discharge wastewater into the Lake Hickory drainage area; however, only the water systems for the Cities of Hickory and Lenoir and the Town of Granite Falls do so through their own wastewater treatment plants (WWTPs), the remaining eleven systems transfer their wastewater to the latter three systems for discharge. Of the three municipalities, the City of Hickory's water system is the only one that withdraws water from the Lake Hickory drainage area. The water systems for the Cities of Lenoir and Granite Falls withdraw all of their water from the Lake Rhodhiss drainage area. Roughly 65% of the water withdrawn from the Lake Hickory drainage area is discharged as wastewater and approximately 40% of that total discharge is returned to the Lake Hickory drainage area. **Table 2-12** summarizes the current and projected discharges in the Lake Hickory drainage area, based on 2002 LWSP data.

Table 2-12: Discharge Projections – Lake Hickory Drainage Area (in MGD)

	2002	2010	2020	2030	2040	2050
Discharge to Lake Hickory						
Withdrawn from Lake Hickory	3.703	3.943	4.366	4.873	5.380	6.015
Withdrawn from Lake Rhodhiss	1.446	2.618	2.787	2.869	3.136	3.325
Withdrawn from Unknown Source	0.120	0.120	0.200	0.200	0.220	0.300
Total	5.269	6.681	7.353	7.942	8.736	9.640
Discharge to Other Drainage Areas						
Discharge to Lake Wylie	3.947	4.394	4.826	5.323	6.076	6.761
Discharge to Lake Norman	1.191	2.201	2.706	3.378	4.254	5.465
Discharge to Lake Rhodhiss	0.122	0.133	0.152	0.170	0.192	0.217
Discharge to Lookout Shoals Lake	0.149	0.098	0.100	0.101	0.103	0.105
Total Discharge From Lake Hickory Drainage Area	9.112	10.769	12.150	13.845	16.005	18.563

(d) Lookout Shoals Lake Drainage Area

The drainage area for Lookout Shoals Lake is located almost entirely within Alexander County, which is the northeastern corner of the Catawba River basin. Small portions of the drainage area also extend into Catawba County and Iredell County (Figure 2-61). It is within this drainage area that the Catawba River turns from a predominantly eastward flow to a more southerly flow.

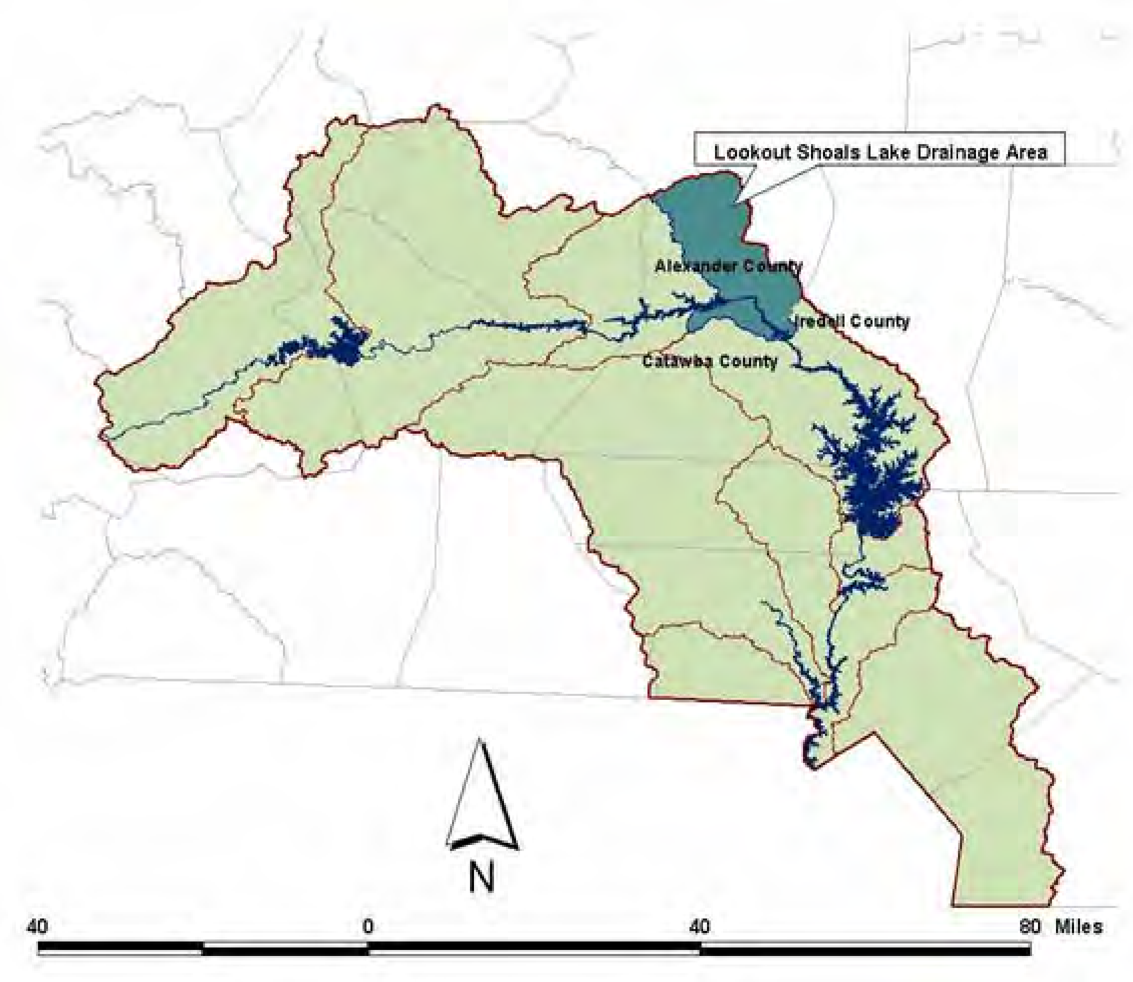

Figure 2-61: Lookout Shoals Lake Drainage Area Location

The City of Statesville operates the only community water system that withdraws water from the Lookout Shoals Lake drainage area via an interbasin transfer. Statesville is located in the Yadkin River basin and discharges all of its wastewater there. The demand projections shown in Table 2-13 are based on the projections presented in the Duke Energy Water Supply Study, because the City of Statesville did not include estimated water withdrawal projections from Lookout Shoals Lake in its 2002 LWSP. The only other withdrawals of surface water occurring in the drainage area are agricultural.

Table 2-13: 2002 Community Water System Service Area Demand Projections (in MGD)

	2002	2010	2020	2030	2040	2050
Surface Water Systems						
City of Statesville	0	4.69	5.68	6.88	8.34	9
Total	0	4.69	5.68	6.88	8.34	9

Since the only estimates of the withdrawal from the Lookout Shoals Lake drainage area come from the Duke Energy Water Supply Study, water demand projections were not calculated.

The Town of Taylorsville operates the only community water system that discharges wastewater directly into the Lookout Shoals Lake drainage area. The Town of Taylorsville's 2002 LWSP shows that it purchased approximately half of its water from Energy United Water Corporation and received their remaining water needs from the City of Hickory in 2002.

Determining the sources of the discharges from community water systems into the Lookout Shoals drainage area is complicated. The City of Hickory withdraws all of its water from Lake Hickory. Energy United Water Corporation's water source is a bit more complicated. In 2002, Energy United withdrew most of its water supply from the Yadkin River basin and purchased a small amount of water from Alexander County; however, Energy United's 2002 LWSP indicated that the latter source would no longer be available. In 2005, Energy United began purchasing all of its water from the City of Newton, which withdraws all of its water from the South Fork Catawba River basin/Lake Wylie drainage area. If Taylorsville continues to purchase water from both Energy United and the City of Hickory at the same levels presented above, it can be assumed that approximately equal amounts of Taylorsville's discharged wastewater into the Lookout Shoals Lake drainage area will originate from the Lake Hickory drainage area and the South Fork Catawba River basin/Lake Wylie drainage area (Table 2-14). In addition to the community water system discharges, there is one industrial discharge to the drainage area.

Table 2-14: Discharge Projections – Lookout Shoals Lake Drainage Area (in MGD)

	2002	2010	2020	2030	2040	2050
Discharge to Lookout Shoals Lake						
Withdrawn from Lake Hickory	0.149	0.098	0.100	0.101	0.103	0.105
Withdrawn from Lake Wylie	0.149	0.098	0.100	0.101	0.103	0.105
Withdrawn from Unknown Source	0.300	0.300	0.300	0.300	0.300	0.300
Total	0.598	0.495	0.499	0.503	0.506	0.510
Discharge to Other Drainage Areas						
Discharge to Yadkin River basin	0.000	4.690	5.680	6.880	8.340	9.000
Total Discharge From Lookout Shoals Lake Drainage Area	0.000	4.690	5.680	6.880	8.340	9.000

(e) Lake Norman Drainage Area

Lake Norman is the largest reservoir in the State of North Carolina, with an area of more than 32,500 acres and extending approximately 34 miles in length from its headwaters to its spillover. Its associated drainage area covers roughly 340 square miles (North Carolina Department of Environment and Natural Resources 2001, 19) and encompasses portions of Iredell, Catawba, Lincoln, Gaston, and Mecklenburg Counties (Figure 2-62). According to the Division of Water Quality Catawba River basin plan, about half of the drainage basin is forested and over a quarter of it is agricultural land (North Carolina Division of Water Quality 1999). Lake Norman's waterfront property is, however, considered the most developed in the Catawba River basin, with 61% of its 569 miles of shoreline developed (North Carolina Department of Environment and Natural Resources 2001, 19).

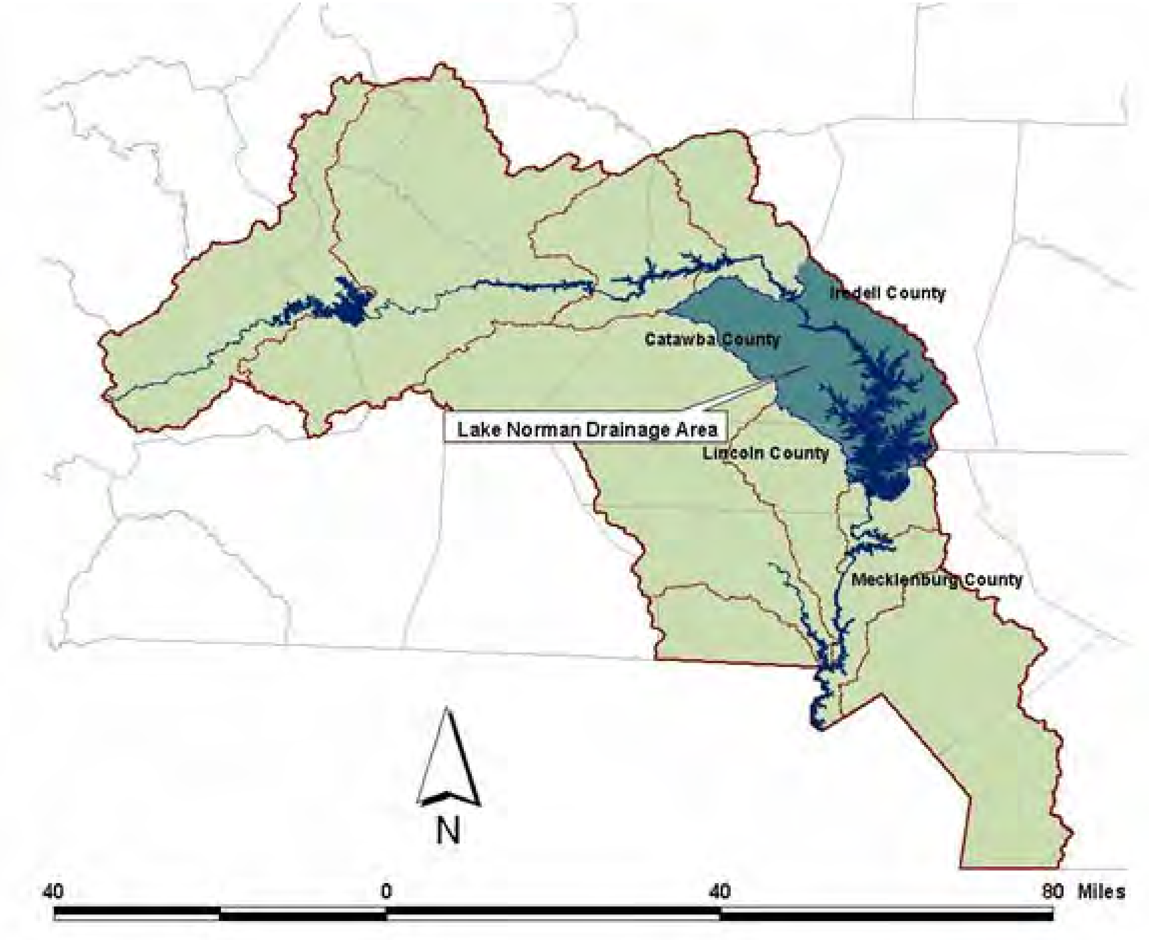

Figure 2-62: Lake Norman Drainage Area Location

Only three community water systems depend on surface water and two systems depend on groundwater in the Lake Norman drainage area. The three surface water systems, Charlotte-Mecklenburg Utilities (CMU), Lincoln County, and the Town of Mooresville, all have intakes in the Catawba River basin. Table 2-15 lists the projected demand of all community water systems that depend on this drainage area for their water supply, as presented in their Local Water Supply Plans (LWSPs). Table 2-15 also includes projections for the proposed Concord/Kannapolis interbasin transfer. In addition to community water system withdrawals, Lake Norman provides for agricultural and irrigation withdrawals and two Duke Energy power facilities, the Marshall Steam Station and the McGuire Nuclear Station. According to Duke Energy's Water Supply Study, the possibility of a third facility is under consideration to begin operations in 2018 (HDR, Inc. Engineering of the Carolinas 2005, 14).

Table 2-15: 2002 Local Water Supply Plan Service Area Demand Projections (in MGD)

Surface Water Systems	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
CMU[a]	17.319	20.048	23.888	27.168	30.451	33.536
Lincoln County	2.102	2.493	3.259	4.073	5.090	6.365
Town of Mooresville	3.680	6.000	8.750	11.750	14.750	17.500
Concord/Kannapolis/ Cabarrus County IBT	0.000	1.000	6.000	11.000	16.600	23.860
Total	23.101	29.541	41.897	53.991	66.891	81.261
Ground Water Systems						
Iredell WC	1.545	1.995	2.536	3.077	3.618	4.159
Claremont[a]	0.048	0.061	0.088	0.128	0.191	0.291
Total	1.593	2.056	2.624	3.205	3.809	4.450

[a] Only the amount of water withdrawn from the Lake Norman Drainage area is represented, based on the percentage of the total amount withdrawn from all sources in 2002.

Figure 2-63[33] shows the lowest and highest service area demand projections calculated in the Lake Norman drainage area[34]. The lowest projections rise from 53.855 MGD in 2010 to 111.920 MGD in 2050. The highest projections increase by 152.711 MGD, from 86.183 MGD in 2010 to 238.894 MGD in 2050. The difference between the highest and lowest projections in 2050 is 126.974 MGD. The LWSP projections fall in between the two; beginning at 70.821 MGD in 2010 and growing by 77.22 MGD to 148.041 MGD in 2050. The Duke Energy Water Supply Study projections fall mainly underneath the lowest projections, only rising to their level between 2040 and 2050 (HDR Engineering of the Carolinas 2005, Appendix C).

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[33] Figure 2.65 represents the range of withdrawal projections calculated for the Lake Norman drainage area. The highest and lowest projections for each year were selected from all projections calculated, and so do not always represent just one projection method. For a table of all of the withdrawal projections calculated, please see Appendix C.

[34] For a description of how the projections were calculated, please see Appendix B.

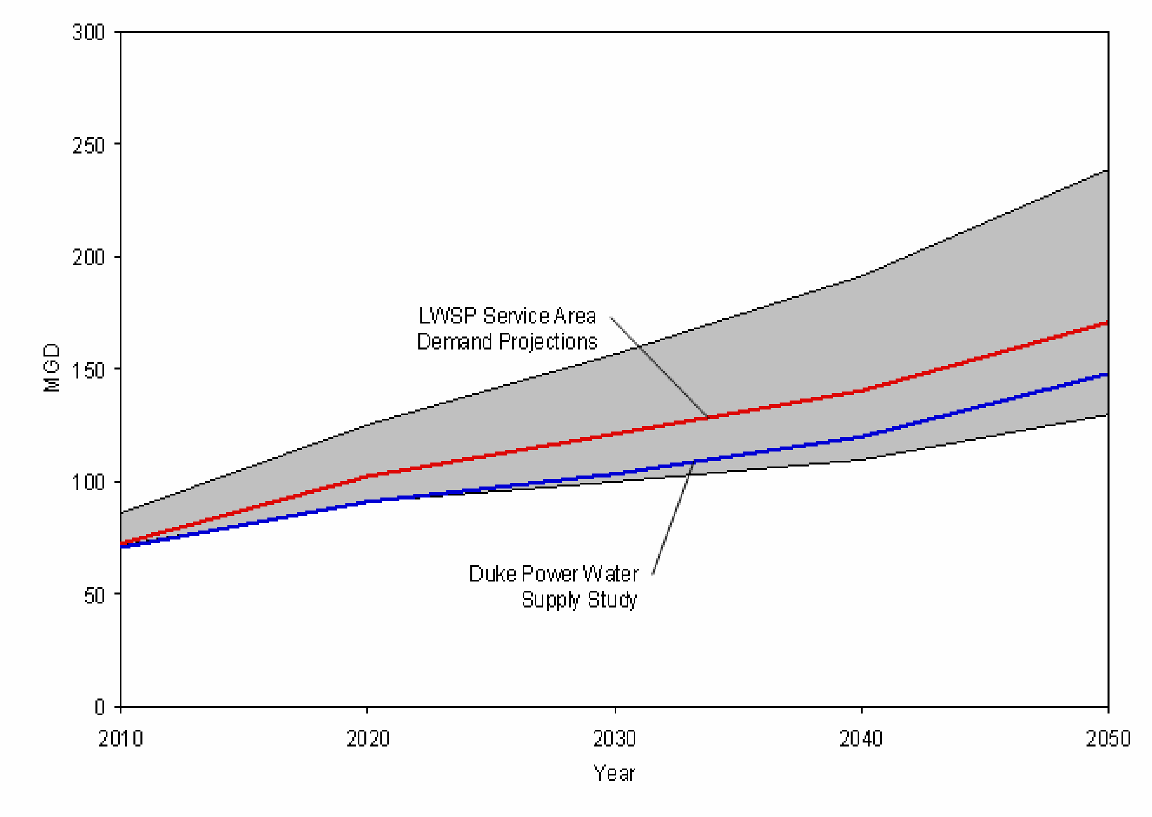

Figure 2-63: Lake Norman Drainage Area Water Demand Projections Range

Four community water systems (the Cities of Claremont, Conover, and Hickory and Lincoln County) and two private water systems (Aqua North Carolina and Heather Utilities, Inc.) return wastewater to the Lake Norman drainage basin through their own wastewater treatment plants. Only two of the community water systems, the City of Claremont and Lincoln County, obtain at least some of their water from the Lake Norman drainage area. The Cities of Conover and Hickory withdraw their water from Lake Hickory. In 2002, of the 12.465 MGD that was discharged as wastewater from the Lake Norman drainage area, only 0.181 MGD was returned to Lake Norman. A summary and projection of the discharges, based on the LWSP service area demand projections, to and from Lake Norman is presented in **Table 2-16**.

Table 2-16: Discharge Projections – Lake Norman Drainage Area (in MGD)

	2002	2010	2020	2030	2040	2050
Discharge to Lake Norman						
Withdrawn from Lake Norman	0.181	0.197	0.227	0.259	0.299	0.348
Withdrawn from Lake Hickory	1.191	2.201	2.706	3.378	4.254	5.465
Withdrawn from Lake Rhodhiss	0.027	0.029	0.033	0.037	0.042	0.048
Withdrawn from Lake Wylie	0.040	0.046	0.048	0.051	0.051	0.054
Withdrawn From Groundwater	0.039	0.050	0.071	0.104	0.154	0.236
Withdrawn from Unknown Source	0.000	0.100	0.100	0.120	0.200	0.200
Total	1.478	2.624	3.186	3.949	5.000	6.351
Discharge to Other Drainage Areas						
Discharge to Mountain Island Lake	0.782	0.692	0.824	0.937	1.051	1.157
Discharge to Fishing Creek Reservoir	10.316	11.066	13.186	14.997	16.809	18.512
Discharge to Rocky River Basin	0.886	2.075	2.472	2.812	3.152	3.471
Discharge to Lake Wylie	0.300	0.349	0.456	0.570	0.713	0.891
Total	12.284	14.182	16.939	19.316	21.724	24.031
Total Discharge from Lake Norman Drainage Area	**12.465**	**14.379**	**17.166**	**19.575**	**22.022**	**24.379**

(f) Mountain Island Lake Drainage Area

The Mountain Island Lake drainage area is, at 70 square miles, the smallest drainage area in the Catawba River basin (North Carolina Department of Environment and Natural Resources 2001, 21). Most of the drainage area is in Mecklenburg County, with smaller portions located in Lincoln and Gaston counties (see Figure 2-64). The Division of Water Quality Catawba River Basinwide Water Quality Plan Plan (1999) estimated, at that time, that half of the drainage area was forested, one fourth of it was agricultural, and the remainder of it was urban.

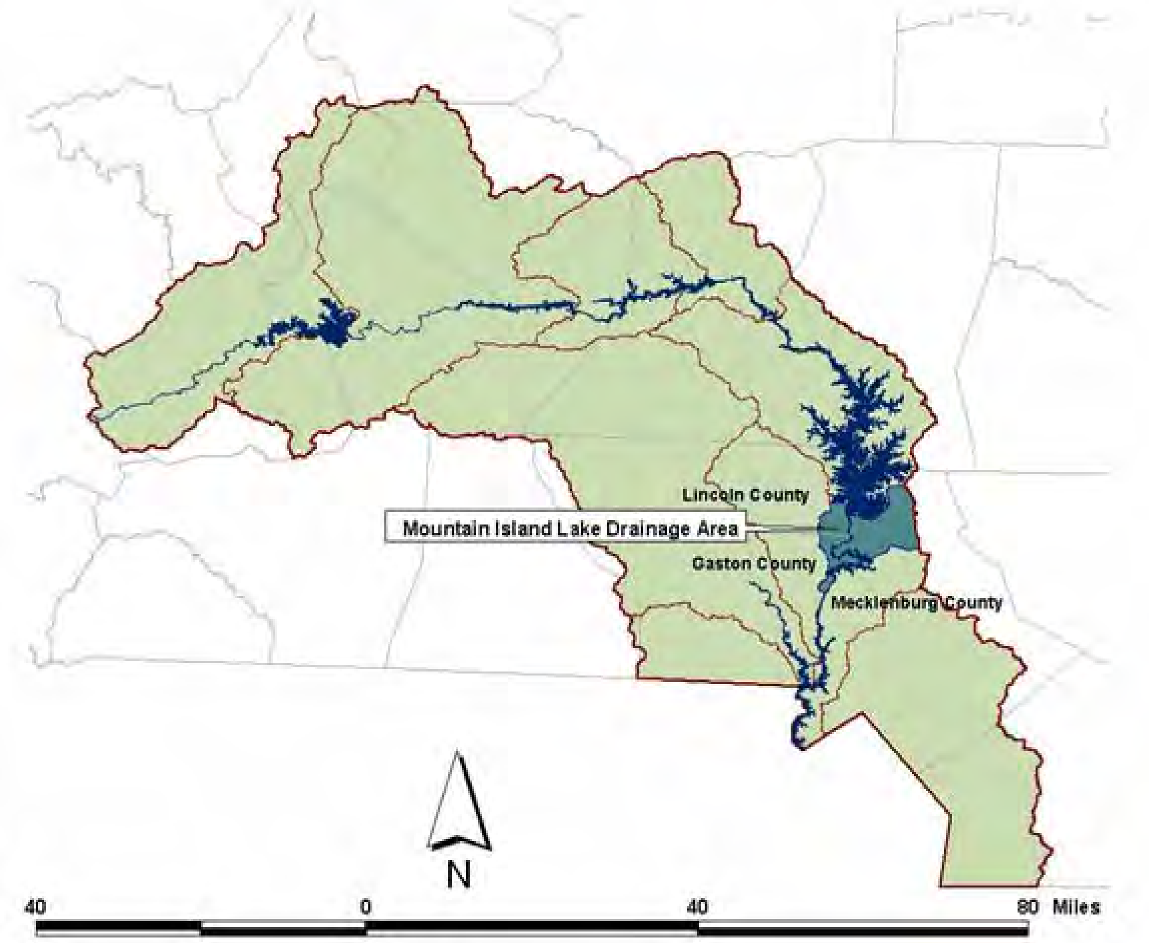

Figure 2-64: Mountain Island Lake Drainage Area

Three community water systems have intakes in the Mountain Island Lake drainage area: Charlotte-Mecklenburg Utilities (CMU), and the Cities of Gastonia and Mount Holly. In addition, the City of Lowell and the Towns of Cramerton, and McAdenville purchase all of their water from the City of Gastonia, and Stanley purchases approximately half of its water from the City of Mount Holly. In terms of non-municipal water withdrawals, there are some agricultural and irrigation withdrawals in the drainage area and Duke Energy operates the Riverbend Steam Station on Mountain Island Lake (HDR, Inc. Engineering of the Carolinas 2005, Appendix C). Table 2-17 shows the projected demand of all community water systems that rely on the Mountain Island Lake drainage area for water, as presented in their Local Water Supply Plans (LWSPs).

Table 2-17: Local Water Supply Plan Service Area Demand Projections (in MGD)

Surface Water Systems	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
CMU[a]	90.925	105.252	125.412	142.632	159.869	176.064
City of Gastonia	10.751	14.233	19.007	21.868	25.164	28.931
City of Mount Holly	1.453	3.272	5.308	7.871	11.954	18.392
Lowell	0.430	0.449	0.471	0.496	0.521	0.546
McAdenville	0.440	0.544	0.565	0.588	0.615	0.643
Cramerton	0.355	0.424	0.461	0.497	0.538	0.575
	2002	**2010**	**2020**	**2030**	**2040**	**2050**
Stanley[a]	0.812	0.859	1.038	1.219	1.342	1.593
Total	105.166	125.033	152.262	175.171	200.003	226.744

[a] Only the amount of water withdrawn from the Mountain Island Lake drainage area is represented, based on the percentage of the total amount withdrawn from all sources in 2002.

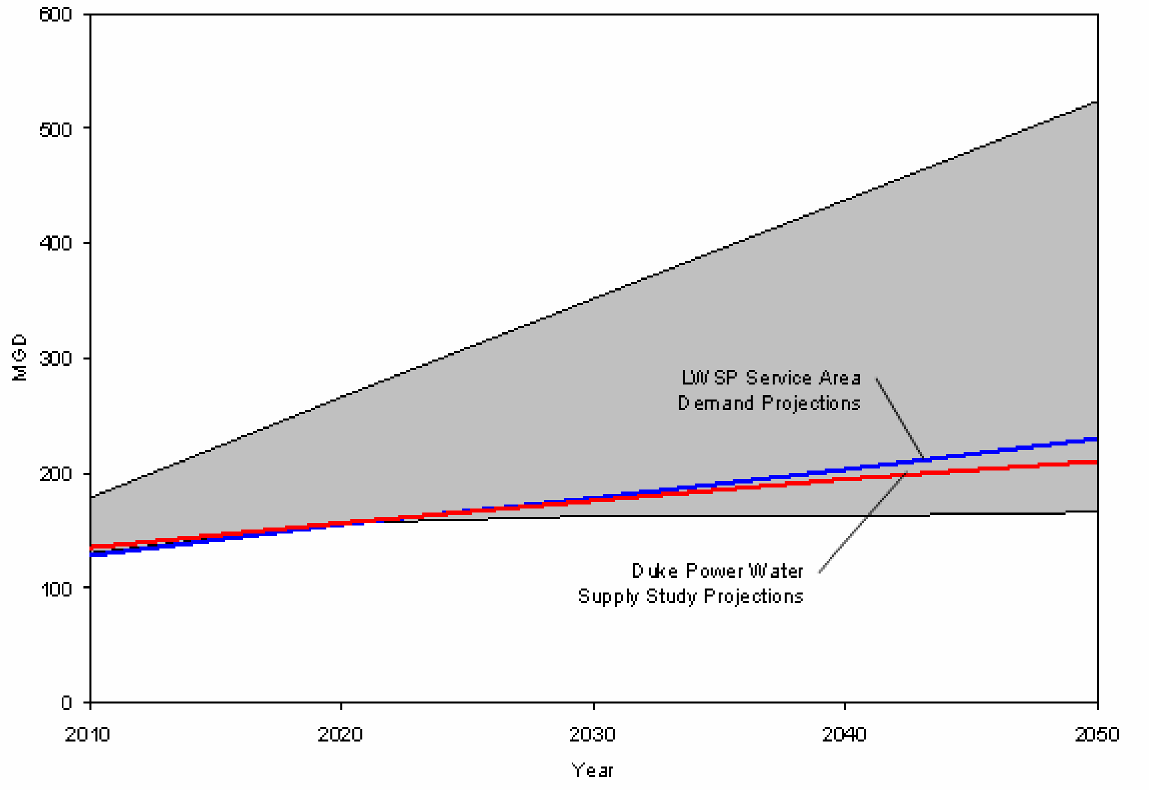

Figure 2-65: Mountain Island Lake Drainage Area Water Demand Projections Range

Figure 2-65[35] shows the lowest and highest service area demand projections in the Mountain Island Lake drainage area[36]. The line for the LWSP service area demand projections is near the bottom of the range, and increases at a faster rate than the lowest projections, which begin at 124.933 MGD in 2010 and grow to 179.109 MGD in 2050. The LWSP service area demand projections begin in 2010 a little above the lowest projections at 130.171 MGD and rise by over 100 MGD to 233.041 MGD in 2050. The Duke Energy Water Supply Study projections begin at 135.34 MGD in 2010 and rise to 210.46 MGD in 2050, staying close to the lowest projections, but continuing to rise once the lowest projections level off between 2020 and 2030 (HDR, Inc. Engineering of the Carolinas 2005, Appendix C). The highest projections begin at 181.025 and increase by over 400 MGD to 526.673 MGD in 2050.

CMU is the only community water system that discharges into the Mountain Island Lake drainage area. Of the water that is withdrawn from this drainage area, most of it is discharged into either the Lake Wylie drainage area or the South Fork Catawba River basin. A summary of the discharge projections to and from Mountain Island Lake is presented in Table 2-18 (LWSP data).

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[35] Figure 2.67 represents the range of withdrawal projections calculated for the Mountain Island Lake drainage area. The highest and lowest projections for each year were selected from all projections calculated, and so do not always represent just one projection method. For a table of all of the withdrawal projections calculated, please see Appendix C.

[36] For information on how these projections were calculated, please see Appendix B.

Table 2-18: Discharge Projections – Mountain Island Lake Drainage Area (in MGD)

	2002	2010	2020	2030	2040	2050
Discharge to Mountain Island Lake						
Discharge from Mountain Island Lake	4.108	3.631	4.327	4.921	5.515	6.074
Discharge from Lake Norman	0.782	0.692	0.824	0.937	1.051	1.157
Total	4.890	4.323	5.151	5.858	6.566	7.231
Discharge to Other Drainage Areas						
Discharge to Fishing Creek Reservoir	54.157	58.099	69.227	78.733	88.248	97.187
Discharge to Rocky River Basin	4.654	10.894	12.980	14.762	16.546	18.223
Discharge to Lake Wylie	10.889	16.220	22.599	28.507	36.983	49.257
Total	69.700	85.212	104.807	122.002	141.777	164.667
Total Discharge From Mountain Island Lake Drainage Area	**73.808**	**88.844**	**109.134**	**126.923**	**147.292**	**170.741**

(g) Lake Wylie Drainage Area and the South Fork Catawba River Basin

For purposes of this report, the Lake Wylie drainage area and the South Fork Catawba River basin have been combined because they both drain into Lake Wylie. Figures 2.68 and 2.69 show the delineated areas for the Lake Wylie drainage area and the South Fork Catawba River basin, relative to the Catawba River basin and each other. Together, the drainage areas form a large piece of the Catawba River basin, covering portions of five counties and containing at least part of 19 different community water systems.

The Lake Wylie drainage area alone covers approximately 369 square miles (North Carolina Department of Environment and Natural Resources 2001). It contains portions of the City of Charlotte and much of the area's growth is a result of the City of Charlotte's expansion. Consequently, this is one of the most urbanized drainage areas in the Catawba River basin (North Carolina Division of Water Quality 1999).

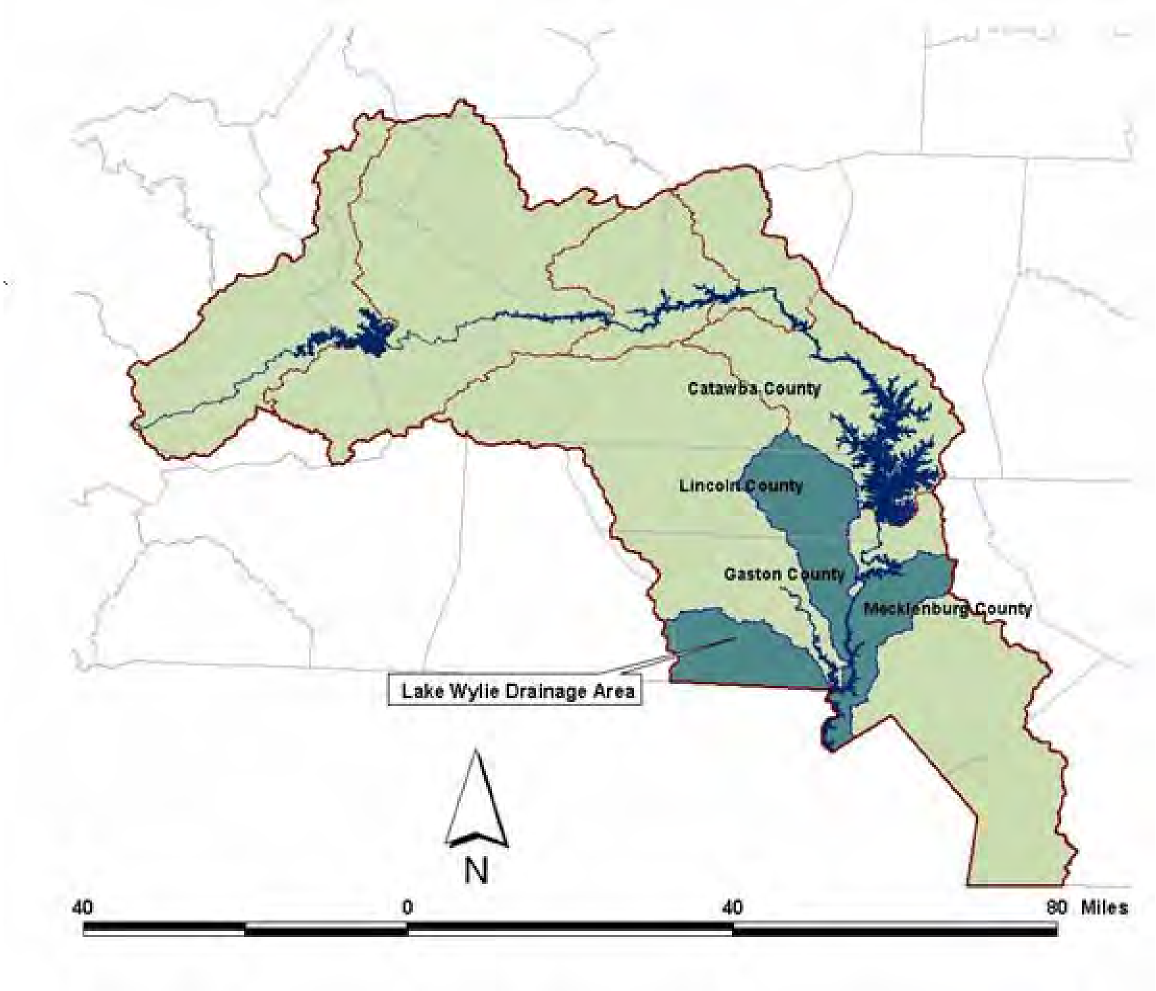

Figure 2-66: Lake Wylie Drainage Area Location

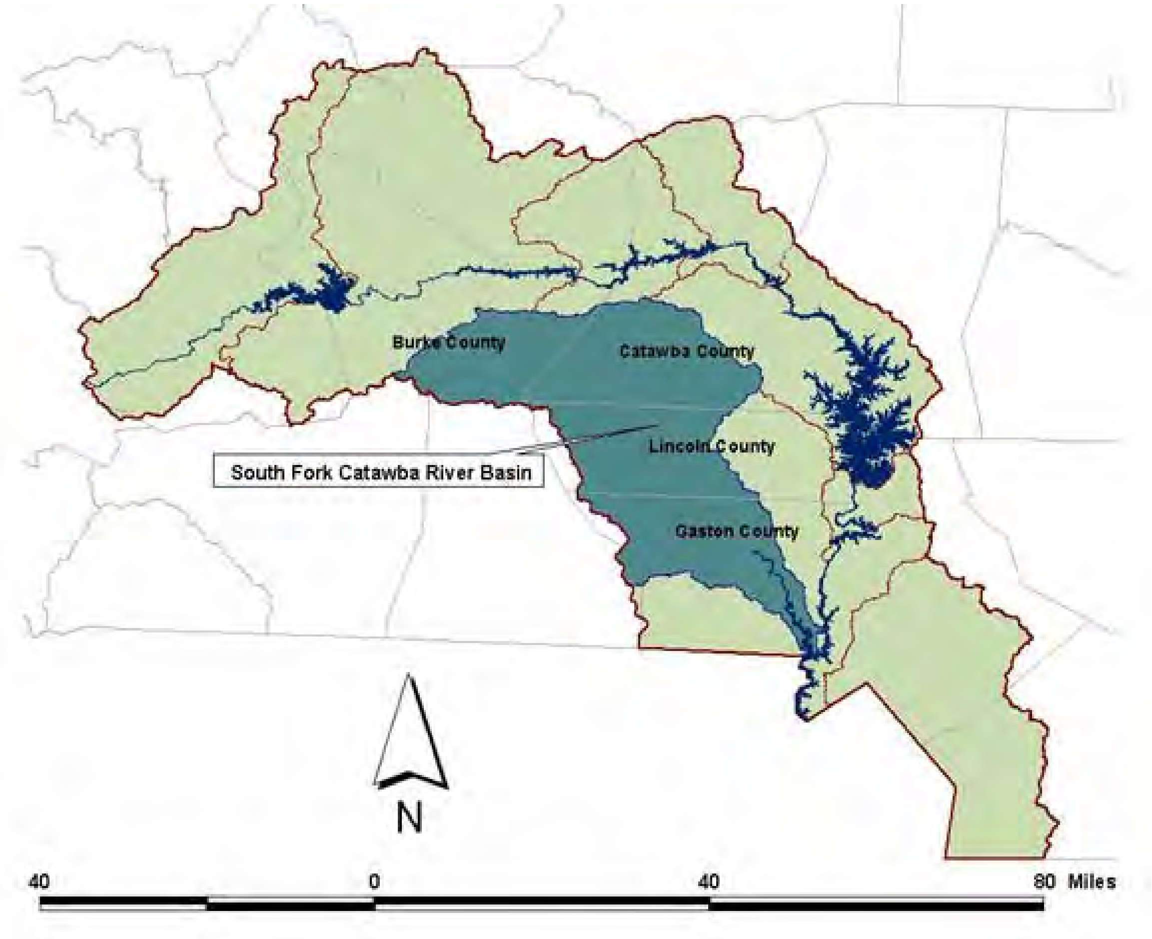

Figure 2-67: South Fork Catawba River Basin Location

The South Fork Catawba River basin adds another 650 square miles of drainage area for Lake Wylie (North Carolina Department of Environment and Natural Resources 2001, 27). The southern portion of the South Fork Catawba River basin, near the City of Charlotte, is more urbanized than its northern reaches, which tend to be more rural[37].

Ten of the aforementioned 19 community water systems depend on water from these two drainage areas for their water supplies. Nine of the ten have surface water intakes, while the tenth water system, the Town of Catawba, purchases all of its water from the City of Newton. Table 2-19 shows the projected demands for all of the community water systems that rely on the Lake Wylie drainage area and the South Fork Catawba River basin for water, as presented in their Local Water Supply Plans (LWSPs). Furthermore, there are several non-municipal water withdrawals in these areas; they include five direct industrial water withdrawals and three Duke Energy power facilities (Allen Steam Plant, Lincoln Combustion Turbine Facility, and Catawba Nuclear Station) on Lake Wylie. Lake Wylie also

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[37] For more detail, please see the county summaries in Chapter 2, Section 2.1

crosses into South Carolina and two of their municipal community water systems (Rock Hill and Tega Cay[38]) rely on the lake for their water source.

Table 2-19: 2002 Local Water Supply Plan Service Area Demand Projections (in MGD)

Surface Water Systems	2002	2010	2020	2030	2040	2050
City of Belmont	2.483	3.783	4.564	5.431	6.379	7.013
Bessemer City	0.861	1.082	1.092	1.107	1.122	1.137
City of Cherryville	0.821	1.129	1.446	1.763	2.079	2.396
Town of Dallas[b]	0.572	0.567	0.617			
Town of High Shoals	0.064	0.110	0.138	0.153	0.170	0.204
City of Lincolnton	4.310	4.825	5.546	6.375	7.329	8.425
City of Newton	2.334	2.581	2.994	3.651	4.449	5.423
Town of Stanley[a]	0.406	0.430	0.519	0.610	0.671	0.797
Catawba	0.073	0.084	0.088	0.092	0.096	0.099
Maiden	1.459	1.548	1.592	1.648	1.696	1.755
Total	13.383	16.139	18.596	20.830	23.991	27.249

[a] Only the amount of water withdrawn from the Lake Wylie drainage area is represented based on the percentage of the total amount withdrawn from all sources in 2002.
[b] The Town of Dallas only provided projections out to 2020 in their 2002 Local Water Supply Plan.

Figure 2-68 displays the lowest and highest service area demand projections in the Lake Wylie drainage area and the South Fork Catawba River basin. Both the line representing the LWSP service area demand projections and the line representing the Duke Energy Water Supply Study projections (HDR, Inc. Engineering of the Carolinas 2005, Appendix C) mimic, but remain slightly above, the line representing the lowest projections. The lowest, LWSP, and Duke Energy Water Supply Study projections (HDR, Inc. Engineering of the Carolinas 2005, Appendix C) all increase by around the same amount (46.9 MGD, 47.8 MGD, and 48.1 MGD respectively) from 2010 to 2050. The highest projections increase at a much faster rate, growing by 156.5 MGD during the same period; from 117.767 MGD in 2010 by 156.543 MGD to 274.310 MGD in 2050. In 2050, the difference between the highest and lowest projections is 131.619 MGD.

In North Carolina, thirteen industrial water users, three private water systems and fourteen community water systems discharge into the Lake Wylie drainage area/ South Fork Catawba River basin. Two more community water systems discharge into the Lake Wylie drainage area in South Carolina. Almost all of the wastewater originally withdrawn from these two areas is discharged back into the Lake Wylie drainage area and South Fork Catawba River basin (99.81% in 2002). A summary of the discharge projections, based on the LWSP service area demand projections, into the Lake Wylie drainage area and South Fork Catawba River basin is presented in Table 2-20.

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[38] Since this plan is focused on the North Carolina portion of the Catawba River basin, the South Carolina municipal withdrawals will not be presented with the North Carolina municipal withdrawal information.

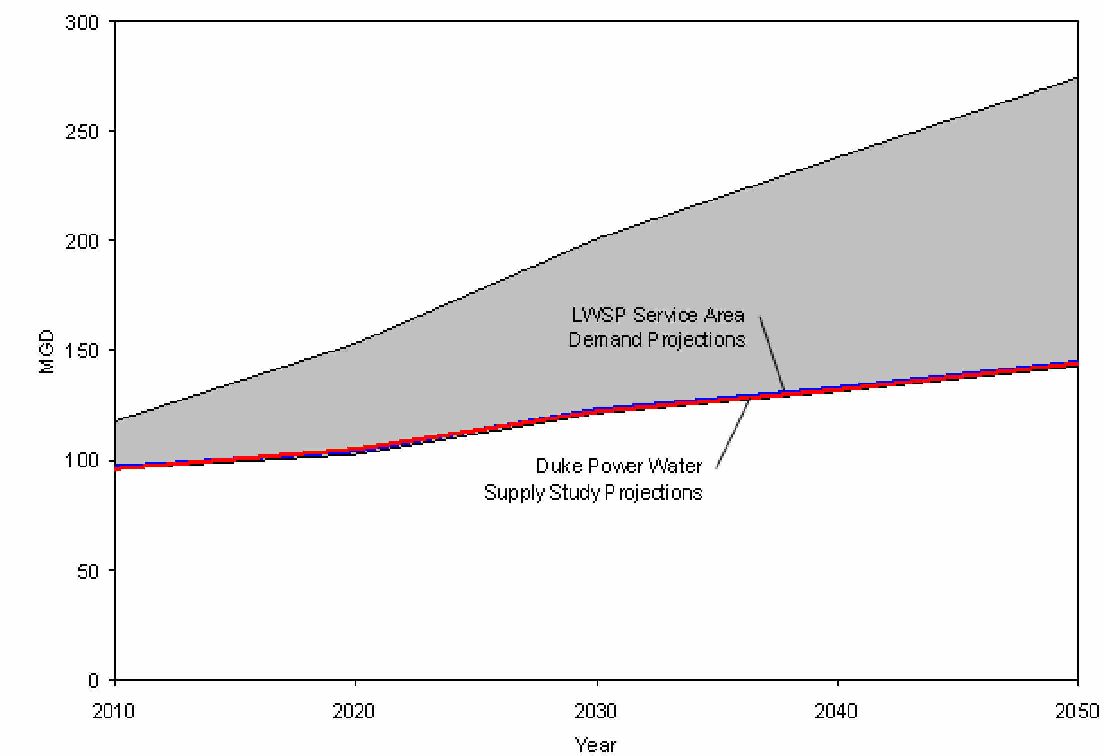

Figure 2-68**:** Lake Wylie Drainage Area and South Fork Catawba River Basin Demand Projections Range

Table 2-20: Discharge Projections – Lake Wylie Drainage Area/South Fork Catawba River Basin (in MGD)

Discharge to Lake Wylie/ South Fork Catawba	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
Withdrawn from Lake Wylie/South Fork Catawba	20.976	23.512	25.691	27.844	30.912	33.770
Withdrawn from Lake Rhodhiss	11.862	12.517	13.280	13.889	15.149	16.190
	2002	**2010**	**2020**	**2030**	**2040**	**2050**
Withdrawn from Lake Hickory	3.947	4.394	4.826	5.323	6.076	6.761
Withdrawn from Lake Norman	0.300	0.349	0.456	0.570	0.713	0.891
Withdrawn from Mountain Island Lake	10.889	16.220	22.599	28.507	36.983	49.257
Total	47.974	56.992	66.852	76.133	89.833	106.869
Discharge to Other Drainage Areas						
Discharge to Lake Norman	0.040	0.046	0.048	0.051	0.051	0.054
Total Discharge from Lake Wylie/SF Catawba	21.016	23.558	25.739	27.895	30.963	33.824

Section 2.4 Interbasin Transfer in the Catawba River Basin

Defining Interbasin Transfer

According to the Interbasin Transfer Statute, interbasin transfer is defined as "the withdrawal, diversion, or pumping of surface water from one river basin and discharge of all or any part of the water in a river basin different from the origin." Expanding on this, the Administrative Code for Interbasin Transfer states that "the amount of a transfer shall be determined by the amount of water moved from the source basin to the receiving basin, less the amount of the water returned to the source basin." Put more simply, an interbasin transfer of water occurs when water is not returned to its source basin.

Calculating interbasin transfer amounts, and then projecting them into the future, however, is not as simple as it may sound. Complicating situations occur, for example, when the service area for a system crosses basin boundaries, so that part of their withdrawal is considered interbasin transfer while another is not. Along with their 2002 Local Water Supply Plans, any community water systems that reported a current or planned interbasin transfer were required to also submit an interbasin transfer worksheet, estimating the amount of water transferred through their system. This data, along with the Local Water Supply Plan data and calculations completed for studies related to these transfers, are all used in constructing an estimate of interbasin transfer amounts for each basin.

Presented below are the Division of Water Resources best estimates of interbasin transfer amounts in and out of the Catawba River Basin. These were calculated for the most part using the 2002 Local Water Supply Plans (including the interbasin transfer worksheets), data collected and projections calculated by the Duke Energy Water Supply Study. These numbers are not exact and are meant only to provide an example of how the interbasin transfer situation in the Catawba River basin may evolve over the years according to the information currently at hand. As the circumstances of each system using water from this basin change, so may the amounts of interbasin transfers.

Interbasin Transfers Into and Out Of the Catawba River Major Basin

There are currently five systems that transfer water out of the Catawba River Major Basin (consisting of both the Catawba River basin and the South Fork Catawba River basin). Of these five systems, only one, Charlotte-Mecklenburg Utilities, has an Interbasin Transfer Certificate; the others have transfers that either do not exceed their grandfathered capacities or do not meet the 2 mgd minimum required for obtaining a certificate. Table 2-21 shows the estimated transfer amounts for these systems.

Table 2-21: Interbasin Transfers Out of the Catawba River Major Basin (average day MGD)

System	Receiving Basin	2002	2010	2020	2030	2040	2050
Charlotte-Mecklenburg Utilities	Rocky River Basin	6.147	11.780	14.100	16.040	17.660	18.900
Concord/Kannapolis[1]	Rocky River Basin	1.480	5.920	11.830	17.750	17.750	17.750
Caldwell County North	Yadkin River Basin	0.218	0.222	0.227	0.231	0.233	0.236
Mooresville[2]	Rocky River Basin	2.786	4.890	6.360	6.214	6.067	5.933
Mooresville[3]	South Yadkin River Basin	0.306	0.290	0.430	0.576	0.723	0.858
System	**Receiving Basin**	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
Statesville	South Yadkin River Basin	0.000	4.690	5.680	6.880	8.340	9.000
Union County[4]	Rocky River Basin	3.200	4.900	7.600	10.200	11.900	14.800
Total Transfer Out of Catawba River Major Basin		**14.137**	**32.692**	**46.227**	**57.891**	**62.687**	**67.476**

[1] The Concord/Kannapolis projection was held flat once it reached the capacity listed in its interbasin transfer request

[2] The overall Mooresville projection was held flat once it reached its grandfathered capacity. For the Rocky River Basin portion of its transfer, the amount projected beginning in 2020 is the grandfathered capacity minus the projection for the transfer to the South Yadkin River Basin.

[3] Because this portion of Mooresville's interbasin transfer is consumptive loss and not a direct discharge, it was projected out to 2050 with no limit.

[4] The estimates for 2002, 2040, and 2050 were calculated based on total demand for water during those years and the interbasin transfer estimates given for the remaining projection years. It is possible that interbasin transfer demand for Union County may decrease in the future due to the development of another water supply source in the Yadkin River Basin.

The only system reporting an interbasin transfer into the Catawba River Major Basin is Kings Mountain, which withdraws all of its water from the Broad River Basin. A portion of their service area lies within the Catawba River Major Basin and they have a contract to discharge a maximum of 1 mgd (average day) to the City of Gastonia. No interbasin transfer worksheet was submitted for the Kings Mountain system, and therefore there is no information about consumptive use within the Catawba River Major Basin. The only thing that can be estimated is Kings Mountain's discharge to the City of Gastonia, presented in Table 2-22.

Table 2-22: Interbasin Transfers Into the Catawba River Major Basin (average day mgd)

System	Source Basin	2002	2010	2020	2030	2040	2050
Kings Mountain	Broad River Basin	1.044	1.000	1.000	1.000	1.000	1.000

Interbasin Transfers Between the Catawba River Basin and the South Fork Catawba River Basin

The Catawba River Major Basin is actually made up of the South Fork Catawba River Basin and the Catawba River Basin and transfers between the two are regulated through the Interbasin Transfer Statute. Currently, there are no interbasin transfer certificates for transfers between these two basins, however there are seven systems that transfer water from the Catawba River Basin to the South Fork Catawba River Basin and four systems that transfer water from the South Fork Catawba River Basin to the Catawba River Basin. Estimates of these transfers are presented in Tables 2-22 and 2-23.

Table 2-23: Interbasin Transfers from the Catawba River Basin to the South Fork Catawba River Basin

System	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
Conover	0.372	0.522	0.678	0.881	1.1431	1.4863
Cramerton	0.355	0.424	0.461	0.497	0.538	0.575
Gastonia	10.672	11.23	14.04	15.3	17.615	20.252
Hickory[1]	4.798	6.948	8.692	10.909	11.942	13.349
Lowell	0.43	0.449	0.471	0.496	0.521	0.546
System	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
Stanley2	0.3814776	0.404	0.4877	0.5727	0.6305	0.7484
McAdenville	0.44	0.544	0.565	0.588	0.615	0.643
Total	**17.4484776**	**20.52**	**25.395**	**29.244**	**33.004**	**37.6**

[1] The interbasin transfer estimates for Hickory were estimated by subtracting the estimated interbasin transfer amounts for Conover (which purchases all of its water from Hickory) from the interbasin transfer amounts given in Hickory's 2002 LWSP.

[2] The interbasin transfer estimates for Stanley were calculated using information from their 2002 LWSP. We are currently waiting for more detailed information concerning their interbasin transfer and will update this estimate when we receive it.

Table 2-24: Interbasin Transfers from the South Fork Catawba River Basin to the Catawba River Basin

System	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
Catawba	0.073	0.084	0.088	0.092	0.096	0.099
Stanley[1]	0.2353176	0.249	0.3008	0.3533	0.3889	0.4617
Taylorsville[2]	0.411	0.277	0.2815	0.2865	0.2915	0.2965
Energy United	0	1.817	2	2	2	2
Total	**0.7193176**	**2.426**	**2.6703**	**2.7318**	**2.7764**	**2.8572**

[1] The interbasin transfer estimates for Stanley were calculated using information from their 2002 LWSP. We are currently waiting for more detailed information concerning their interbasin transfer and will update this estimate when we receive it.

[2] The interbasin transfer estimates for Taylorsville were calculated using information from their 2002 LWSP. We are currently waiting for more detailed information concerning their interbasin transfer and will update this estimate when we receive it.

Section 2.5 Issues that May Impact Water Supplies

(a) Flood Management

Catawba River is a source of energy, recreation, drinking water as well as flood management. Most floods in the Catawba River basin occur during the spring as a result of intense, short duration seasonal rains and rainfall events of prolonged duration caused by stationary frontal systems. Flood occurring during midsummer and late summer are often associated with tropical storms moving north along the Atlantic coastline (ncfloodmaps.com, *Catawba final plan 3-17-06*, 13). North Carolina faces extreme hazard and consequences from hurricanes and flooding. Only in Catawba basin total flood claims and repetitive loss claims were 1750 and 278 respectively since 1978 till 2004. The vulnerability to hurricanes and flooding makes it crucial that communities and property owners have accurate, up-to-date information about the flood risk.

State of North Carolina has taken an action to provide reliable flood data for the citizen's along the basin. The State, through the Federal Emergency Management Agency's (FEMA) Cooperating Technical Community partnership initiative, was designated as the nation's first Cooperating Technical State (CTS). As a CTS, the state assumed primary ownership and responsibility of the National Flood Insurance Program's (NFIP) Flood Insurance Rate Maps (FIRMs) for all North Carolina communities. This role has traditionally been fulfilled by FEMA. This flood program benefits include: (Catawba final plan 3-17-06, Table 1, pg 7)

- Updated flood hazard data will provide current, accurate information for the communities and property owners to make proper sitting and design decisions.
- The use of updated data will dramatically reduce long-term flood losses to local communities.
- New flood information will alert those at risk of flooding of the need to purchase insurance.
- A digital information system will allow online access to all map users 24 hours a day without requiring sophisticated software
- Up-to-date base maps along with the digital format will allow users to make more efficient and accurate flood risk determinations.

Duke Energy works closely with local, county and state emergency management officials during high water and flooding conditions to provide information to help ensure they can make appropriate public action decisions.

During recent FERC relicensing application, Duke Energy also conducted a study on the high water management in the lower portion of the Catawba River. This study examined the historical frequency of flood occurrences. High intensity rainfall events have been shown to cause Lake Wateree to rise above the normal full reservoir elevation. The potential for such occurrences is exacerbated if the rainfall events occur within the portion of the Catawba watershed downstream of Lake Wylie. The study included a comprehensive review of operational and physical changes that would be implemented to mitigate the magnitude and impact of high water events at Lake Wateree. A High Inflow Protocol for Lake Wylie is also available through FERC relicensing agreements (C-W final Agreement Signature Copy 07-18-06, Page A -10).

(b) Sedimentation

Sedimentation in reservoirs is principally the result of fluvial erosion within the reservoir's drainage basin. As a part of the on-going hydropower relicensing process required by the Federal Energy Regulatory Commission (FERC), Duke Energy has conducted a study to determine the impacts of sedimentation over the years on the surface area and capacity of each of the reservoirs. A review of available data has allowed the determination of the appropriate annual sedimentation/deposition volumes to be used to project reductions in storage within the reservoirs. In addition, the distribution of the deposition within the reservoirs has been evaluated.

For selected reservoirs, Duke Energy has performed bathymetric surveys to compute and evaluate accumulated depositions. Observations on the data include:

- The lowest yield was computed for Lake James, which is consistent with the high percentage of undeveloped and forest land with the Lake James drainage basin.
- Yields are comparable for drainage basin within the central portion of the Catawba basin.
- Lake Wateree has the highest calculated sediment yield. It is felt that this is in part due to sedimentation entering the lake from upstream (Rocky Creek – Cedar Creek) discharges.

The details on this study can be found on the report "Estimating Sediment Deposition and Volume Reduction in the Catawba – Wateree Reservoirs" by Duke Energy available in the Appendix – C8 (DUKE Energy, November 2004, FERC 2232, Appendix – C8).

Chapter 3 - Water Management and Water Balance

The purpose of this chapter is to provide the simulation model description, the model input information, assign basin plan demand to the model, observe response to the river system in the first section. The next two sections describe the drought management plan and data management necessary to cover the surface and groundwater sources.

Section 3.1 Basin Model and Modeling Results

(a) Model Description

Duke Energy, for the purpose of the relicensing process, contracted with Devine Tarbell & Associates, Inc [DTA] to develop the Computer Hydro Electric Operations and Planning Software CHEOPS^{TM} for the Catawba River basin. The first version of CHEOPS was released to stakeholders in the relicensing process in January of 2005. Since then, several versions have been released, modifying the model as it was first developed and adding new features. The version of the model used in this plan is the Catawba-Wateree CHEOPS Interface 8.3 released in mid-October of 2005. A version 8.7 was released in March of 2006, after this study was started. The interface of the CHEOPS model is shown in Figure 3-1.

CHEOPS is designed for long-term analysis of the effects of operational and physical changes made to the modeled hydrologic system. Along with hydropower generation, it also supports the water supply feature as a management and operation tool. For this basin water supply plan, the CHEOPS model has been used to simulate long-term demand growth, using a base year of 2002 and projecting water demand forward to the year 2050, and to figure out how demand will impact the entire river system. For future planning activities, it is necessary to determine how many of these demands can be met and how much of a shortage or surplus there will be, if any, before the reservoir storage becomes fully or partially exhausted without harming the environment. It is also important to know the supply ability (safe yield) of the reservoirs before planning begins. In general, safe yield for any reservoir systems can be described as the maximum quantity of water that can be withdrawn from each of the reservoir in a dry year without depleting the source or causing any negative impact while considering all the operational and physical constraints implemented.

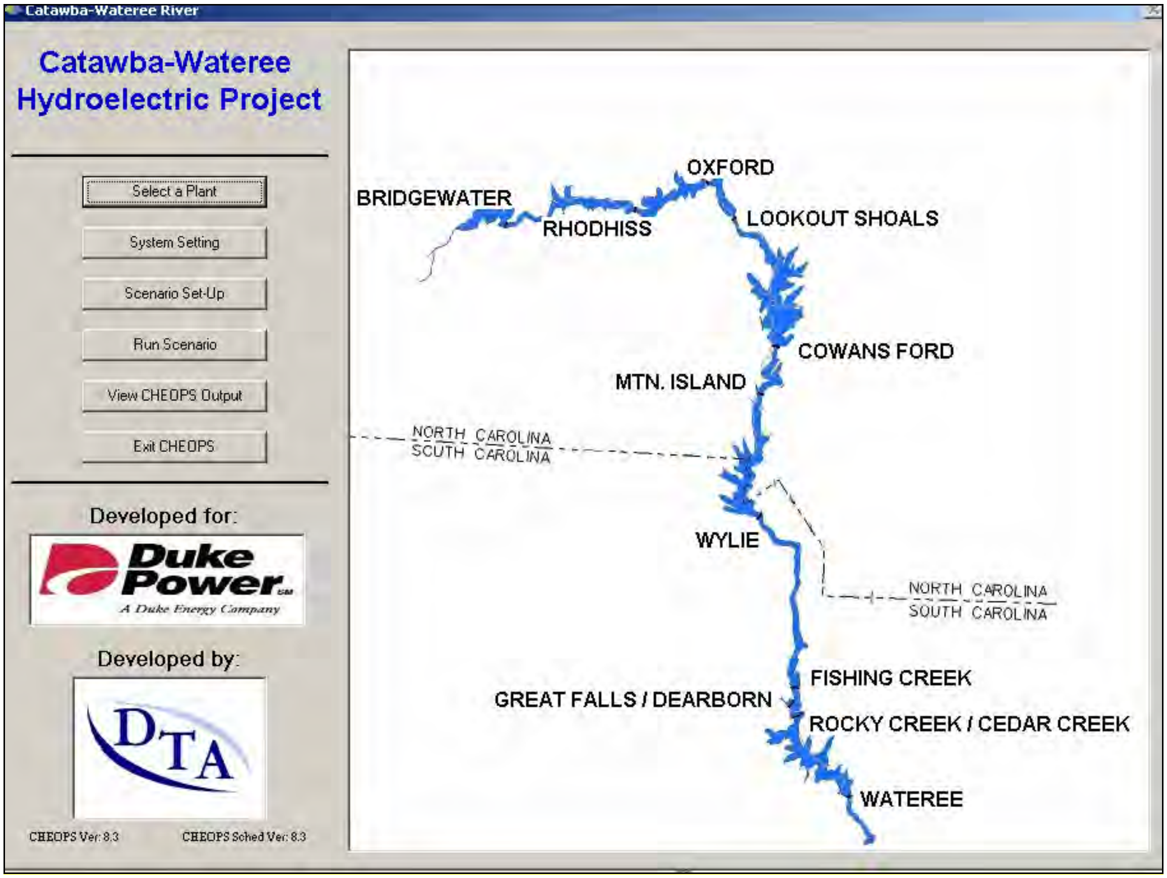

Figure 3-1: CHEOPS Model Interface

In the model, the demands from each water intake are aggregated to each drainage area, or reservoir level. The return flows from the systems are also aggregated to the drainage area level. Since the river system works as a unit, any unmet demand from one drainage area can be met from another drainage area.

(b) Summary of Model Inputs and Assumptions

The model is developed for existing licensed reservoir operational and physical conditions. The hydropower generation plant, reservoir, river, weather, environment and operation information are entered into the model in several different input format sets. The basic input options for the model interface can be categorized as physical, operational and generation conditions, as shown in Figure 3-2.

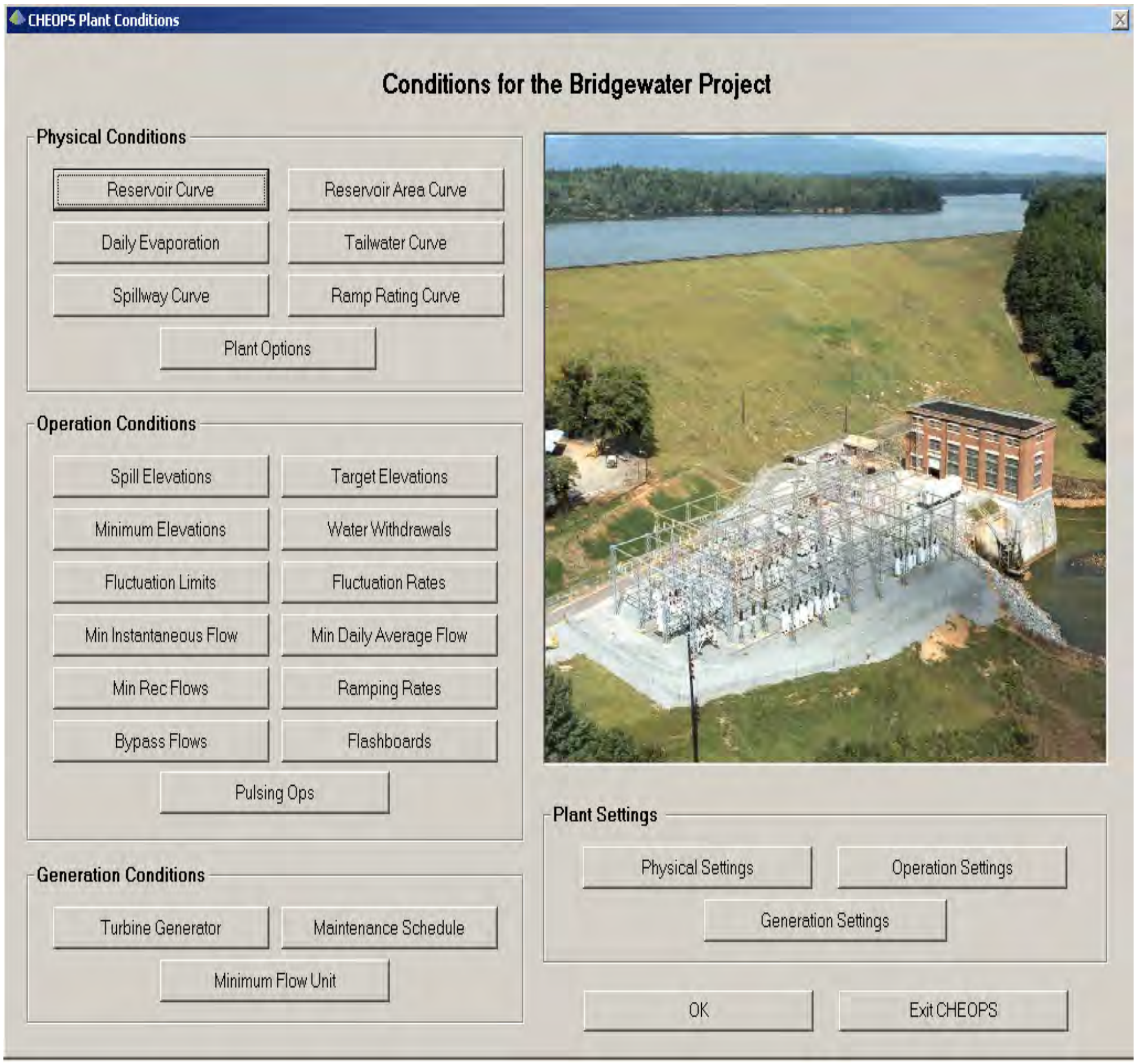

Figure 3-2: CHEOPS Input Options for Physical, Operation and Generation Conditions for Bridgewater Project

(i) Temporal Data:

The model simulates the hydrologic system in a time series for the period from January 1st, 1929, to December 31st, 2003, with 75 years of daily hydrological data. The input for hydrological data are in a daily format; however the outputs are in a daily format for reservoir and river conditions, and 15 minute time steps for both hydrologic operation and reservoir conditions.

(ii) Engineering Data

The engineering data for this model are the static data for the plants and reservoirs in the river basin. For the purposes of this study, none of this data was varied. Two examples of engineering data used in this model are:

- *Rating curves* – include relationships of reservoir surface area to the elevation of water surface, of the storage volume to elevation, and the spillway capacity curve.
- *Generation conditions* – include generating components such as turbine or generator's information and plant's scheduling.

(iii) Hydrological Data

The hydrological data is the naturally occurring water data that is available on the surface as surface water or stream flow, below or subsurface as ground water and in the atmosphere as cloud or rain. For this surface water modeling purposes, only surface and atmospheric water are included as assumption in the format of evaporation from open surface water body, rainfall to the surface or water body and inflow[39] to the reservoir from upper part of the river reach.

- ***Evaporation/Rainfall*** - In the model, monthly patterns of daily evaporation rates were used to estimate the evaporation from each reservoir. Rainfall data, however, was not included.
- ***Inflow*** - The inflows to the reservoirs were computed in two steps:

    1. *Inflow Estimation based on Historical Reservoir Operation*
    The inflows at the hydropower generation plant locations are not available. Therefore, DTA chose to use historical hydrological generation data to estimate inflows to the reservoirs at the plant locations.
    2. *Adjustments of Inflow Data*
    The inflows generated as described above also generated numerous negative inflows. Tributary inflow data for all of the reservoirs (Itrib[40]) were adjusted to remove negatives by using USGS gage data, as well as the North Carolina runoff isohyets map and the engineering judgments, as appropriate, with an emphasis on maintaining the Mass Volume close to the Inflow Raw value generated in the first step. Minimum values were selected to replace negatives based on a review of drainage area (DA) and runoff production using the cfs/square mile and flow duration curves from unregulated gages. The adjusted Inflows were used as the inflow to the CHEOPS model to compare to historical Duke Generation numbers for each plant and system-wide. In the next step it was refined based on generation comparison (DTA, CHEOPS Inflow Data Generation Worksheet).

(iv) Variable Data

Variable data is the type of modeling input data that can be altered or varied to simulate any operational and physical condition over the hydrologic period and adjustments can be made to have minimal impacts on the river system. Some variable data are related to the physical conditions set to the reservoir operation.

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[39] Hydrological term for river or stream flow

[40] Itrib – Tributary Inflow

There are several variable input data set assumed for the purpose of basin water supply planning as future operational condition.

- ***Water Demand*** - During the relicensing process a water supply study report was prepared by HDR in December 2005. In this report future water demand is projected for the next five decades starting from 2008 to 2058 and used in the model as withdrawal data. Return flows were also estimated in this report and projected for the same time horizon, although are not necessarily a function of the water withdrawals from each reservoir or to that specific watershed from where it was withdrawn. Rather, they are a function of withdrawals from different combinations of reservoirs and the projected return flow percentages to a specific reservoir for different decades also vary.
- ***Reservoir level conditions*** – include reservoirs' spill levels, target elevations, minimum elevations, and fluctuation limits.
- ***Required flow conditions*** – include the minimum flow requirements, such as minimum instantaneous flow, minimum daily average flow, bypass flow and minimum recreational flow.
- ***Other operational conditions*** – include other conditions such as ramping rate and the use of flashboard.

(v) Model Flexibility/Functionality:

The model can be run for a variety of physical, operational and generation settings for individual plants. The current condition with HDR's water supply 2008 demand is called the Baseline scenario. Any change to reflect operational condition proposed by the water user or interest groups with 2008 demand is called the current licensed condition.

As explained previously, there are options to vary the physical or operational conditions, such as gradual increase in future sedimentation that reduces the storage capacity of the reservoirs and projected gradual increase in water withdrawal. The modeler does have the option to either use the fixed sedimentation or withdrawal for any particular year of interest or gradually increase the sedimentation and withdrawal over the hydrologic period of records.

(vi) Model Enhancements for Operational Conditions:

- ***Low Inflow Protocol [LIP]:***

As a part of future drought management, this feature has been added to the model in order to comply with the LIP adopted in the relicensing agreement and to simulate operational constraints effectively. The purpose of the LIP was to establish procedures for reductions in water use during periods of low inflow to the Catawba-Wateree reservoir system. This LIP provides trigger points and procedures for how the Catawba-Wateree reservoir system will be operated as well as water withdrawal reduction measures for other water users during periods of low inflow (i.e., periods when there is not enough water flowing into the reservoirs to meet the normal water demands plus maintain lake levels within the normal ranges). The LIP was developed on the basis that all parties with interests in water quantity will share the responsibility to conserve the limited water supply (DUKE Energy June 2006, Low Inflow Protocol for the Catawba-Wateree Project). The details of the latest LIP including LIP stages can be found in the document in Appendix D1 – LIP Document.

- ***Mutual Gains Conditions:***

To meet the demands needed for community water systems and to maintain recommended water levels at the reservoirs and rivers within the normal ranges for a safe and sound ecosystem and seasonal public recreational activities, several scenarios were simulated by DTA to establish a flow schedule where all interested parties benefit equally. These flow schedules are called Mutual Gain (MG) scenarios and have been added as future operational constraints.

(vii) Modeling Assumptions for Catawba River Basin Plan Runs:

The model scenarios were set up according to several basin plan specific conditions. The overall model set ups were for two general groupings:

1. Baseline or existing conditions and demand
2. Future licensed conditions and projected demand.

The input assumptions were as follows:

- ***Sedimentation:*** No gradual sedimentation over the projection period was included.
- ***Routing*****:** The routing function was not used.
- ***Water Withdrawal***
  - *Planning year* - The demands were projected for the planning years 2010, 2020 and 2050
  - *Withdrawal and Return Flow quantity & distribution* – For comparison purposes, 2002 demand data was run as a baseline with the model's original baseline setup. The projected demand and return flow values for the planning years 2010, 2020 and 2050 were entered into the model with HDR's original withdrawal and return flow distributions for the corresponding years. The only exception is for 2002 demand, 2008 model demand and return flow distributions were used.

    The projected demands have High, Low and LWSP options for all three projected decades. Therefore, 10 scenarios were simulated:

    1. Plan 2002– 2002 demand with baseline setup
    2. Plan 2010 High – 2010 high demand with future licensed condition
    3. Plan 2010 Low – 2010 low demand with future licensed condition
    4. Plan 2010 LWSP – 2010 LWSP demand with future licensed condition
    5. Plan 2020 High – 2020 high demand with future licensed condition

6. Plan 2020 Low – 2020 low demand with future licensed condition
7. Plan 2020 LWSP – 2020 LWSP demand with future licensed condition
8. Plan 2050 High – 2050 high demand with future licensed condition
9. Plan 2050 Low – 2050 low demand with future licensed condition
10. Plan 2050 LWSP – 2050 LWSP demand with future licensed condition

- ***Low Inflow Protocol:*** - The Low Inflow Protocol [LIP] option is added to all future demands scenarios, except for the 2002 base scenario with current conditions. However, for basin planning purposes, older version of the LIP data that was available during the analyses was used and this input data is available in Appendix D2_LIP Input Table.
- ***Mutual Gain:*** - Mutual Gain [MG] reservoir conditions and flow schedules published by Duke in November, 2005 that was available at the time of the analyses were used for future demand conditions. A summary of this set up is attached in Appendix D3 _ Mutual Gain CHEOPS Scenario Input Sheet. Notice this is an older version of MG scenario data and in the relicensing agreement version of the model used later final version of data released in March 2006.

The model assumes that all withdrawals are from hydropower generation plant locations; therefore plant names were used in the plots and tables in this report instead of reservoir. The following list shows the reservoir names along with their corresponding plant names:

	Reservoir	Plant Names Used [Acronyms]
01.	Lake James	Bridgewater [BW]
02.	Lake Rhodhiss	Rhodhiss [RH]
03.	Lake Hickory	Oxford [OX]
04.	Lookout Shoals	Lookout Shoals [LS]
05.	Lake Norman	Cowans Ford [CF]
06.	Lake Mountain Island	Mountain Island [MI]
07.	Lake Wylie	Wylie [WY]
08.	Fishing Creek Reservoir	Fishing Creek [FC]
09.	Great Falls Reservoir	Great Falls [GF]
10.	Rocky Creek Reservoir	Rocky Creek [RC]
11.	Lake Wateree	Wateree [WA]

(c) A Comparison of Demand Types

The plan contains variable demands for the water service area for the years 2010, 2020, 2030, 2040, and 2050. These variable demands can be categorized into four types: Municipal, Power, Industrial and Irrigation. All these types of demands for any single drainage area are aggregated at the reservoir level and this demand is entered into the model input sheet as a single demand. Therefore, model input demands or output withdrawals do not separate or color code the types of water. Separate tables have been prepared to summarize the demands according to the types. Tables 3-1, 3-2 and 3-3 show the High, Low and LWSP demands for the years 2010, 2020, and 2050 for individual reservoirs and a total for the entire system. It is obvious that municipal demands are the highest for all of the years, followed by industrial. Figure 3-3 through 3-5 compare the municipal type for High, Low and LWSP demands. Mountain Island has the highest municipal demand whereas Wylie and Cowans Ford [Lake Norman] take the second and third positions. Figures 3-6 through 3-8 compare the power type of demands for High, Low and LWSP. Cowans Ford and Wylie require the most power demands for the next two decades with additional requirements from Bridgewater and Wateree in year 2050. Fishing Creek registers the highest industrial demand, as shown in Figure 3-9 through 3-11. Where all the demands gradually increase over time, irrigation demands are mostly consistent with slight increase from all reservoirs along the river, as shown in Figure 3-12 through 3-14.

Table 3-1: Summary for High Demand Types

Catawba-Wateree High Withdrawals Summary Sheet (in MGD)

2002 Demands

2002	**BW**	**RH**	**OX**	**LS**	**CF**	**MI**	**WY**	**FC**	**GF**	**RC**	**WA**	**TOTAL**
Municipal	1.500	22.67	13.86	0	23.0	105.0	26.98	15.98	0	0	5.1	**214.127**
Industrial	1.080	0.00	0.00	0	0.0	0.0	14.82	73.10	0	0	0	**89.000**
Power	0.000	0.00	0.00	0	0.0	2.5	0.00	0.00	0	0	0	**2.500**
Irrigation	8.759	4.53	1.20	1.2	2.8	0.8	8.50	8.20	1.4	0.6	1.2	**39.189**
Total	**11.339**	**27.197**	**15.058**	**1.200**	**25.800**	**108.336**	**50.303**	**97.283**	**1.400**	**0.600**	**6.300**	**344.816**

2010 High Demand

2010 High	**BW**	**RH**	**OX**	**LS**	**CF**	**MI**	**WY**	**FC**	**GF**	**RC**	**WA**	**TOTAL**
Municipal	1.971	46.08	28.93	4.5	43.9	175.3	26.98	34.68	0	0	6.3	**368.594**
Industrial	1.200	0.00	0.00	0	0.0	0.0	14.82	102.10	0	0	0	**118.120**
Power	0.000	0.00	0.00	0	36.4	2.5	0.00	0.00	0	0	0	**38.900**
Irrigation	9.100	4.80	1.30	1.3	2.9	0.8	8.50	8.40	1.5	0.6	1.2	**40.400**
Total	**12.271**	**50.884**	**30.226**	**5.800**	**83.203**	**178.553**	**50.303**	**145.175**	**1.500**	**0.600**	**7.500**	**566.014**

2020 High Demand											
2020 High	**BW**	**RH**	**OX**	**LS**	**CF**	**MI**	**WY**	**FC**	**GF**	**RC**	**WA**	**TOTAL**
Municipal	2.754	73.04	51.42	5.5	75.2	263.2	102.65	56.34	0	0	8	**638.115**
Industrial	1.400	0.00	0.00	0	0.0	0.0	15.62	104.60	0	0	0	**121.620**
Power	0.000	0.00	0.00	0	46.0	2.5	41.90	0.00	0	0	0	**90.400**
Irrigation	9.700	5.20	1.50	1.6	3.2	0.9	9.60	8.80	1.6	0.7	1.3	**44.100**
Total	**13.854**	**78.244**	**52.915**	**7.100**	**124.400**	**266.621**	**169.765**	**169.736**	**1.600**	**0.700**	**9.300**	**894.235**

2050 High Demand												
2050 High	**BW**	**RH**	**OX**	**LS**	**CF**	**MI**	**WY**	**FC**	**GF**	**RC**	**WA**	**TOTAL**
Municipal	4.968	143.33	114.45	9	171.3	520.4	235.27	141.78	0	0	12.7	**1353.114**
Industrial	2.300	0.00	0.00	0	0.0	0.0	18.52	113.90	0	0	0	**134.720**
Power	15.300	0.00	0.00	0	62.5	2.5	53.00	0.00	0	0	13.1	**146.400**
Irrigation	12.900	7.30	2.50	2.7	4.2	1.0	12.60	10.30	2.1	0.8	1.6	**58.000**
Total	**35.468**	**150.625**	**116.946**	**11.700**	**237.954**	**523.876**	**319.389**	**265.976**	**2.100**	**0.800**	**27.400**	**1692.234**

Table 3-2: Summary for Low Demand Types

Catawba-Wateree Low Withdrawals Summary Sheet (in MGD)

2002 Demand

2002	**BW**	**RH**	**OX**	**LS**	**CF**	**MI**	**WY**	**FC**	**GF**	**RC**	**WA**	**TOTAL**
Municipal	1.500	22.67	13.86	0	23.0	105.0	26.98	15.98	0	0	5.1	**214.127**
Industrial	1.080	0.00	0.00	0	0.0	0.0	14.82	73.10	0	0	0	**89.000**
Power	0.000	0.00	0.00	0	0.0	2.5	0.00	0.00	0	0	NA	**2.500**
Irrigation	8.759	4.53	1.20	1.2	2.8	0.8	8.50	8.20	1.4	0.6	1.2	**39.189**
Total	**11.339**	**27.197**	**15.058**	**1.200**	**25.800**	**108.336**	**50.303**	**97.283**	**1.400**	**0.600**	**6.300**	**344.816**

2010 Low Demand

2010 Low	**BW**	**RH**	**OX**	**LS**	**CF**	**MI**	**WY**	**FC**	**GF**	**RC**	**WA**	**TOTAL**
Municipal	1.611	24.26	15.83	4.5	29.3	127.4	26.98	20.24	0	0	6.3	**256.436**
Industrial	1.200	0.00	0.00	0	0.0	0.0	14.82	102.10	0	0	0	**118.120**
Power	0.000	0.00	0.00	0	36.4	2.5	0.00	0.00	0	0	0	**38.900**
Irrigation	9.100	4.80	1.30	1.3	2.9	0.8	8.50	8.40	1.5	0.6	1.2	**40.400**
Total	**11.911**	**29.060**	**17.134**	**5.800**	**68.592**	**130.714**	**50.303**	**130.741**	**1.500**	**0.600**	**7.500**	**453.856**

2020 Low Demand											
2020 Low	**BW**	**RH**	**OX**	**LS**	**CF**	**MI**	**WY**	**FC**	**GF**	**RC**	**WA**	**TOTAL**
Municipal	1.860	27.34	18.66	5.5	41.0	153.1	37.66	27.86	0	0	8	**320.953**
Industrial	1.400	0.00	0.00	0	0.0	0.0	15.60	104.60	0	0	0	**121.600**
Power	0.000	0.00	0.00	0	46.0	2.5	41.90	0.00	0	0	0	**90.400**
Irrigation	9.700	5.20	1.50	1.6	3.2	0.9	9.60	8.80	1.6	0.7	1.3	**44.100**
Total	**12.960**	**32.539**	**20.161**	**7.100**	**90.170**	**156.507**	**104.756**	**141.259**	**1.600**	**0.700**	**9.300**	**577.053**

2050 Low Demand												
2050 Low	**BW**	**RH**	**OX**	**LS**	**CF**	**MI**	**WY**	**FC**	**GF**	**RC**	**WA**	**TOTAL**
Municipal	2.868	39.27	29.94	9	62.3	162.7	62.35	51.13	0	0	12.7	**432.276**
Industrial	2.300	0.00	0.00	0	0.0	0.0	18.50	113.90	0	0	0	**134.700**
Power	15.300	0.00	0.00	0	62.5	2.5	53.00	0.00	0	0	13.1	**146.400**
Irrigation	12.900	7.30	2.50	2.7	4.2	1.0	12.60	10.30	2.1	0.8	1.6	**58.000**
Total	**33.368**	**46.572**	**32.439**	**11.700**	**129.036**	**166.177**	**146.454**	**175.330**	**2.100**	**0.800**	**27.400**	**771.376**

Table 3-3: Summary for LWSP Demand Types

Catawba-Wateree LWSP Withdrawals Summary Sheet (in MGD)

2002 Demands

2002	BW	RH	OX	LS	CF	MI	WY	FC	GF	RC	WA	TOTAL
Municipal	1.500	22.39	13.91	0	23.0	105.0	26.98	15.98	0	0	5.1	**213.899**
Industrial	1.080	0.00	0.00	0	0.0	0.0	14.82	73.10	0	0	0	**89.000**
Power	0.000	0.00	0.00	0	0.0	2.5	0.00	0.00	0	0	NA	**2.500**
Irrigation	8.759	4.53	1.20	1.2	2.8	0.8	8.50	8.20	1.4	0.6	1.2	**39.189**
Total	**11.339**	**26.916**	**15.111**	**1.200**	**25.800**	**108.336**	**50.303**	**97.283**	**1.400**	**0.600**	**6.300**	**344.587**

2010 LWSP Demand

2010 LWSP	BW	RH	OX	LS	CF	MI	WY	FC	GF	RC	WA	TOTAL
Municipal	1.717	22.88	14.71	4.5	28.5	125.0	26.98	25.81	0	0	6.3	**256.476**
Industrial	1.200	0.00	0.00	0	0.0	0.0	14.82	102.10	0	0	0	**118.120**
Power	0.000	0.00	0.00	0	36.4	2.5	0.00	0.00	0	0	0	**38.900**
Irrigation	9.100	4.80	1.30	1.3	2.9	0.8	8.50	8.40	1.5	0.6	1.2	**40.400**
Total	**12.017**	**27.677**	**16.013**	**5.800**	**67.841**	**128.333**	**50.303**	**136.312**	**1.500**	**0.600**	**7.500**	**453.896**

2020 LWSP Demand

2020 LWSP	**BW**	**RH**	**OX**	**LS**	**CF**	**MI**	**WY**	**FC**	**GF**	**RC**	**WA**	**TOTAL**
Municipal	1.983	24.05	16.79	5.5	40.9	152.3	38.51	32.50	0	0	8	**320.495**
Industrial	1.400	0.00	0.00	0	0.0	0.0	15.60	104.60	0	0	0	**121.600**
Power	0.000	0.00	0.00	0	46.0	2.5	41.90	0.00	0	0	0	**90.400**
Irrigation	9.700	5.20	1.50	1.6	3.2	0.9	9.60	8.80	1.6	0.7	1.3	**44.100**
Total	**13.083**	**29.250**	**18.292**	**7.100**	**90.097**	**155.662**	**105.613**	**145.898**	**1.600**	**0.700**	**9.300**	**576.595**

2050 LWSP Demand

2050 LWSP	**BW**	**RH**	**OX**	**LS**	**CF**	**MI**	**WY**	**FC**	**GF**	**RC**	**WA**	**TOTAL**
Municipal	2.889	28.90	25.38	9	80.4	226.7	63.35	55.39	0	0	12.7	**504.748**
Industrial	2.300	0.00	0.00	0	0.0	0.0	18.50	113.90	0	0	0	**134.700**
Power	15.300	0.00	0.00	0	62.5	2.5	53.00	0.00	0	0	13.1	**146.400**
Irrigation	12.900	7.30	2.50	2.7	4.2	1.0	12.60	10.30	2.1	0.8	1.6	**58.000**
Total	**33.389**	**36.196**	**27.884**	**11.700**	**147.101**	**230.244**	**147.447**	**179.587**	**2.100**	**0.800**	**27.400**	**843.848**

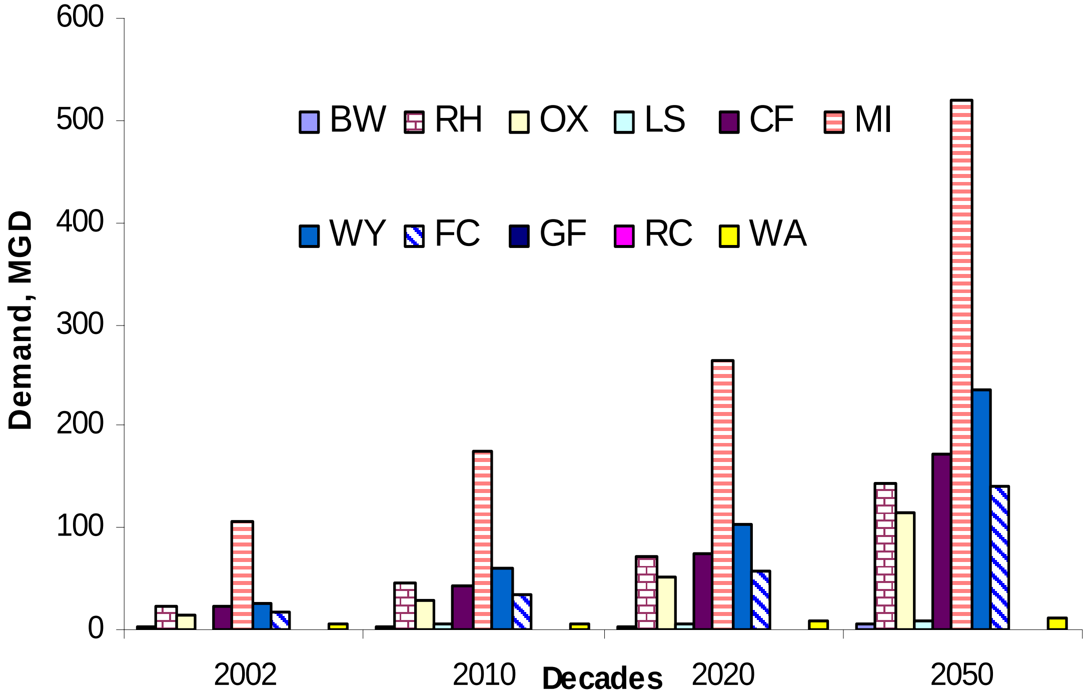

Figure 3-3: Municipal High Demand Plots for Reservoirs

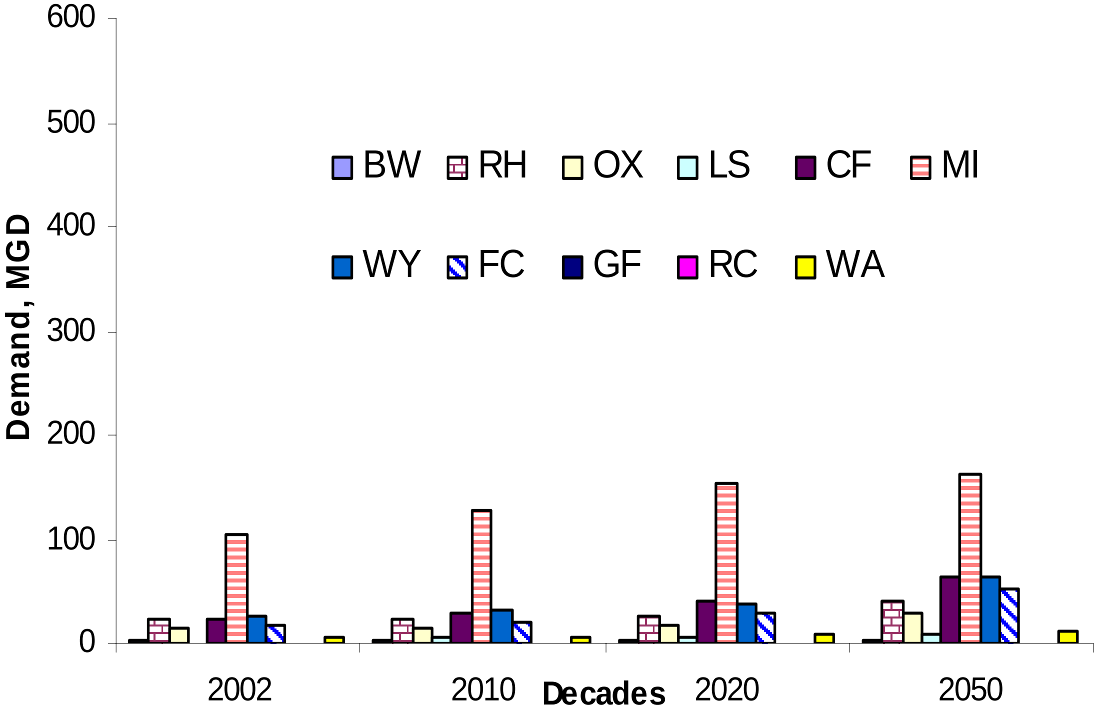

Figure 3-4: Municipal Low Demand Plots for Reservoirs

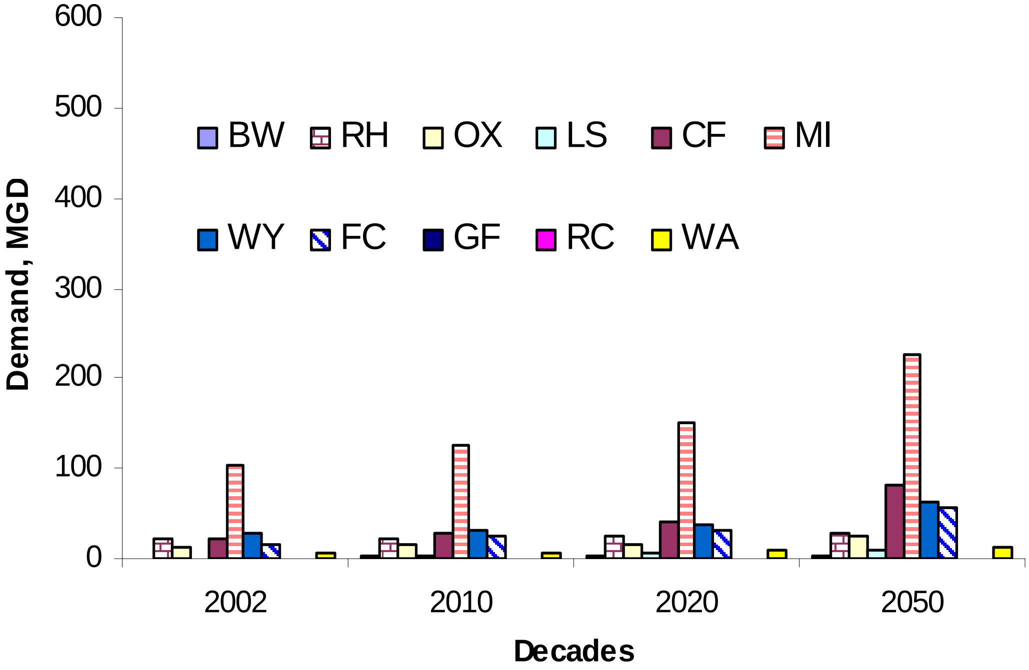

Figure 3-5: Municipal LWSP Demand Plots for Reservoirs

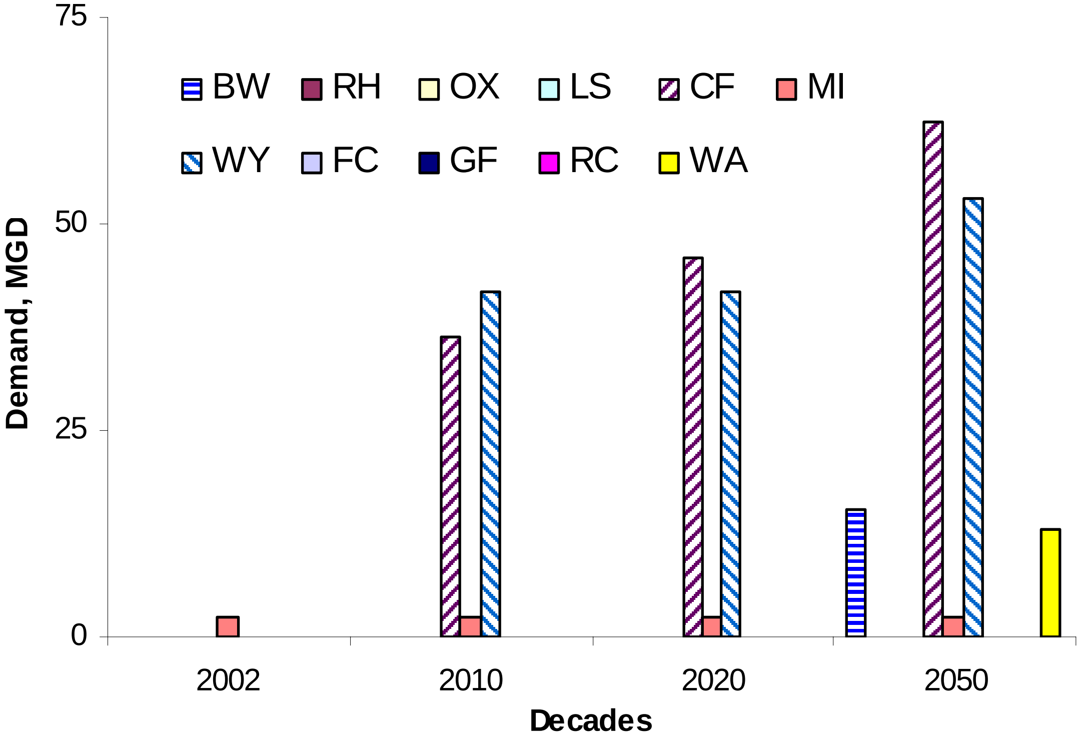

Figure 3-6: Power High Demand Plots for Reservoirs

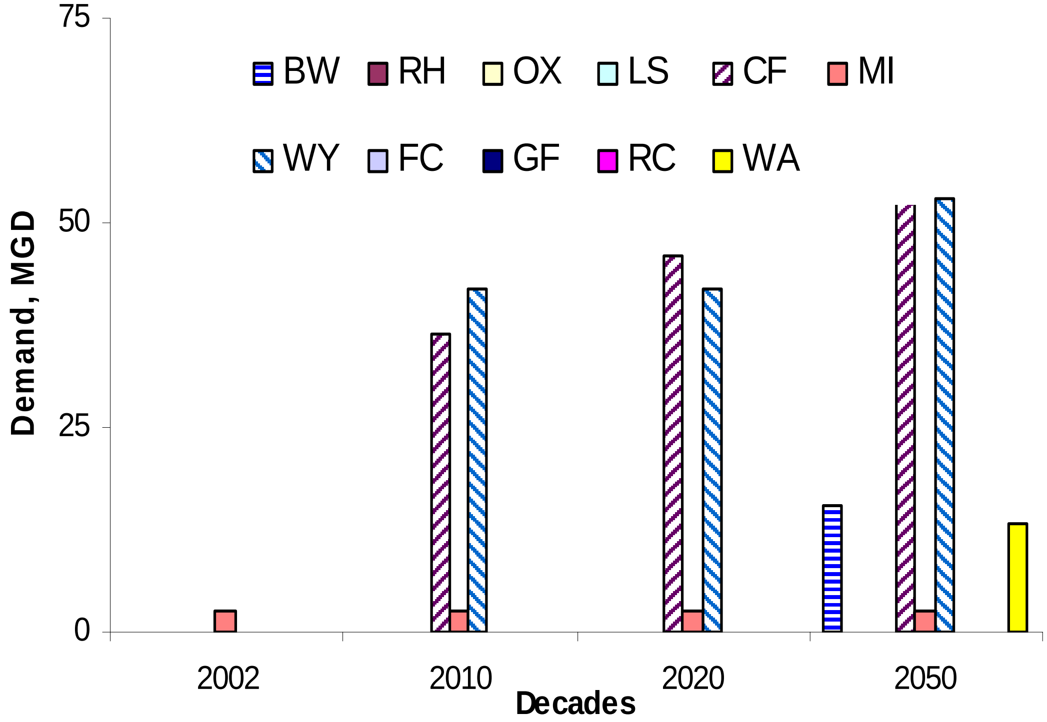

Figure 3-7: Power Low Demand Plots for Reservoirs

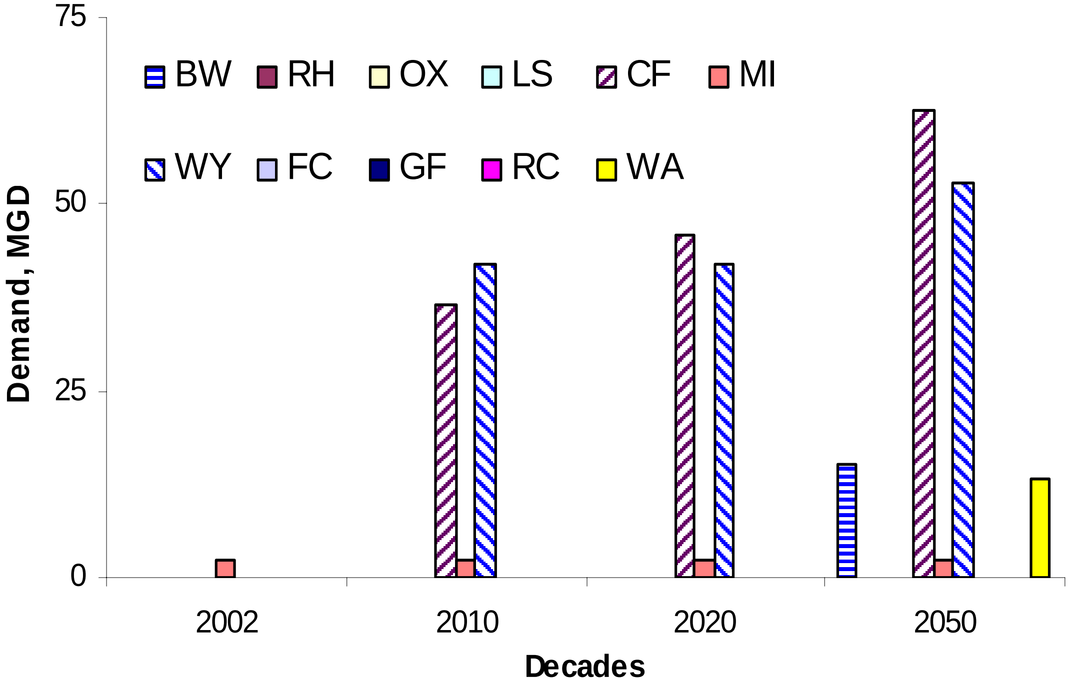

Figure 3-8: Power LWSP Demand Plots for Reservoirs

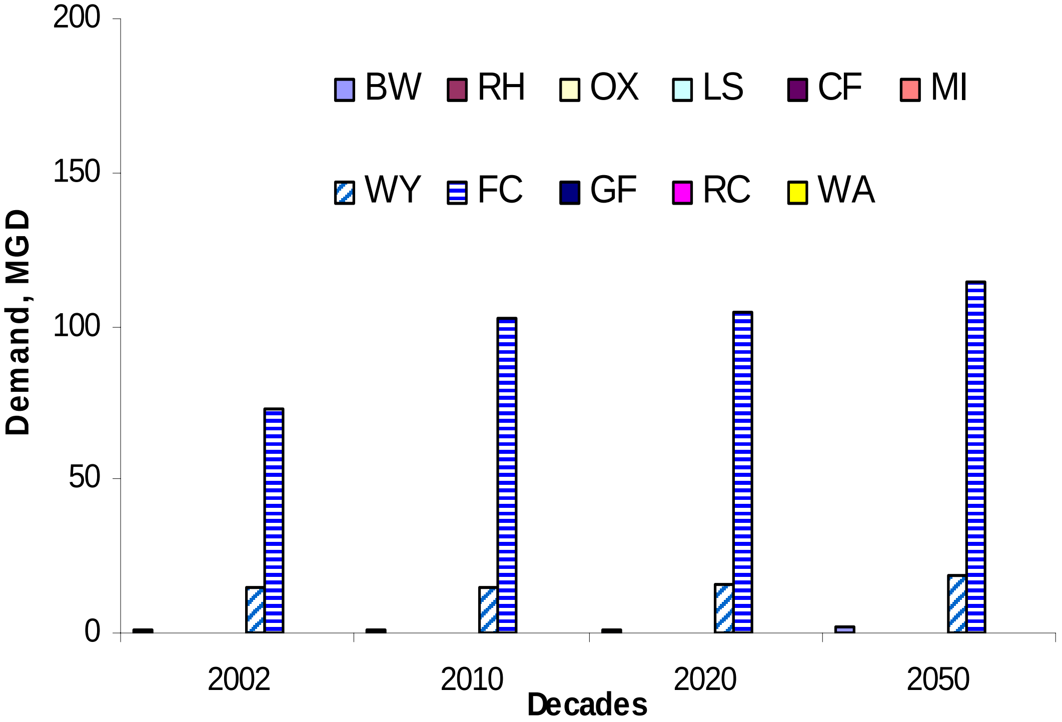

Figure 3-9: Industrial High Demand Plots for Reservoirs

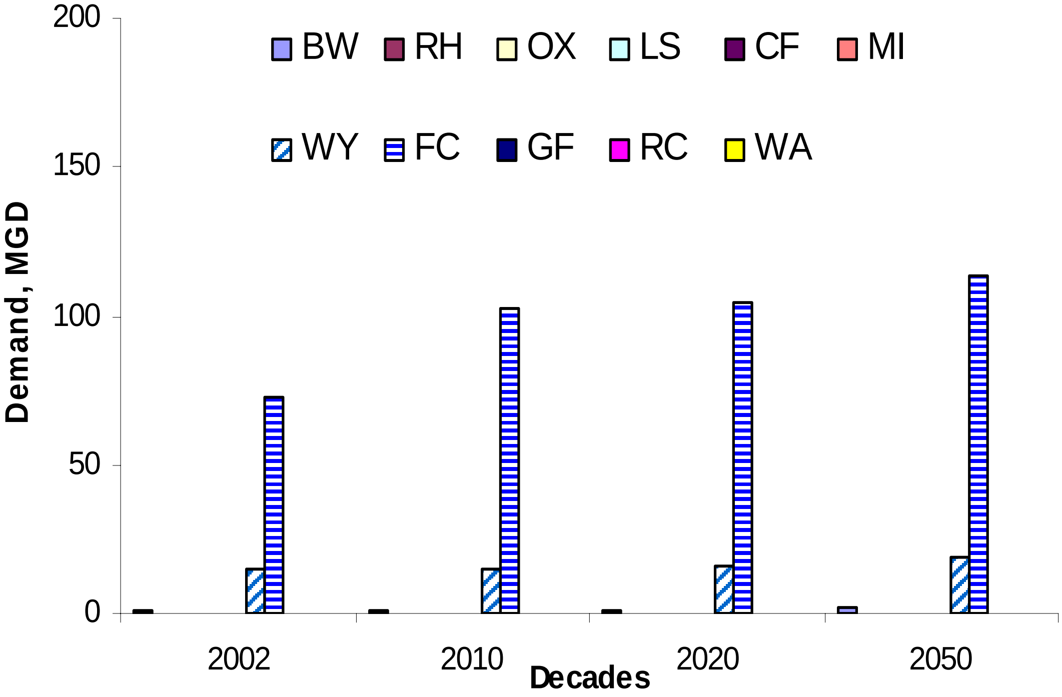

Figure 3-10: Industrial Low Demand Plots for Reservoirs

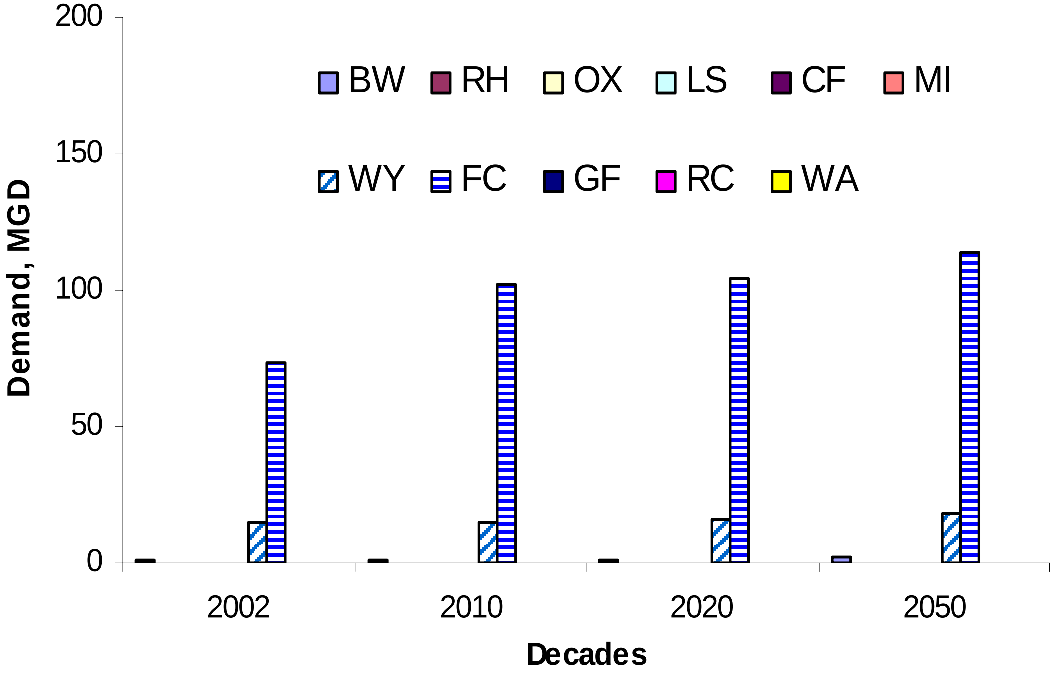

Figure 3-11: Industrial LWSP Demand Plots for Reservoirs

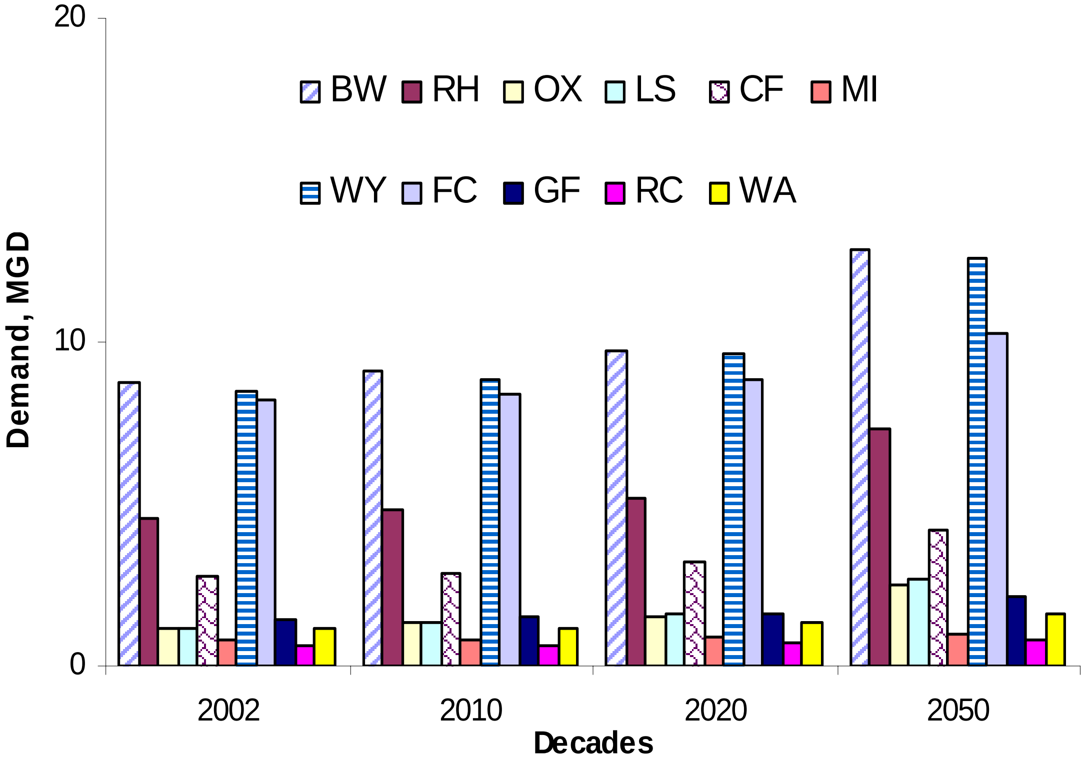

Figure 3-12: Irrigation High Demand Plots for Reservoirs

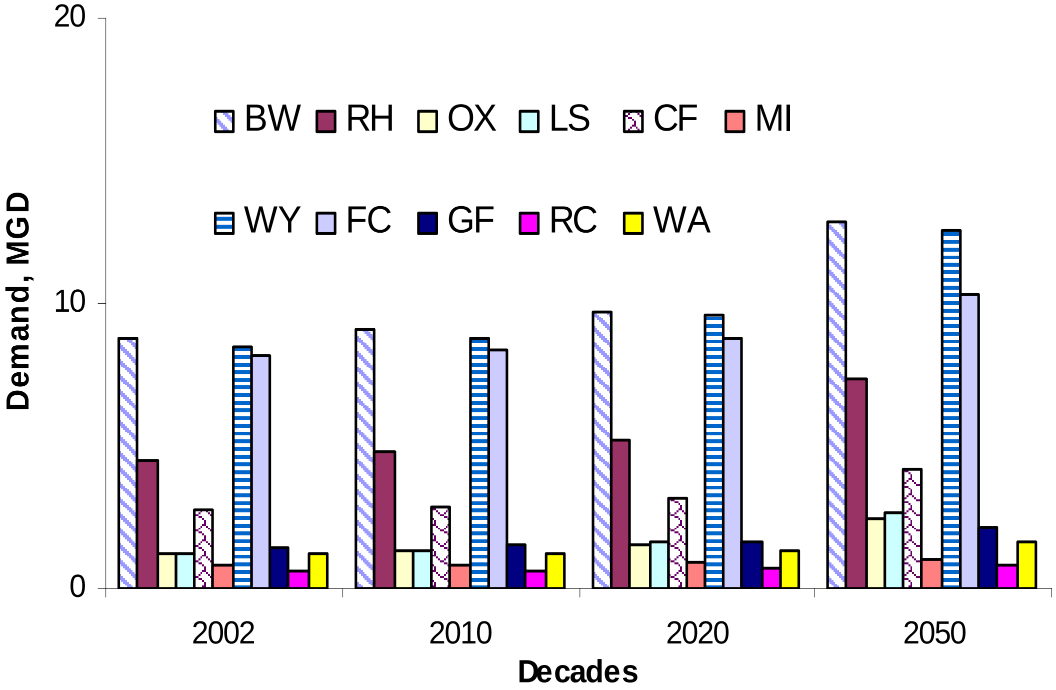

Figure 3-13: Irrigation Low Demand Plots for Reservoirs

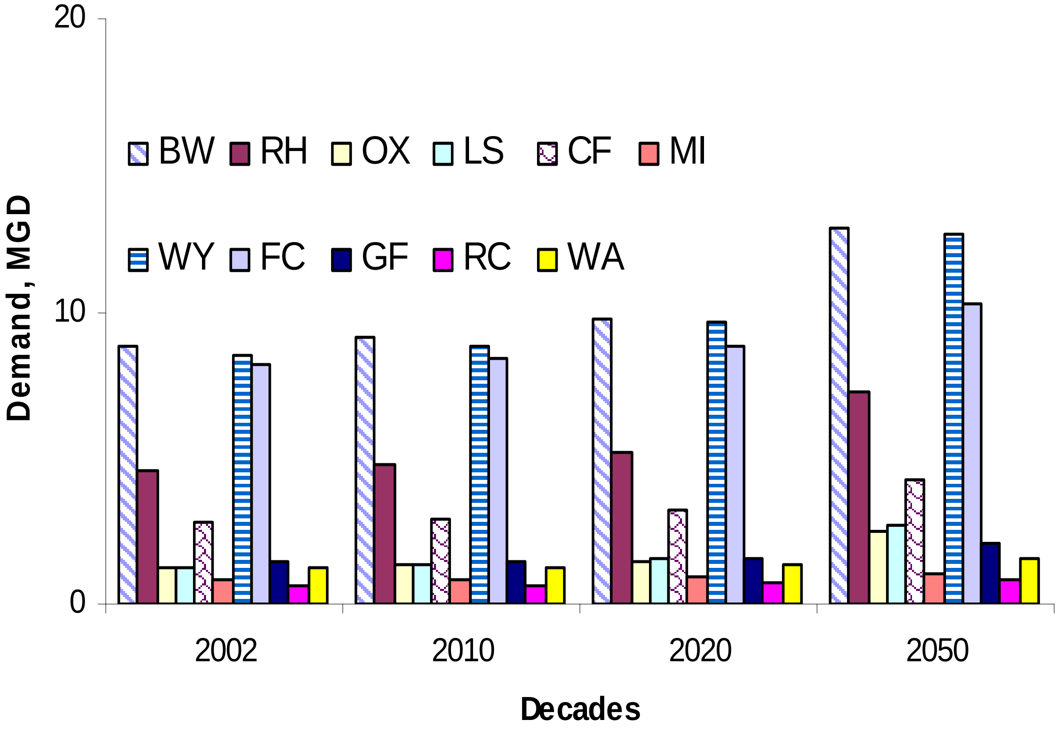

Figure 3-14: Irrigation LWSP Demand Plots for Reservoirs

(d) Summary of Model Results.

(i) Brief description of HDR Safe Yield Analysis

For Duke Energy’s Water Supply Study, HDR analyzed the CHEOPS model results to estimate the safe yields for the eleven reservoirs. Safe yield is a term used in that study to describe the amount of water theoretically available at a given location in a watershed. It is a commonly used measure of the dependability of a water supply sources. To estimate safe yield, the basic analytical approach generally employed is the calculation of a water budget that allocates and accounts for the water, given the constraints imposed by the facilities and their operation, over the critical low flow period of the available hydrologic record (HDR 2006, page 2).

Safe yield analyses were completed for the Baseline and Mutual Gain (MG) operating scenarios. MG operating conditions include many new and proposed operating parameters and constraints, such as down stream flow requirements from each reservoir, normal minimum elevations for each reservoir, and implementation of the LIP. Table 3-4 shows safe yield values for the reservoirs for the different operating scenarios. MG Critical Intake values are used for comparison purposes.

Table 3-4: Lower Range Safe Yield Data from HDR’s CHEOPS Analysis[41]

SAFE Yield [MGD] Summary from HDR's Water Supply Study

Lakes	**Baseline Critical Intake**	**MG Critical Intake**	**MG Boat Access**	**MG Full Reservoir Access**
BW	34	32	12	44
RH	40	40	52	52
OX	37	37	17	54
LS	12	12	15	15
CF	133	169	202	223
MI	192	207	131	272
WY	171	141	95	189
FC	225	238	238	238
GF	2	3	3	3
RC	1	1	1	1
WA	74	74	74	74
Total System Yield	**921**	**954**	**840**	**1165**

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[41] Source: HDR 2006, Table 4-15, Page 67

(ii) Reservoir net withdrawal comparison with safe yield

The MG critical intake safe yield quantities for upper 7 reservoirs have been compared to the modeled net withdrawal data (supply) as output and demand withdrawal data as input to determine the sustainability of the reservoirs for the planning horizon. The net withdrawal data have been averaged for the 75 years, and the difference between the input and output withdrawals (between demand and supply) are low.

For the year 2010, and in some cases for 2020, the output withdrawals are much lower than safe yield. However, many of the reservoirs have much higher withdrawals for the High demands especially for the year 2050, whereas Low and LWSP demands for 2050 are below safe yield as shown in the following few figures. Lake Norman and Mountain Island reservoir withdrew the most water compared to other reservoirs and exceeded the safe yield for the High demand option only. Lake Rhodhiss and Lake Hickory on the other hand exceeded the safe yield with lower demands. Few downstream reservoirs have negative demands with higher return flow values. The exception is Lake Wateree, which has a higher demand, but because it gets the return flow from the upper two reservoirs, the demands are safely lower than safe yield value.

In the figures the net High withdrawals are sometimes lower than the Low or LWSP demands. This is because the comparisons were between the net withdrawals, and for High demands the return flows were much higher than for the Low and LWSP demands, resulting in lower net withdrawals than Low and LWSP demands as shown in Figure 3-15.

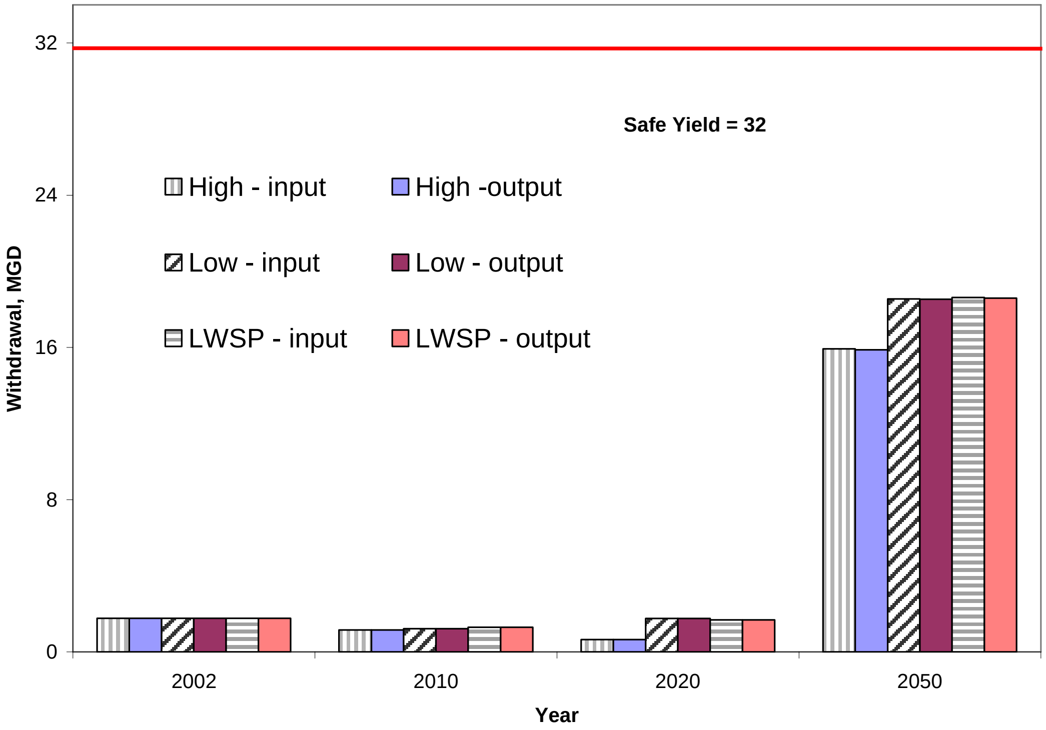

Figure 3-15 : Lake James at Bridgewater Demand – SY Plots

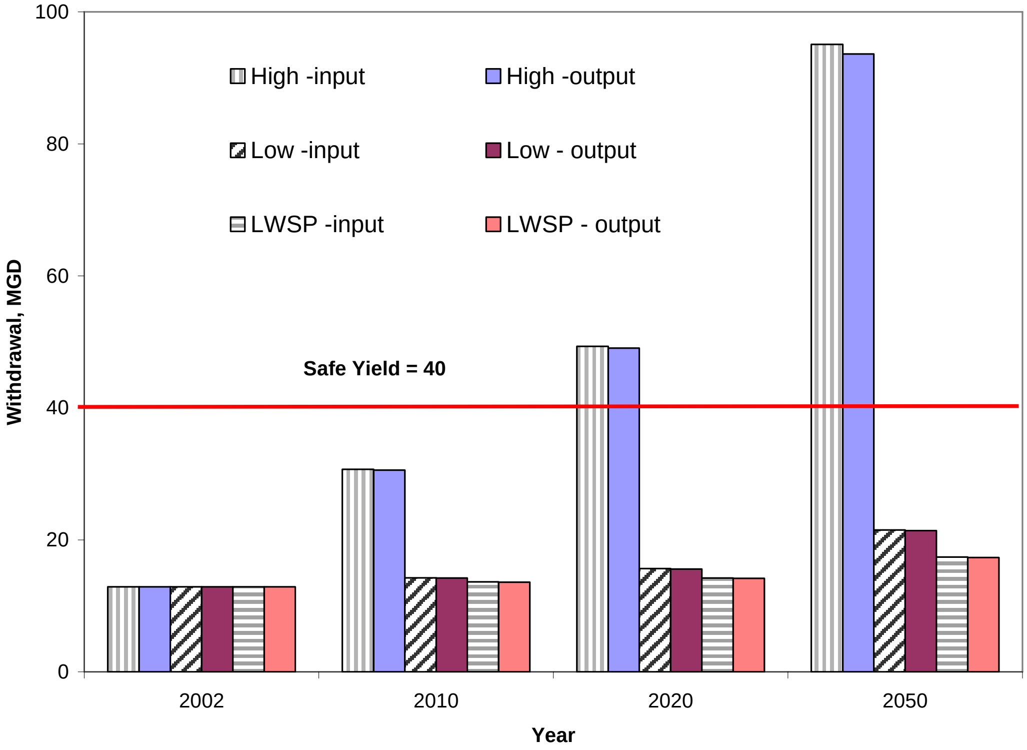

Figure 3-16: Lake Rhodhiss Demand – SY Plots

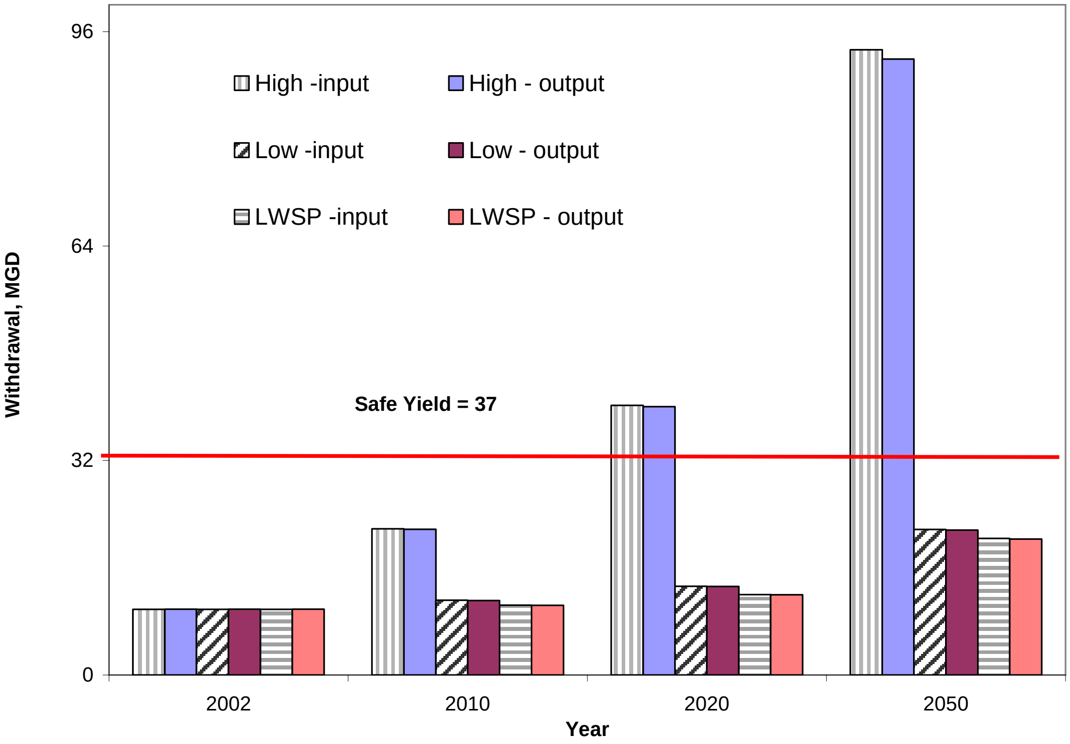

Figure 3-17: Lake Hickory at Oxford Demand – SY Plots

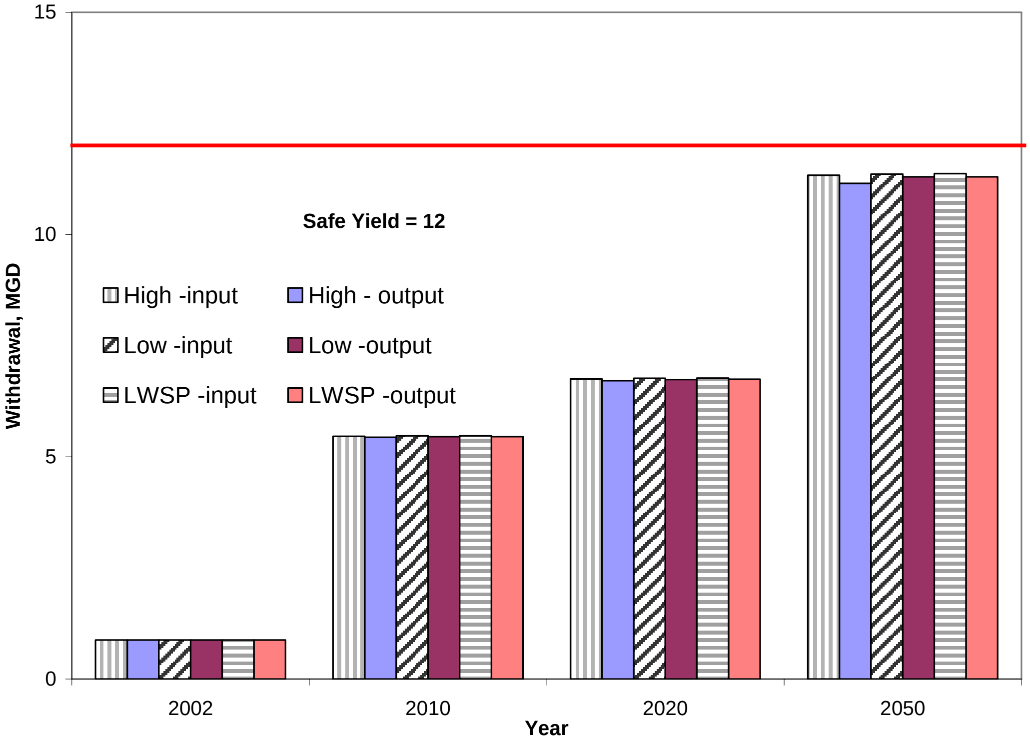

Figure 3-18: Lake Lookout Shoals Demand – SY Plots

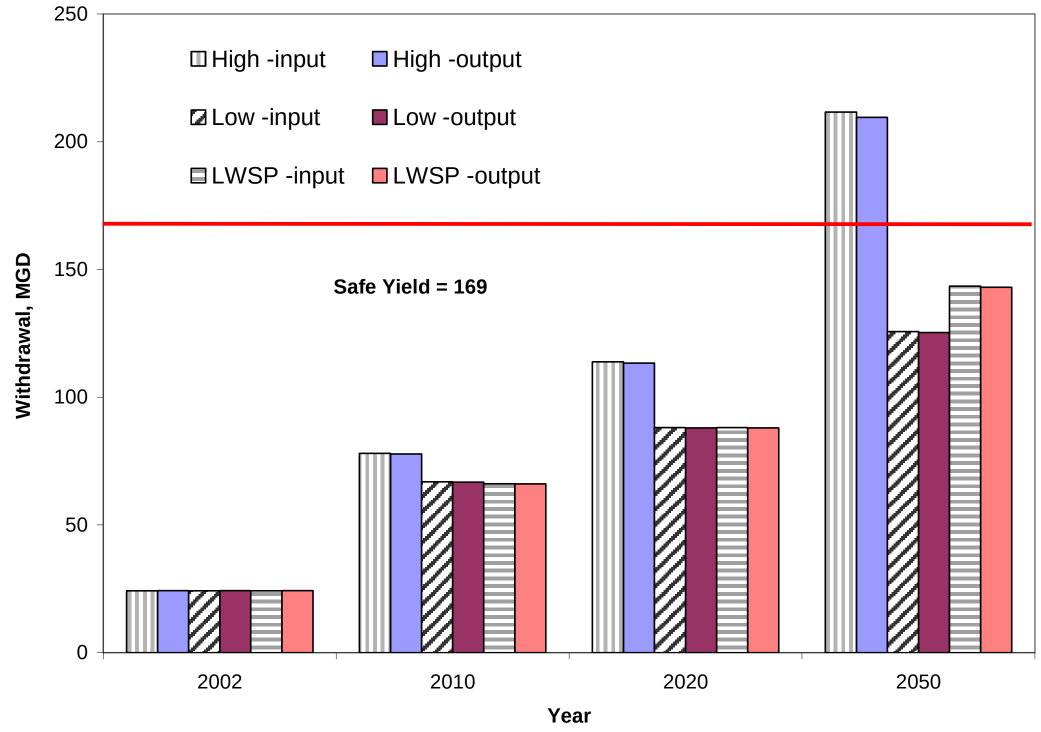

Figure 3-19: Lake Norman at Cowans Ford Demand – SY Plots

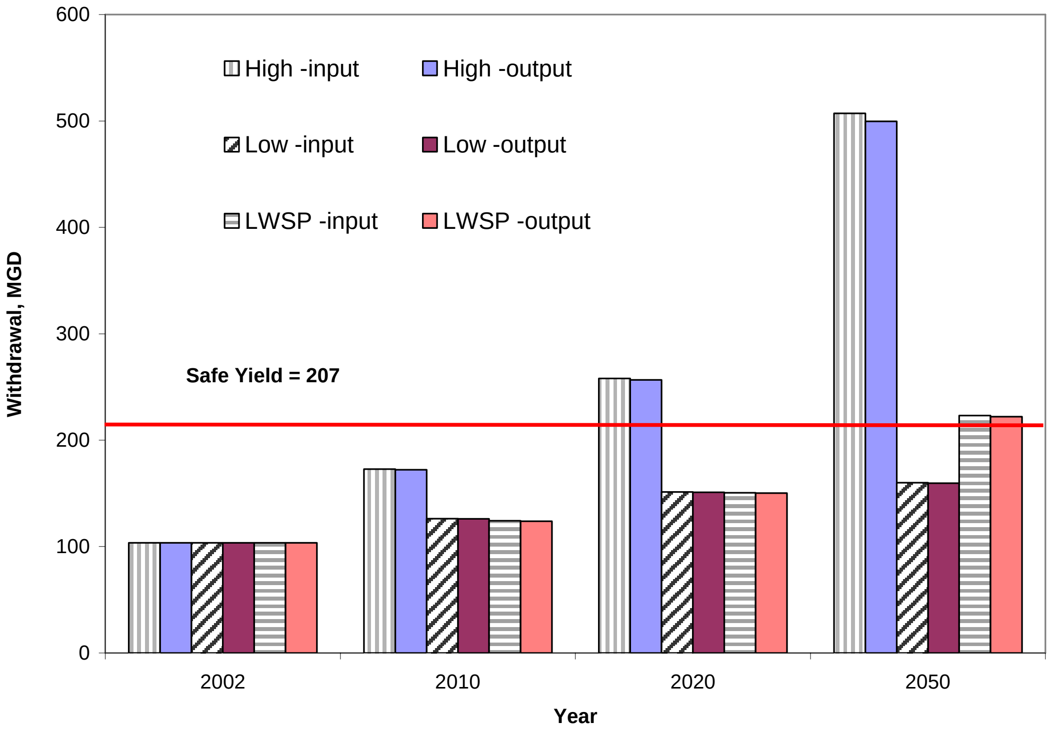

Figure 3-20: Mountain Island Lake Demand – SY Plots

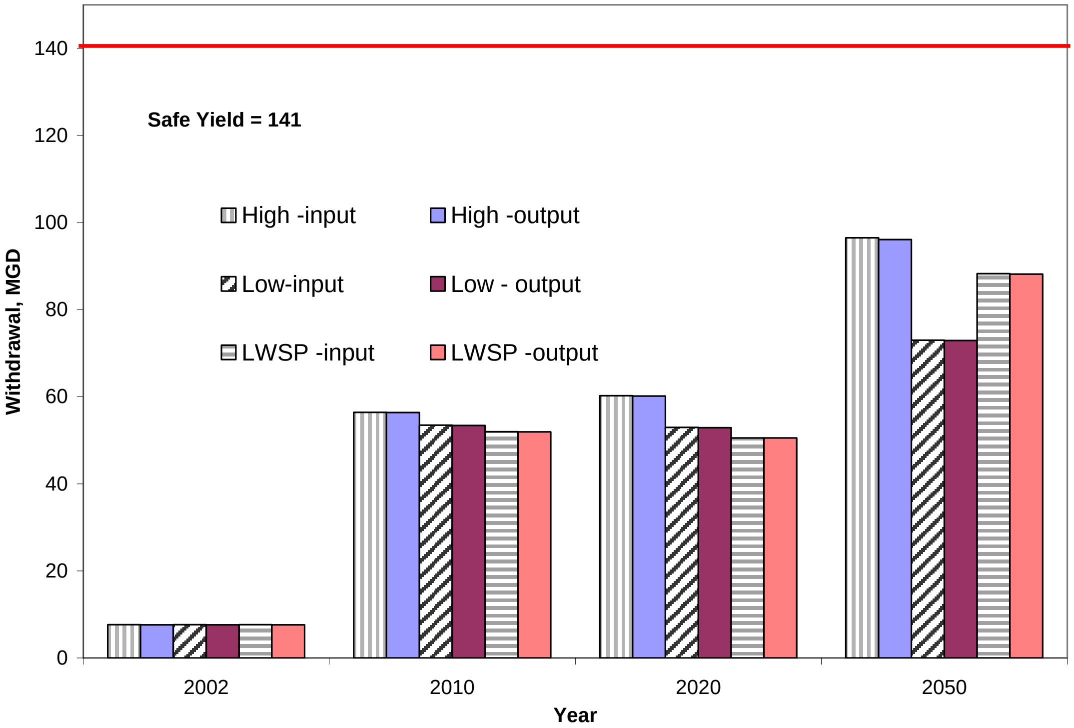

Figure 3-21: Lake Wylie Demand – SY Plots

(iii) Demand - Supply Summary Tables

In the model, the demands for a scenario year are fixed throughout the 75 years of variable hydrology in order to determine the impacts on the reservoir system. The supply of water from the watershed for any year depends upon the hydrological condition of the watershed and the operational constraints determined by the hydrological conditions. The demands can be met fully or partially according to the simulated conditions. Therefore the surplus or shortage after the withdrawal varies over time and for the different demand options. The model includes the LIP to simulate future operational conditions. At the beginning of the month if the hydrological or storage condition becomes unfavorable or falls at or below certain trigger levels (Appendix D2 – LIP Input Table), LIP stages are triggered and that stage remains in effect for the rest of the month for the system. Therefore, the triggering of the LIP stages depend upon the conditions set for the system. An earlier trigger can conserve water by maintaining lower storage levels for longer periods and thus any long, severe drought can be avoided in the long run.

Figure 3-22 shows the LIP stages activated during the simulation of 75 years of hydrology for the entire river system for the demand years 2010 and 2050. There are 5 LIP stages from 0 to 4, with 4 being the most severe condition and 0 being the LIP watch condition shown in the scale in Figure 3-22. The hydrology and LIP conditions show that there were four distinct major droughts that occurred in the 1930s, 1950s, the late 1980s, and in the year 2002.

Summaries of the storage conditions and supply statuses (shortages or surpluses) have been presented in the Table 3-5 through 3-11 for the 1950s, 1980s and 2002 drought periods. Table 3-12 provides a summary of the shortages during the major drought periods for all 11 reservoirs. With the 2050 High demand, Mountain Island had a severe drought condition for about 18 months with the highest shortage in the 1950s. With this demand, the drought severity and shortage were much less in 2002, but moderate during the 1980s for the same location. The 2010 High demand created almost similar shortages in Mountain Island; however the LIP level was higher in 2002. During the 1950s drought, only a few reservoirs experienced shortages, whereas in the 1980s and 2002, the shortages were progressively worse, as shown in Table 3-12.

Figure 3-23 through 25 compare the shortages along the river system for the three drought periods. The shortages were mostly in Mountain Island, the downstream reservoirs experienced little or no shortages, which is because these reservoirs receive return flows from the upstream reservoirs and the net withdrawals are negative for few reservoirs.

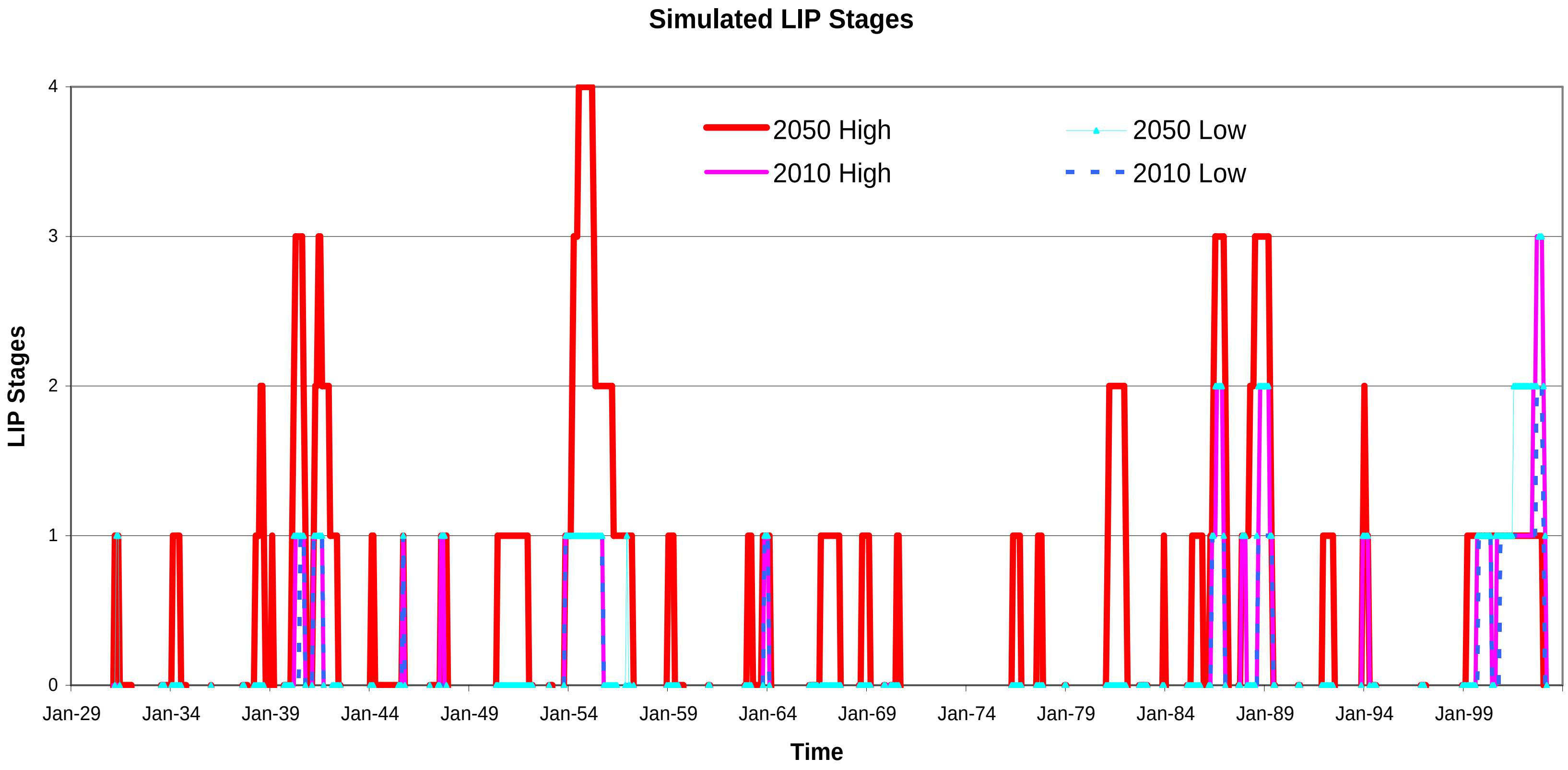

Figure 3-22: Simulated LIP Stages for the Entire Reservoir System

Table 3-5: Demand Supply Summary for Lake James at Bridgewater

Bridgewater		**2002**	**2010 High**	**2010 Low**	**2050 High**	**2050 Low**
Drought:1954	**Lowest Elevation Date**	10/26/1954	11/18/1953	11/21/1953	10/26/1954	02/26/1934
	Lowest Elevation, MSL	1188.49	1190.99	1191.05	1156.33	1188.00
	Storage at Lowest Elevation [LS], ac-ft	214,706	228,090	228,427	84,550	212,216
	Storage at Critical Elevation [CS], ac-ft	98,789	98,789	98,789	98,789	98,789
	Storage Diff =[LS - CS], ac-ft	**115,917**	**129,301**	**129,638**	**(14,239)**	**113,427**
	Actual Demand on Lowest Elevation Date, ac-ft	4.39	2.26	2.49	48.47	58.05
	Modeled Supply on that Date, ac-ft	4.39	2.25	2.47	46.24	58.05
	Shortage =[Supply - Demand], ac-ft	**-**	**(0.01)**	**(0.02)**	**(2.23)**	**(0.00)**
Drought: 1988	**Lowest Elevation Date**	08/31/1986	02/10/1986	09/05/1988	02/04/1989	03/26/1989
	Lowest Elevation, MSL	1185.20	1192.00	1190.64	1181.83	1198.08
	Storage at Lowest Elevation [LS], ac-ft	197,905	233,671	226,181	181,398	268,588
	Storage at Critical Elevation [CS], ac-ft	98,789	98,789	98,789	98,789	98,789
	Storage Diff =[LS - CS], ac-ft	**99,116**	**134,882**	**127,392**	**82,609**	**169,799**
	Actual Demand on Lowest Elevation Date, ac-ft	5.75	3.56	3.55	49.34	58.24
	Modeled Supply on that Date, ac-ft	5.75	3.56	3.53	47.98	57.49
	Shortage =[Supply - Demand], ac-ft	**-**	**-**	**(0.02)**	**(1.36)**	**(0.75)**
Drought: 2002	**Lowest Elevation Date**	10/11/2002	11/04/2002	11/09/2002	02/27/2002	11/05/2002
	Lowest Elevation, MSL	1161.53	1183.00	1190.00	1189.98	1186.80
	Storage at Lowest Elevation [LS], ac-ft	100,509	187,049	222,756	222,623	206,156
	Storage at Critical Elevation [CS], ac-ft	98,789	98,789	98,789	98,789	98,789
	Storage Diff =[LS - CS], ac-ft	**1,720**	**88,260**	**123,967**	**123,834**	**107,367**
	Actual Demand on Lowest Elevation Date, ac-ft	4.39	2.26	2.49	49.34	52.82
	Modeled Supply on that Date, ac-ft	4.39	2.20	2.45	49.07	52.82
	Shortage =[Supply - Demand], ac-ft	**-**	**(0.06)**	**(0.04)**	**(0.27)**	**-**

Table 3-6: Demand Supply Summary for Lake Rhodhiss

Rhodhiss		2002	2010 High	2010 Low	2050 High	2050 Low
Drought:1954	**Lowest Elevation Date**	08/05/1953	11/05/1953	11/02/1953	09/14/1954	11/21/1953
	Lowest Elevation, MSL	988.38	988.26	989.12	984.09	988.09
	Storage at Lowest Elevation [LS], ac-ft	34,538	34,334	35,750	27,923	34,057
	Storage at Critical Elevation [CS], ac-ft	28,521	28,521	28,521	28,521	28,521
	Storage Diff =[LS - CS], ac-ft	**6,017**	**5,813**	**7,229**	**(598)**	**5,536**
	Actual Demand on Lowest Elevation Date, ac-ft	50.06	73.06	31.33	287.62	46.32
	Modeled Supply on that Date, ac-ft	50.06	70.86	31.33	215.71	44.93
	Shortage =[Supply - Demand], ac-ft	**(0.00)**	**(2.20)**	**(0.00)**	**(71.91)**	**(1.39)**
Drought: 1988	**Lowest Elevation Date**	12/16/1992	10/12/1986	10/13/1988	08/28/1988	10/14/1988
	Lowest Elevation, MSL	988.43	987.12	988.14	985.97	987.12
	Storage at Lowest Elevation [LS], ac-ft	34,611	32,512	34,142	30,727	32,505
	Storage at Critical Elevation [CS], ac-ft	28,521	28,521	28,521	28,521	28,521
	Storage Diff =[LS - CS], ac-ft	**6,090**	**3,991**	**5,621**	**2,206**	**3,984**
	Actual Demand on Lowest Elevation Date, ac-ft	26.92	81.30	36.26	344.94	53.74
	Modeled Supply on that Date, ac-ft	26.92	75.61	35.17	293.20	49.98
	Shortage =[Supply - Demand], ac-ft	**(0.00)**	**(5.69)**	**(1.09)**	**(51.74)**	**(3.76)**
Drought: 2002	**Lowest Elevation Date**	03/18/2003	09/06/2002	09/22/2002	05/23/2003	09/13/2001
	Lowest Elevation, MSL	989.50	986.80	987.10	983.73	987.00
	Storage at Lowest Elevation [LS], ac-ft	36,369	32,005	32,484	27,398	32,379
	Storage at Critical Elevation [CS], ac-ft	28,521	28,521	28,521	28,521	28,521
	Storage Diff =[LS - CS], ac-ft	**7,848**	**3,484**	**3,963**	**(1,123)**	**3,858**
	Actual Demand on Lowest Elevation Date, ac-ft	33.15	92.66	42.99	329.20	65.18
	Modeled Supply on that Date, ac-ft	33.15	78.76	39.98	329.20	60.62
	Shortage =[Supply - Demand], ac-ft	**-**	**(13.90)**	**(3.01)**	**(0.00)**	**(4.56)**

Table 3-7: Demand Supply Summary for Lake Hickory at Oxford

Oxford		2002	2010 High	2010 Low	2050 High	2050 Low
Drought:1954	**Lowest Elevation Date**	08/19/1956	08/20/1956	08/19/1956	09/23/1956	08/19/1956
	Lowest Elevation, MSL	929.00	927.90	928.30	925.80	928.00
	Storage at Lowest Elevation [LS], ac-ft	103,759	99,897	101,351	92,673	100,487
	Storage at Critical Elevation [CS], ac-ft	103,767	103,767	103,767	103,767	103,767
	Storage Diff =[LS - CS], ac-ft	**(8)**	**(3,870)**	**(2,416)**	**(11,095)**	**(3,280)**
	Actual Demand on Lowest Elevation Date, ac-ft	38.60	83.68	43.94	297.49	84.87
	Modeled Supply on that Date, ac-ft	38.60	83.68	43.94	288.56	84.87
	Shortage =[Supply - Demand], ac-ft	**-**	**0.00**	**(0.00)**	**(8.93)**	**(0.00)**
Drought: 1988	**Lowest Elevation Date**	08/23/1988	08/06/1988	08/07/1988	08/30/1987	08/22/1987
	Lowest Elevation, MSL	929.63	928.48	928.47	927.72	928.79
	Storage at Lowest Elevation [LS], ac-ft	106,076	101,908	101,868	99,257	103,023
	Storage at Critical Elevation [CS], ac-ft	103,767	103,767	103,767	103,767	103,767
	Storage Diff =[LS - CS], ac-ft	**2,309**	**(1,859)**	**(1,899)**	**(4,510)**	**(744)**
	Actual Demand on Lowest Elevation Date, ac-ft	38.59	83.68	43.94	349.84	84.87
	Modeled Supply on that Date, ac-ft	38.60	83.68	43.94	349.83	84.87
	Shortage =[Supply - Demand], ac-ft	**0.01**	**-**	**(0.00)**	**(0.01)**	**(0.00)**
Drought: 2002	**Lowest Elevation Date**	11/20/2001	08/15/1999	09/25/1999	09/23/2002	08/14/2000
	Lowest Elevation, MSL	929.70	928.40	928.61	918.00	928.44
	Storage at Lowest Elevation [LS], ac-ft	106,229	101,687	102,391	69,254	101,871
	Storage at Critical Elevation [CS], ac-ft	103,767	103,767	103,767	103,767	103,767
	Storage Diff =[LS - CS], ac-ft	**2,462**	**(2,080)**	**(1,376)**	**(34,513)**	**(1,896)**
	Actual Demand on Lowest Elevation Date, ac-ft	24.28	83.68	35.89	297.49	84.87
	Modeled Supply on that Date, ac-ft	24.28	83.68	35.89	288.56	82.32
	Shortage =[Supply - Demand], ac-ft	**-**	**0.00**	**0.00**	**(8.93)**	**(2.55)**

Table 3-8: Demand Supply Summary for Lookout Shoals Lake

Lookout Shoals		2002	2010 High	2010 Low	2050 High	2050 Low
Drought:1954	Lowest Elevation Date	01/09/1955	08/16/1956	08/16/1956	11/21/1954	08/16/1956
	Lowest Elevation, MSL	825.16	830.84	831.04	812.90	830.84
	Storage at Lowest Elevation [LS], ac-ft	15,005	19,026	19,177	8,244	19,025
	Storage at Critical Elevation [CS], ac-ft	8,274	8,274	8,274	8,274	8,274
	Storage Diff =[LS - CS], ac-ft	6,731	10,752	10,903	(30)	10,751
	Actual Demand on Lowest Elevation Date, ac-ft	3.13	13.74	13.76	27.63	28.98
	Modeled Supply on that Date, ac-ft	3.13	13.74	13.76	20.72	28.98
	Shortage =[Supply - Demand], ac-ft	0.00	(0.00)	(0.00)	(6.91)	0.00
Drought: 1988	Lowest Elevation Date	04/22/1988	07/24/1986	08/04/1986	09/23/1988	08/04/1986
	Lowest Elevation, MSL	826.03	830.89	831.03	829.07	830.07
	Storage at Lowest Elevation [LS], ac-ft	15,583	19,061	19,166	17,710	18,444
	Storage at Critical Elevation [CS], ac-ft	8,274	8,274	8,274	8,274	8,274
	Storage Diff =[LS - CS], ac-ft	7,309	10,787	10,892	9,436	10,170
	Actual Demand on Lowest Elevation Date, ac-ft	3.36	18.57	13.76	25.43	28.98
	Modeled Supply on that Date, ac-ft	3.36	18.02	13.35	21.62	26.95
	Shortage =[Supply - Demand], ac-ft	0.00	(0.55)	(0.41)	(3.81)	(2.03)
Drought: 2002	Lowest Elevation Date	05/02/2002	09/05/2002	09/13/2002	10/17/2002	09/13/2002
	Lowest Elevation, MSL	825.40	829.00	829.80	829.37	829.00
	Storage at Lowest Elevation [LS], ac-ft	15,166	17,725	18,247	17,927	17,828
	Storage at Critical Elevation [CS], ac-ft	8,274	8,274	8,274	8,274	8,274
	Storage Diff =[LS - CS], ac-ft	6,892	9,451	9,973	9,654	9,554
	Actual Demand on Lowest Elevation Date, ac-ft	3.46	12.04	12.06	27.70	25.52
	Modeled Supply on that Date, ac-ft	3.46	10.23	11.22	26.87	23.73
	Shortage =[Supply - Demand], ac-ft	-	(1.81)	(0.84)	(0.83)	(1.79)

Table 3-9: Demand Supply Summary for Lake Norman at Cowans Ford

Cowan Ford		2002	2010 High	2010 Low	2050 High	2050 Low
Drought:1954	Lowest Elevation Date	03/02/1956	12/09/1953	12/08/1953	10/21/1956	01/06/1954
	Lowest Elevation, MSL	751.93	750.90	753.00	748.32	750.79
	Storage at Lowest Elevation [LS], ac-ft	821,094	793,859	851,838	726,189	790,262
	Storage at Critical Elevation [CS], ac-ft	769,254	769,254	769,254	769,254	769,254
	Storage Diff =[LS - CS], ac-ft	51,840	24,605	82,584	(43,065)	21,008
	Actual Demand on Lowest Elevation Date, ac-ft	58.24	222.78	193.23	627.06	364.60
	Modeled Supply on that Date, ac-ft	58.24	218.48	189.50	614.96	357.57
	Shortage =[Supply - Demand], ac-ft	-	(4.30)	(3.73)	(12.10)	(7.03)
Drought: 1988	Lowest Elevation Date	03/01/1991	02/02/1986		08/20/1988	11/26/1987
	Lowest Elevation, MSL	751.92	754.02		749.90	753.78
	Storage at Lowest Elevation [LS], ac-ft	820,921	880,054		766,656	873,168
	Storage at Critical Elevation [CS], ac-ft	769,254	769,254		769,254	769,254
	Storage Diff =[LS - CS], ac-ft	51,667	110,800		(2,598)	103,914
	Actual Demand on Lowest Elevation Date, ac-ft	58.24	224.42		715.58	337.92
	Modeled Supply on that Date, ac-ft	58.24	224.42		646.57	331.40
	Shortage =[Supply - Demand], ac-ft	-	(0.00)		(69.01)	(6.52)
Drought: 2002	Lowest Elevation Date	03/02/1999	09/13/2002	09/28/2002	10/02/2002	02/10/2001
	Lowest Elevation, MSL	751.90	751.10	753.80	649.00	750.24
	Storage at Lowest Elevation [LS], ac-ft	818,708	798,093	875,734	47	775,758
	Storage at Critical Elevation [CS], ac-ft	769,254	769,254	769,254	769,254	769,254
	Storage Diff =[LS - CS], ac-ft	49,454	28,839	106,480	(769,207)	6,504
	Actual Demand on Lowest Elevation Date, ac-ft	58.24	237.37	202.55	627.06	358.49
	Modeled Supply on that Date, ac-ft	58.24	214.48	193.44	614.96	351.57
	Shortage =[Supply - Demand], ac-ft	-	(22.89)	(9.11)	(12.10)	(6.92)

Table 3-10: Demand Supply Summary for Mountain Island Lake

Mountain Island		2002	2010 High	2010 Low	2050 High	2050 Low
Drought:1954	**Lowest Elevation Date**	06/11/1940	05/03/1953	01/26/1937	10/15/54 - 11	01/26/1937
	Lowest Elevation, MSL	641.73	641.66	640.50	577.50	640.50
	Storage at Lowest Elevation [LS], ac-ft	44,493	44,317	41,554	-	41,648
	Storage at Critical Elevation [CS], ac-ft	44,669	44,669	44,669	44,669	44,669
	Storage Diff =[LS - CS], ac-ft	**(176)**	**(353)**	**(3,115)**	**(44,669)**	**(3,022)**
	Actual Demand on Lowest Elevation Date, ac-ft	**410.61**	**616.75**	**327.54**	**1,474.47**	**416.87**
	Modeled Supply on that Date, ac-ft	**410.60**	**616.75**	**327.53**	**1,110.33**	**416.87**
	Shortage =[Supply - Demand], ac-ft	**(0.01)**	**(0.00)**	**(0.01)**	**(364.14)**	**0.00**
Drought: 1988	**Lowest Elevation Date**	06/28/1988	01/29/1989		08/22/1988	12/12/1988
	Lowest Elevation, MSL	641.74	641.15		577.50	641.16
	Storage at Lowest Elevation [LS], ac-ft	44,523	43,096		-	43,134
	Storage at Critical Elevation [CS], ac-ft	44,669	44,669		44,669	44,669
	Storage Diff =[LS - CS], ac-ft	**(146)**	**(1,573)**		**(44,669)**	**(1,535)**
	Actual Demand on Lowest Elevation Date, ac-ft	**410.61**	**447.94**		**1,828.02**	**397.10**
	Modeled Supply on that Date, ac-ft	**410.60**	**416.96**		**1,557.14**	**369.64**
	Shortage =[Supply - Demand], ac-ft	**(0.01)**	**(30.98)**		**(270.88)**	**(27.46)**
Drought: 2002	**Lowest Elevation Date**	06/23/2002	11/19/2002	10/20/2002	06/29/01 - 8/	04/21/2002
	Lowest Elevation, MSL	641.73	641.10	641.10	577.50	614.14
	Storage at Lowest Elevation [LS], ac-ft	44,502	43,159	43,197	-	43,087
	Storage at Critical Elevation [CS], ac-ft	44,669	44,669	44,669	44,669	44,669
	Storage Diff =[LS - CS], ac-ft	**(167)**	**(1,510)**	**(1,472)**	**(44,669)**	**(1,582)**
	Actual Demand on Lowest Elevation Date, ac-ft	**410.61**	**447.65**	**367.69**	**1,997.83**	**487.77**
	Modeled Supply on that Date, ac-ft	**410.60**	**381.31**	**342.26**	**1,938.59**	**454.04**
	Shortage =[Supply - Demand], ac-ft	**(0.01)**	**(66.34)**	**(25.43)**	**(59.24)**	**(33.73)**

Table 3-11: Demand Supply Summary for Lake Wylie

Wylie		2002	2010 High	2010 Low	2050 High	2050 Low
Drought:1954	**Lowest Elevation Date**	09/06/1954	11/04/1953	09/25/1956	08/29/1953	11/04/1953
	Lowest Elevation, MSL	566.48	555.20	561.20	504.40	549.60
	Storage at Lowest Elevation [LS], ac-ft	203,179	106,218	154,023	-	71,612
	Storage at Critical Elevation [CS], ac-ft	160,707	160,707	160,707	160,707	160,707
	Storage Diff =[LS - CS], ac-ft	**42,472**	**(54,489)**	**(6,684)**	**(160,707)**	**(89,095)**
	Actual Demand on Lowest Elevation Date, ac-ft	**33.17**	**173.34**	**180.54**	**335.78**	**225.14**
	Modeled Supply on that Date, ac-ft	**33.13**	**173.33**	**180.54**	**335.78**	**225.14**
	Shortage =[Supply - Demand], ac-ft	**(0.04)**	**(0.01)**	**0.00**	**(0.00)**	**(0.00)**
Drought: 1988	**Lowest Elevation Date**	07/23/1988	09/14/1986	07/06/1986	10/12/1987	10/19/1988
	Lowest Elevation, MSL	562.03	561.70	562.10	504.40	561.70
	Storage at Lowest Elevation [LS], ac-ft	160,974	158,045	161,617	-	158,134
	Storage at Critical Elevation [CS], ac-ft	160,707	160,707	160,707	160,707	160,707
	Storage Diff =[LS - CS], ac-ft	**267**	**(2,662)**	**910**	**(160,707)**	**(2,573)**
	Actual Demand on Lowest Elevation Date, ac-ft	**31.56**	**195.15**	**180.06**	**331.92**	**240.48**
	Modeled Supply on that Date, ac-ft	**31.56**	**192.46**	**179.00**	**331.92**	**237.16**
	Shortage =[Supply - Demand], ac-ft	**-**	**2.69**	**(1.06)**	**(0.00)**	**(3.32)**
Drought: 2002	**Lowest Elevation Date**	07/31/2001	08/03/2002	09/13/2002	08/05/2001	11/26/1993
	Lowest Elevation, MSL	562.00	561.70	561.65	504.40	555.39
	Storage at Lowest Elevation [LS], ac-ft	160,699	158,067	157,591	-	107,363
	Storage at Critical Elevation [CS], ac-ft	160,707	160,707	160,707	160,707	160,707
	Storage Diff =[LS - CS], ac-ft	**(8)**	**(2,640)**	**(3,116)**	**(160,707)**	**(53,344)**
	Actual Demand on Lowest Elevation Date, ac-ft	**31.56**	**206.37**	**180.54**	**335.78**	**225.14**
	Modeled Supply on that Date, ac-ft	**31.56**	**186.85**	**178.05**	**333.80**	**225.14**
	Shortage =[Supply - Demand], ac-ft	**-**	**(19.52)**	**(2.49)**	**(1.98)**	**(0.00)**

Table 3-12: Demand Shortage Summaries for Drought Periods

Demand Shortage	**Drought Period: 1953-57**				**Drought Period: 1986-88**				**Drought Period: 2000-2002**			
Reservoirs	**2010 High**	**2010 Low**	**2050 High**	**2050 Low**	**2010 High**	**2010 Low**	**2050 High**	**2050 Low**	**2010 High**	**2010 Low**	**2050 High**	**2050 Low**
BW			(2.2)				(1.4)	(0.8)				
RH			(71.9)	(1.4)	(5.7)	(1.1)	(51.7)	(3.8)	(13.9)	(3.0)		(4.6)
OX			(8.9)								(8.9)	(2.6)
LS			(6.9)		(0.6)	(0.4)	(3.8)	(2.0)	(1.8)	(0.8)	(0.8)	(1.8)
CF	(4.3)	(3.7)	(12.1)	(7.0)			(69.0)	(6.5)	(22.9)	(9.1)	(12.1)	(6.9)
MI			(364.1)		(31.0)	-	(270.9)	(27.5)	(66.3)	(25.4)	(59.2)	(33.7)
WY					2.7	(1.1)		(3.3)	(19.5)	(2.5)	(2.0)	
FC											8.2	
GF												
RC												
WA												
Start of LIP/ Drought	Nov-53	Nov-53	Nov-53	Nov-53	Sep-88	Sep-88	Nov-87	Aug-88	Sep-00	Nov-00	Mar-99	Aug-00
End of LIP/ Drought	Sep-55	Sep-55	Mar-57	Sep-55	May-89	May-89	May-89	May-89	Jan-03	Jan-03	Dec-02	Feb-03
Highest LIP Stage	**1**	**1**	**4**	**1**	**2**	**1**	**3**	**2**	**3**	**2**	**1**	**3**
Longest LIP Stage	**1**	**1**	**3**	**1**	**1**	**1**	**3**	**2**	**1**	**1**	**1**	**2**

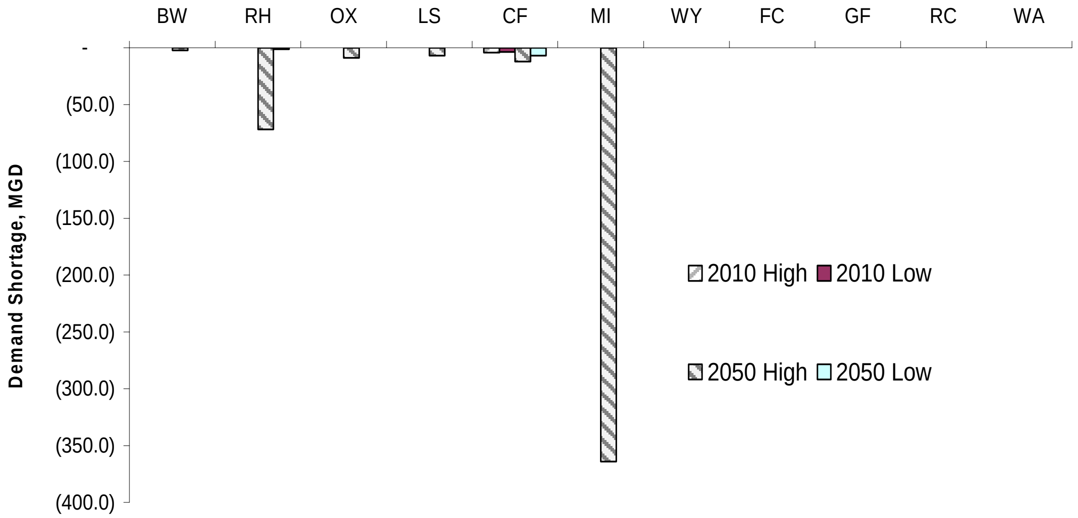

Figure 3-23: Demand Shortage Plot for 1950s Drought

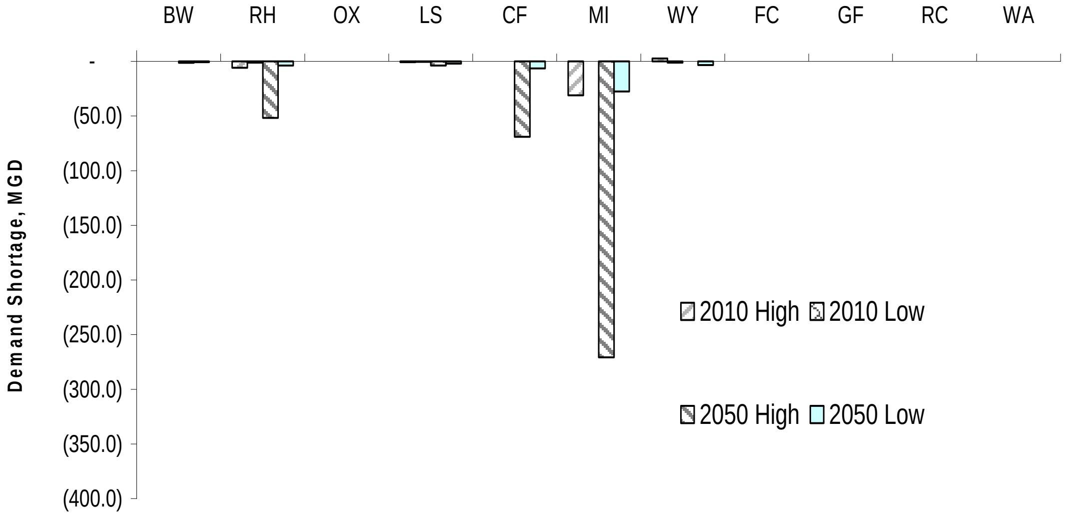

Figure 3-24: Demand Shortage Plot for 1980s Drought

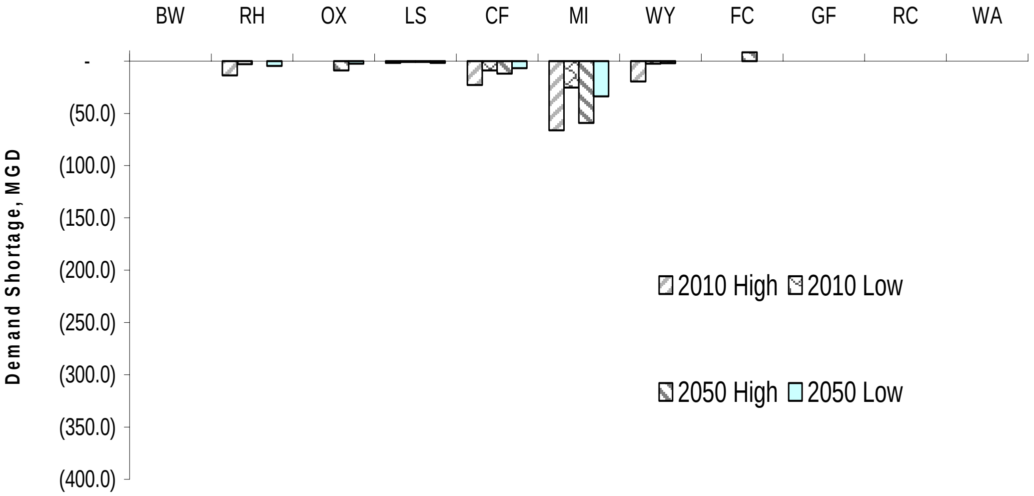

Figure 3-25: Demand Shortage Plot for 2002 Drought

(iv) Reservoir Outflow Percentiles Plots

The calculated total outflow from each reservoir is the sum of the releases for hydropower generation and the spill for the wet conditions. Mutual Gain (MG) operating conditions require maintaining downstream flows from reservoirs with generation plant locations at Bridgewater [BW], Oxford [OX], Wylie [WY] and Wateree [WA]. Since the demands for years 2020 High and 2050 High and 2050 LWSP are much higher and sometimes exceed several of the reservoirs' safe yields, these two years' (2020 and 2050) outflows have been presented in the plots for few aforementioned reservoirs.

The hydrology for the system shows that the years 1954 and 2002 were among the driest years in the 75 years of hydrology for most of the reservoirs. The plots in logarithmic scale in this subsection include combinations of the daily data from the years 1954, 1988 and 2002 as appropriate and compare the conditions such as dry (10th percentile) in yellow, normal (25th to 75th percentile) in green and wet (90th to 95th percentile) in blue. The 2002 outflows were near the lower percentiles, whereas the 1954 outflows varied. Plots shown in Figure 3-26 through 3-34 are at the plant locations for the reservoirs and thus refer to plant names or acronyms.

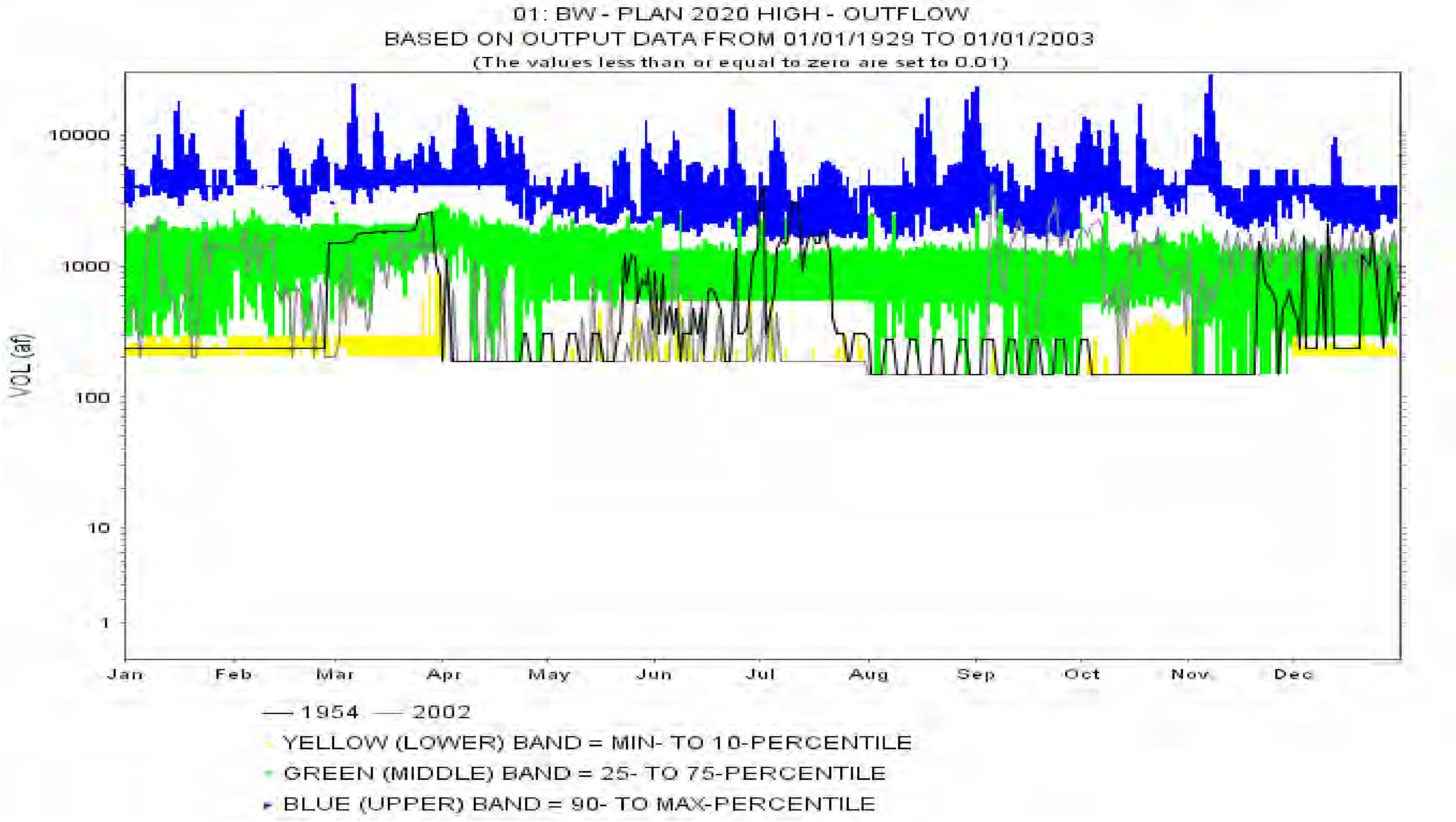

Figure 3-26: Lake James at Bridgewater Outflows for 2020 High Demand

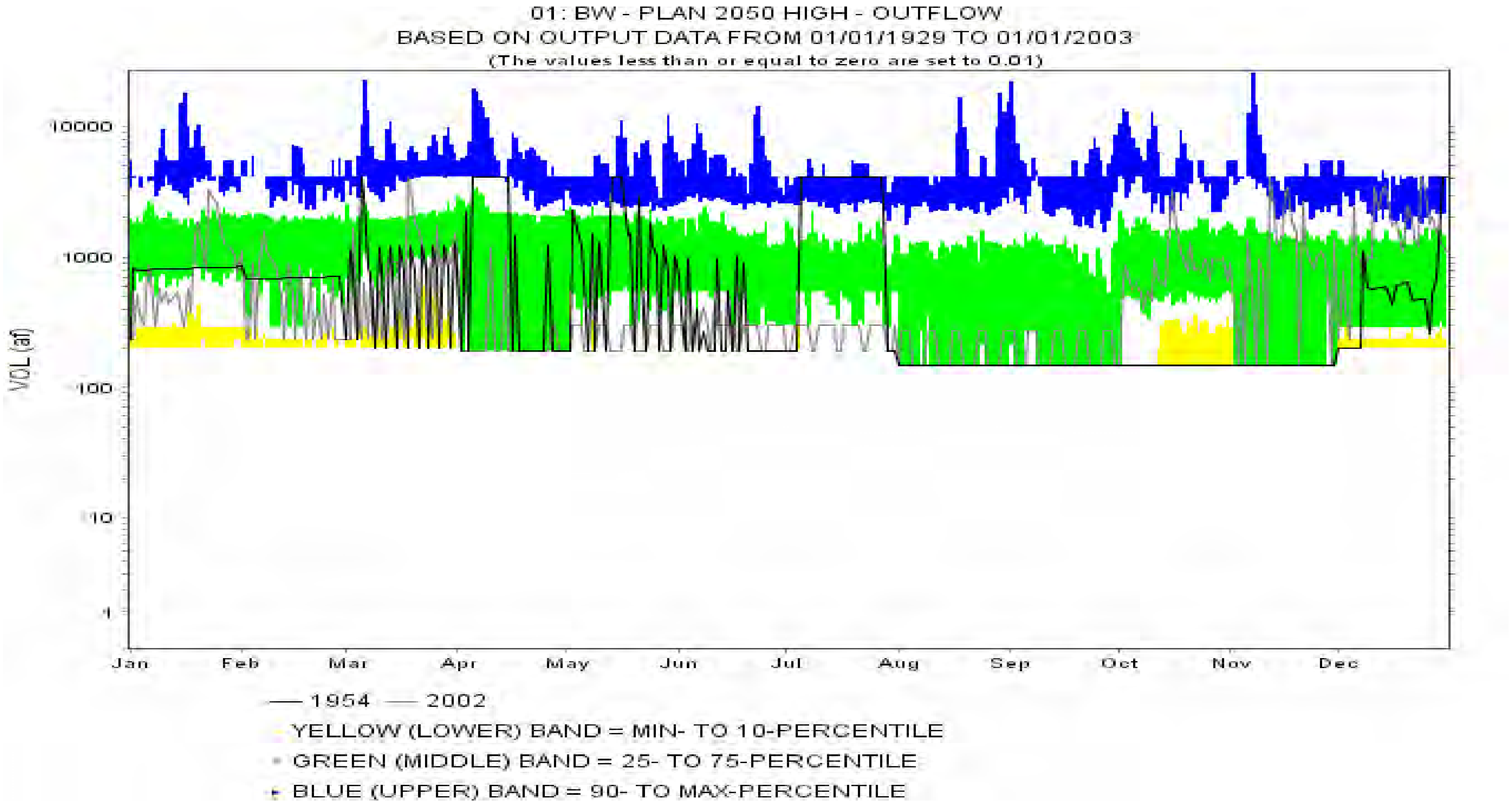

Figure 3-27: Lake James Bridgewater Outflows for 2050 High Demand

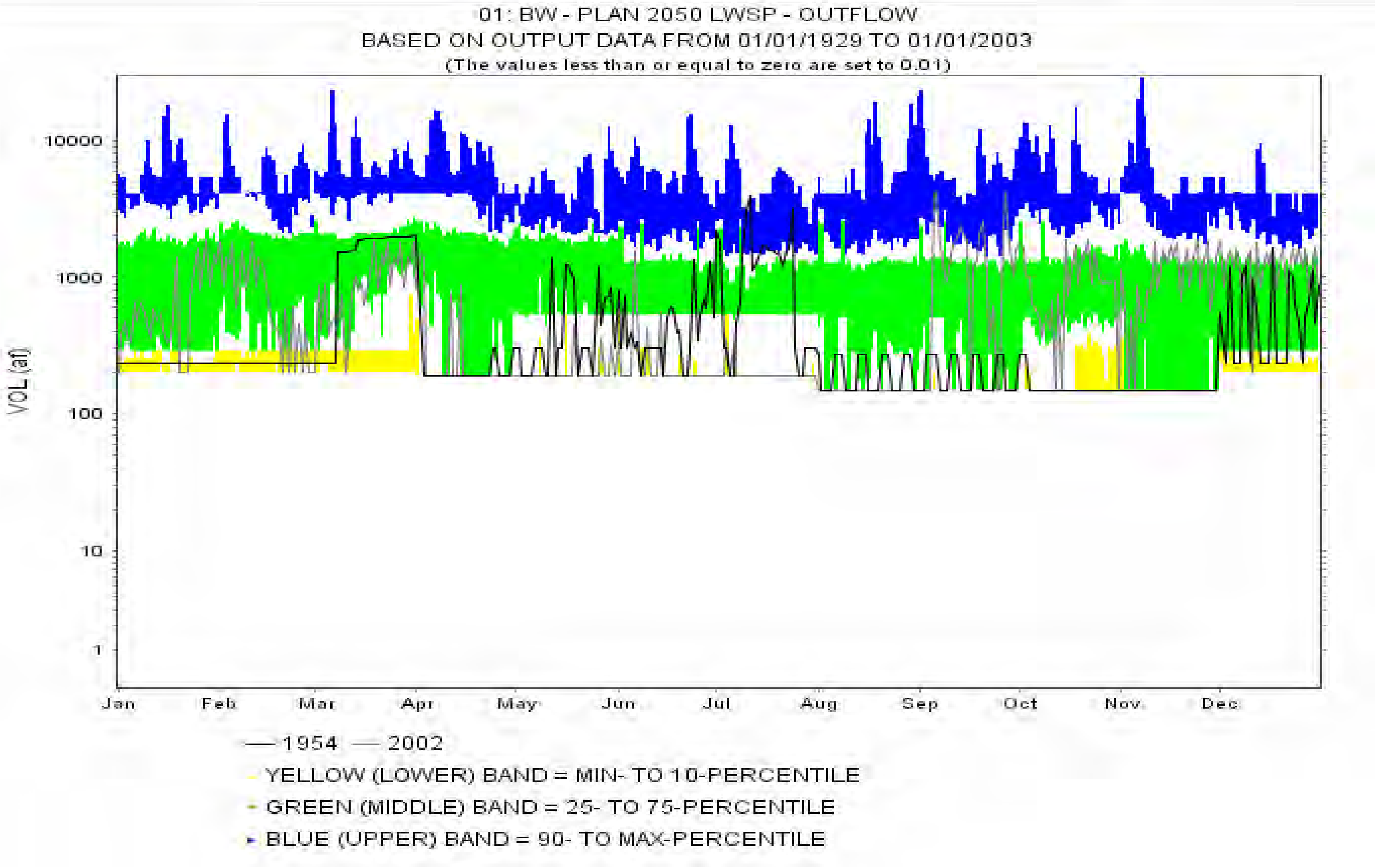

Figure 3-28: Lake James at Bridgewater Outflows for 2050 LWSP Demand

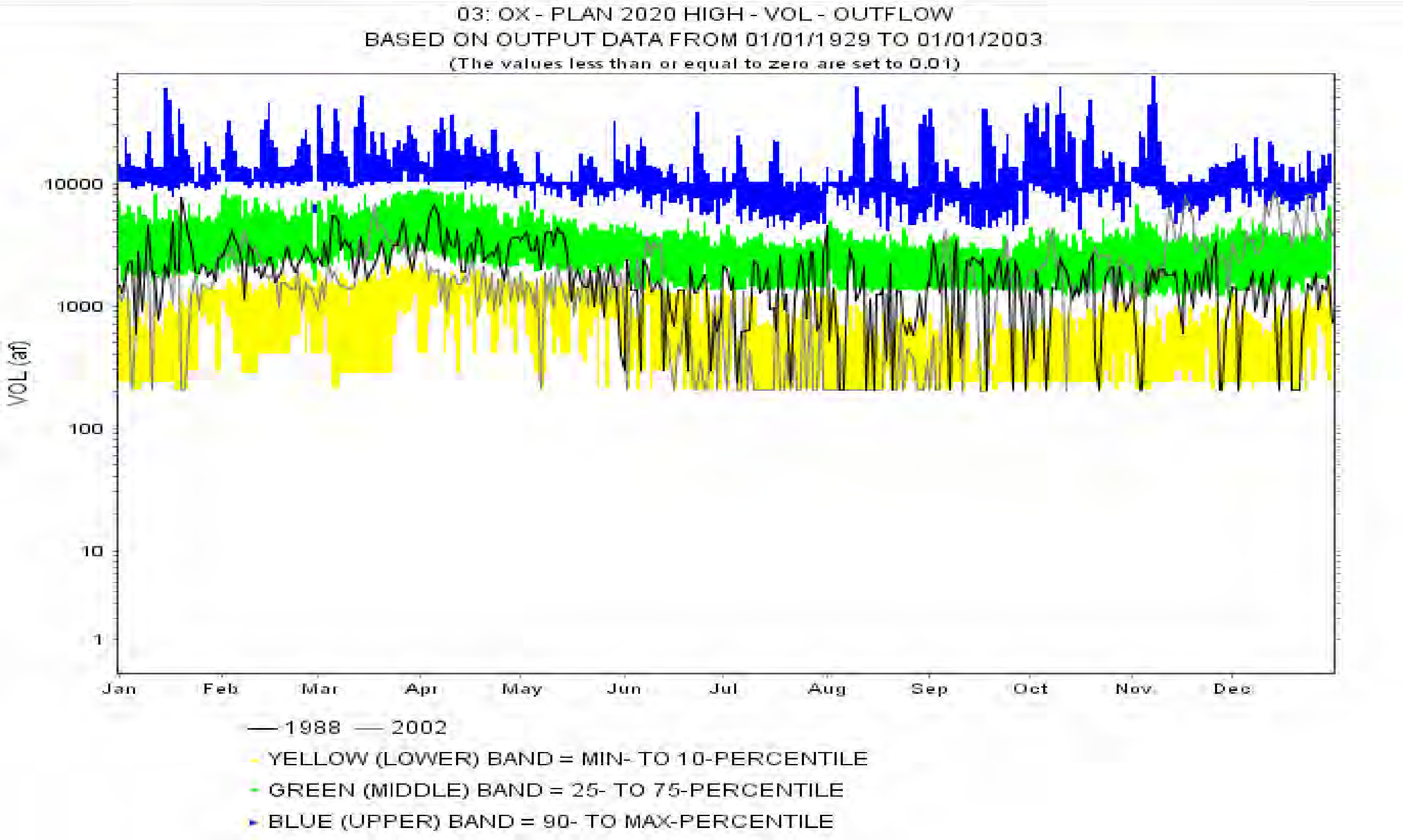

Figure 3-29: Lake Hickory at Oxford Outflows for 2020 High Demand

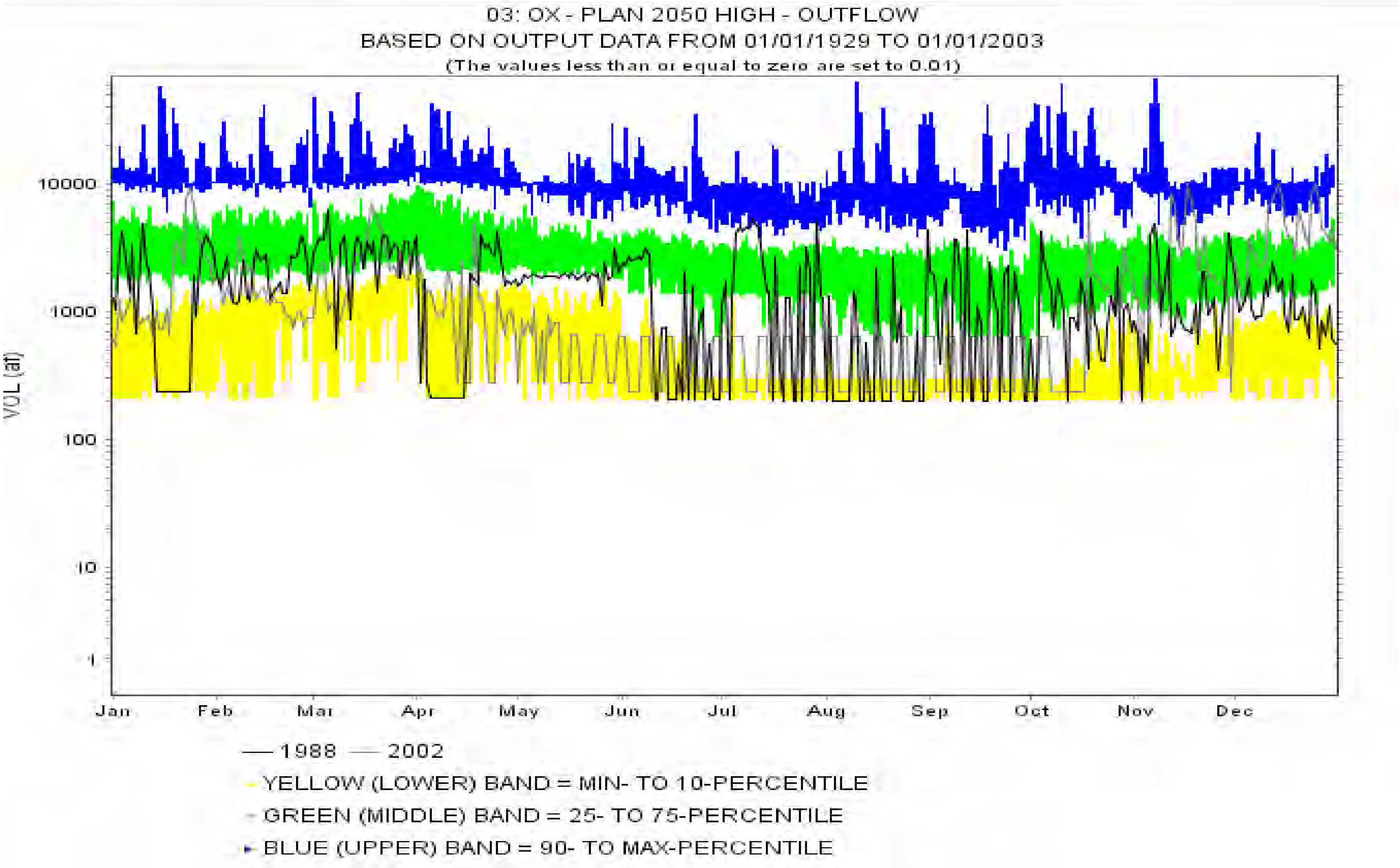

Figure 3-30: Lake Hickory at Oxford Outflows for 2050 High Demand

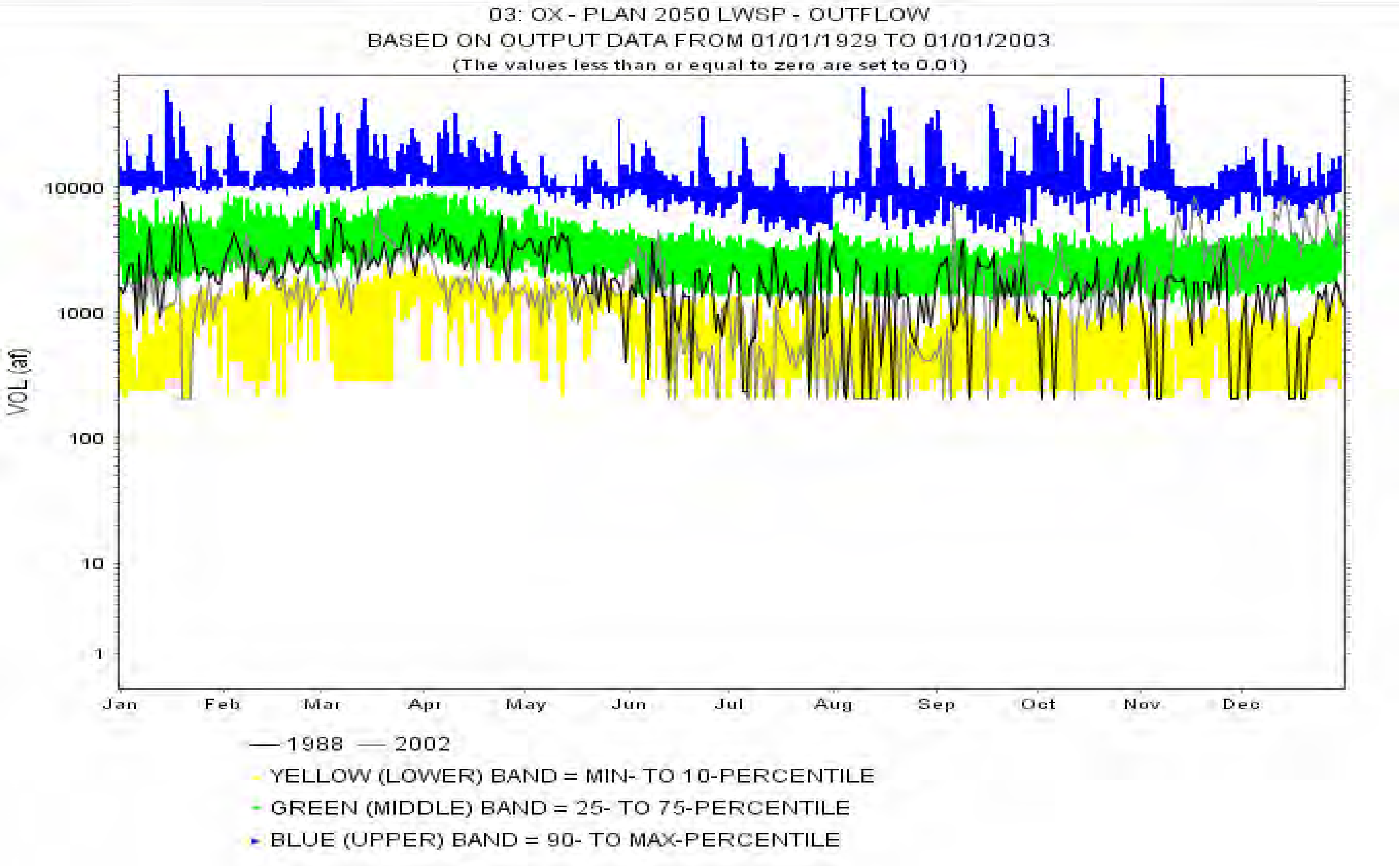

Figure 3-31: Lake Hickory at Oxford Outflows for 2050 LWSP Demand

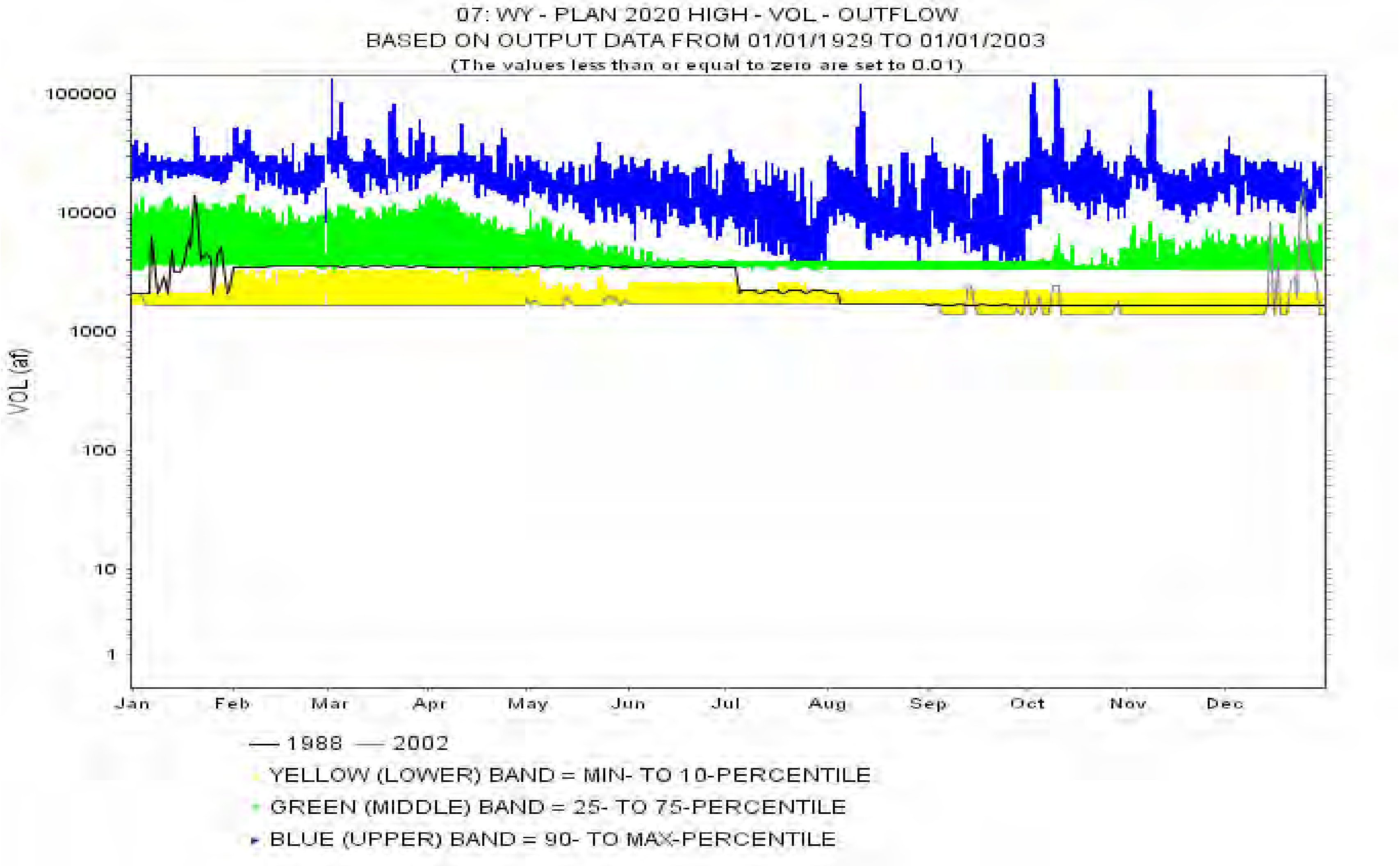

Figure 3-32: Lake Wylie Outflows for 2020 High Demand

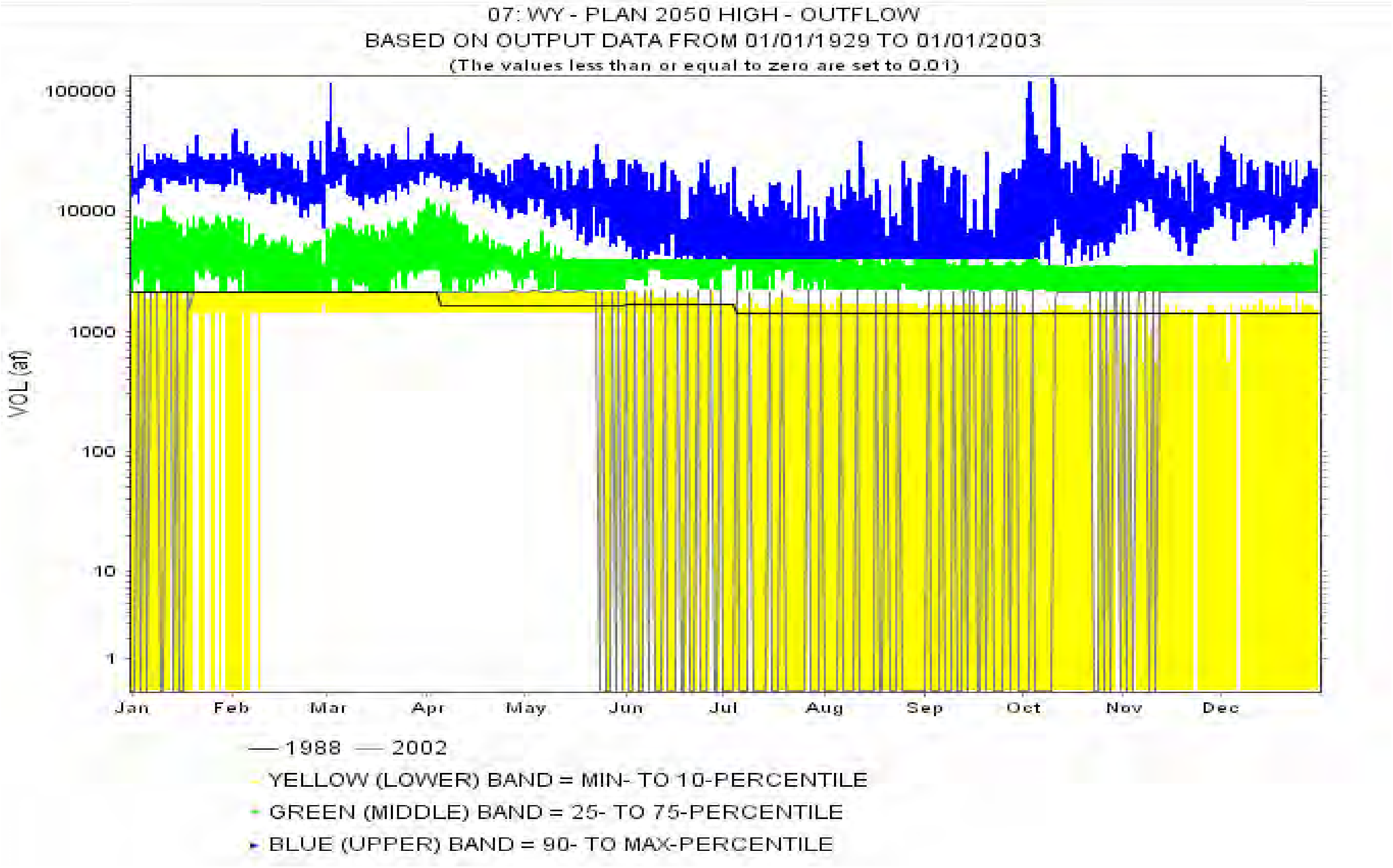

Figure 3-33: Lake Wylie Outflows for 2050 High Demand

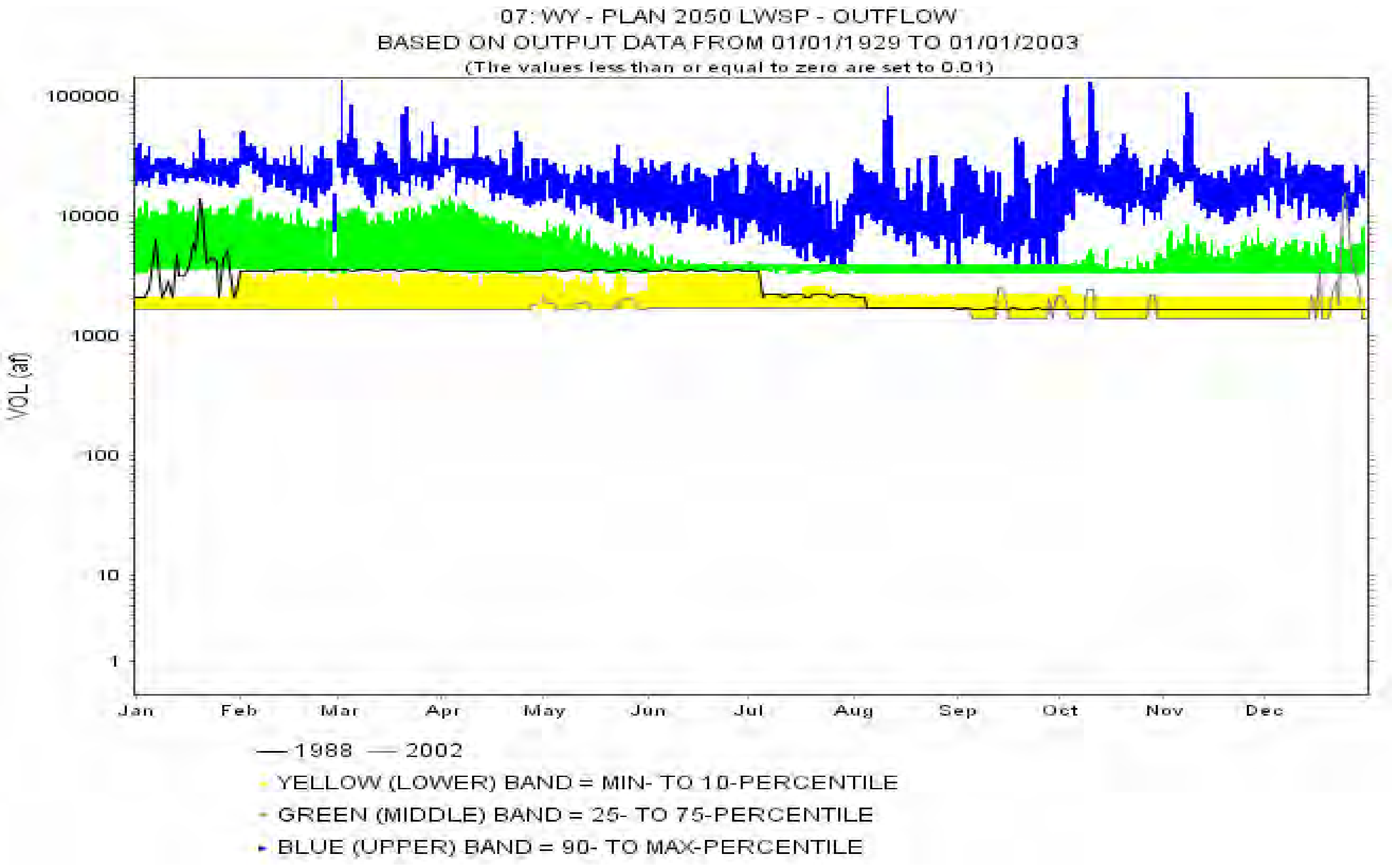

Figure 3-34: Lake Wylie Outflows for 2050 LWSP Demand

(v) Reservoir Elevation Plots

There are three types of reservoir elevation plots: elevation percentile, elevation profile, and elevation duration plots.

Similar to the outflow percentile plots, the elevation percentile plots include daily data from the years 1954 and 2002 and compare to dry conditions (10th percentile) in yellow, normal conditions (25th to 75th percentile) in green, and wet conditions (90th to 95th percentile) in blue. The reference lines in the plots are the critical elevations, offered as a comparison to the modeled elevation conditions. The 2020 High, 2050 High and 2050 Low percentiles are presented here[42]. The elevation profiles are plotted by reservoir. The duration plots show only the highest demand for the year 2050 in comparison to the 2002 base case.

Figure 3-36 shows that for the 2050 High demand, the elevation level for Lake James at Bridgewater (BW) remained below critical elevation for more than 4 months in 1954. The elevation profile shows the same result for the 2050 High demand in Figure 3-38. The 2002 base case shows much lower elevations during the 2002 drought because the model simulated baseline operational condition and did not use the future modified operational constraints along with implementation of LIP during low flow conditions. In the same Figure 3-38, profiles for the High demand for 2010 and 2020 show less fluctuation throughout the 75-year of simulation period. The duration plots in Figure 3-39 show the majority of the times elevations were well above the critical level.

Figure 3-43 shows the elevation at Rhodhiss (RH) went below the critical level in 1954 and 2002 for a short time for the 2050 High demands. The 1954 hydrology stressed both Bridgewater and Rhodhiss locations. The elevations at Oxford were below critical for long time for both the 2020 and 2050 scenarios as shown in Figure 3-45 through Figure 3-47. Elevations for Lookout Shoals (LS) are above critical but it was close with the 2050 High demand condition as shown in Figure 3-51.

Lake Norman elevations are above critical level for both the 2020 and 2050 Low demands, but much below critical level for the 2050 High demand as shown in Figure 3-55 through Figure 3-57. Figure 3-58 shows the Lake Norman elevation profiles. For almost 4 years the elevation was below the critical level during the late 1990s through mid 2003 for the 2050 High demand.

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[42] CHEOPS does not include the leap years in the time series, so data for February 29th is missing and is shown as a blank or sudden change in the plots.

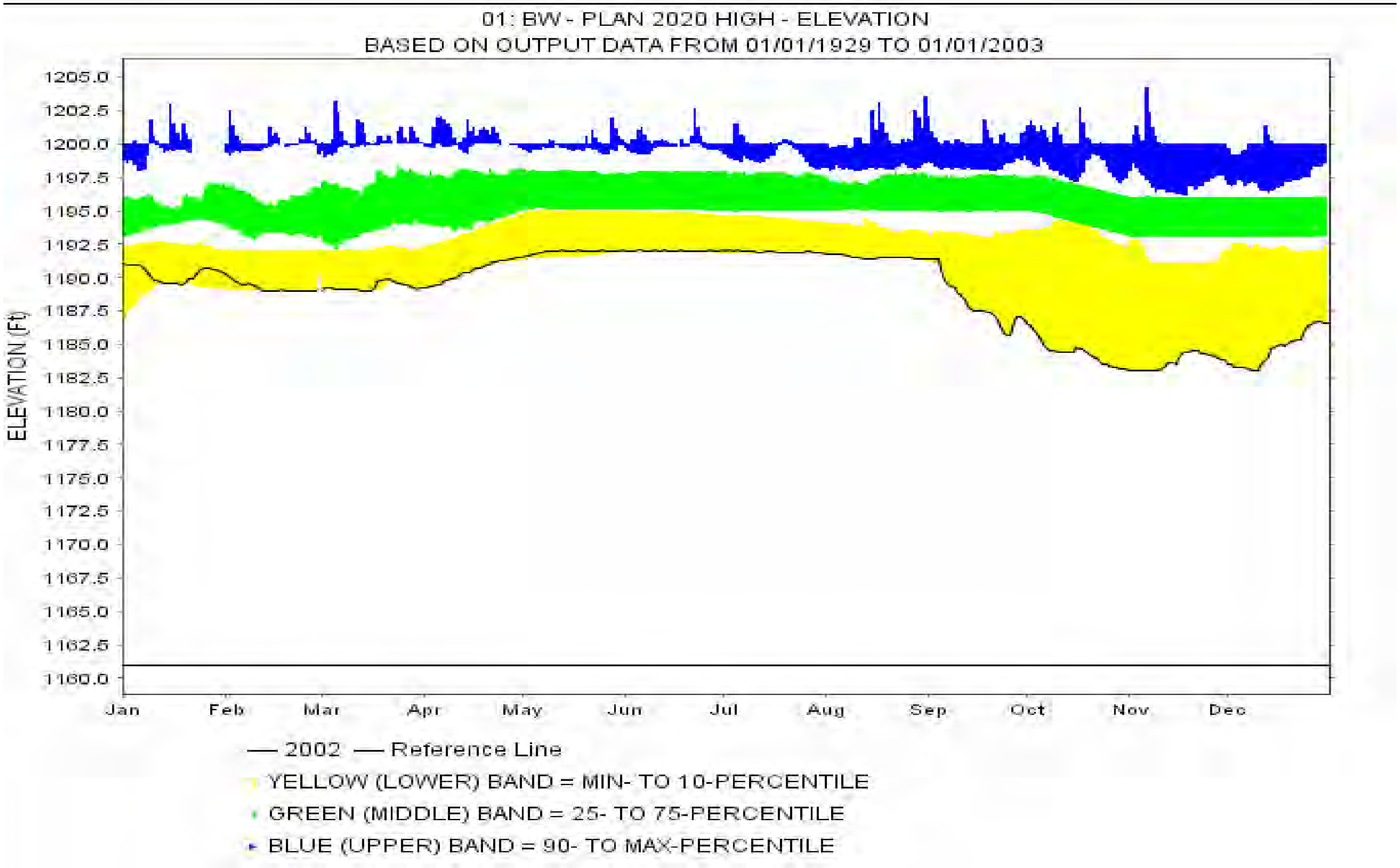


Figure 3-35: Lake James at Bridgewater Elevation Percentiles for 2020 High Demand

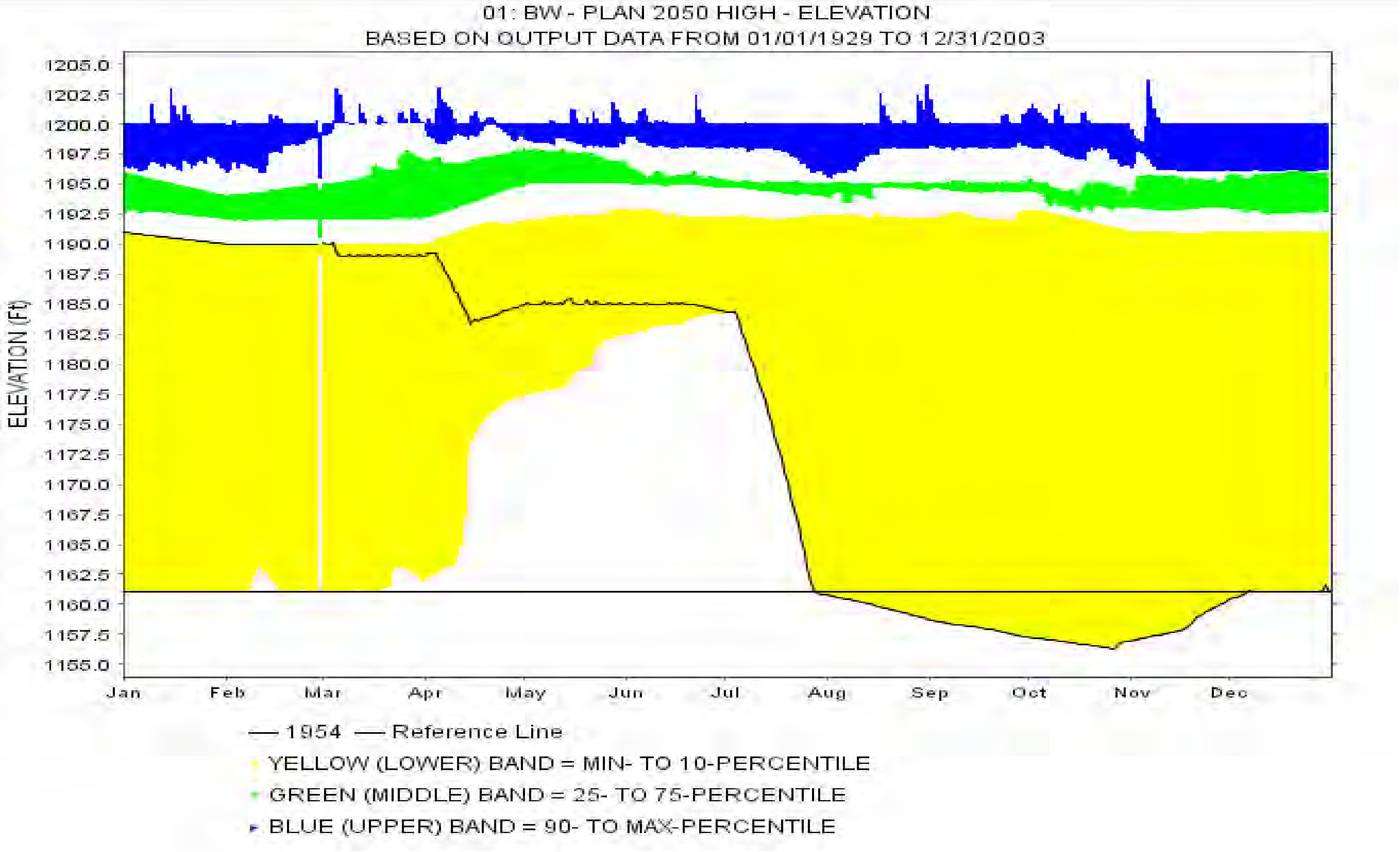


Figure 3-36: Lake James at Bridgewater Elevation Percentiles for 2050 High Demand

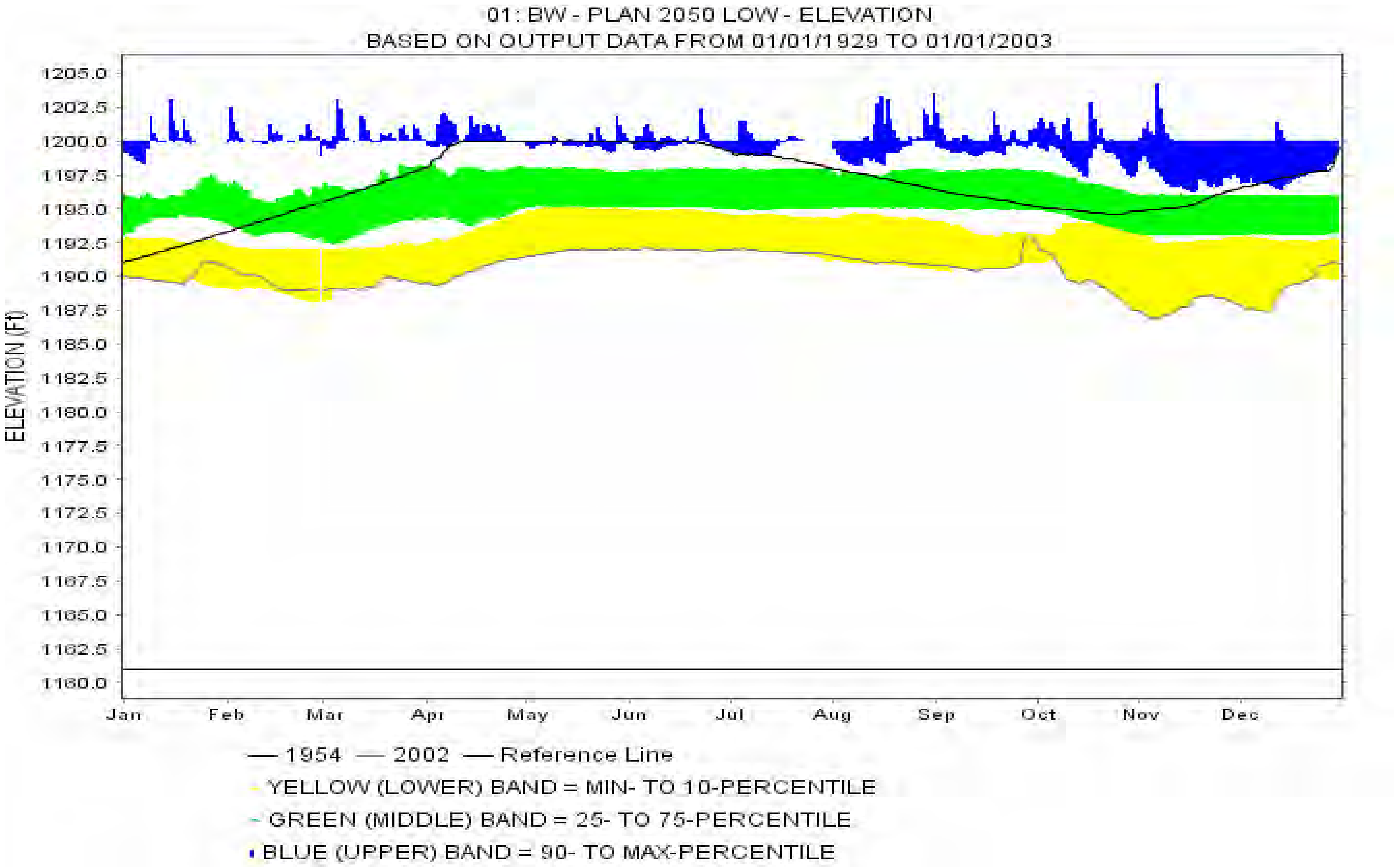


Figure 3-37: Lake James at Bridgewater Elevation Percentiles for 2050 Low Demand

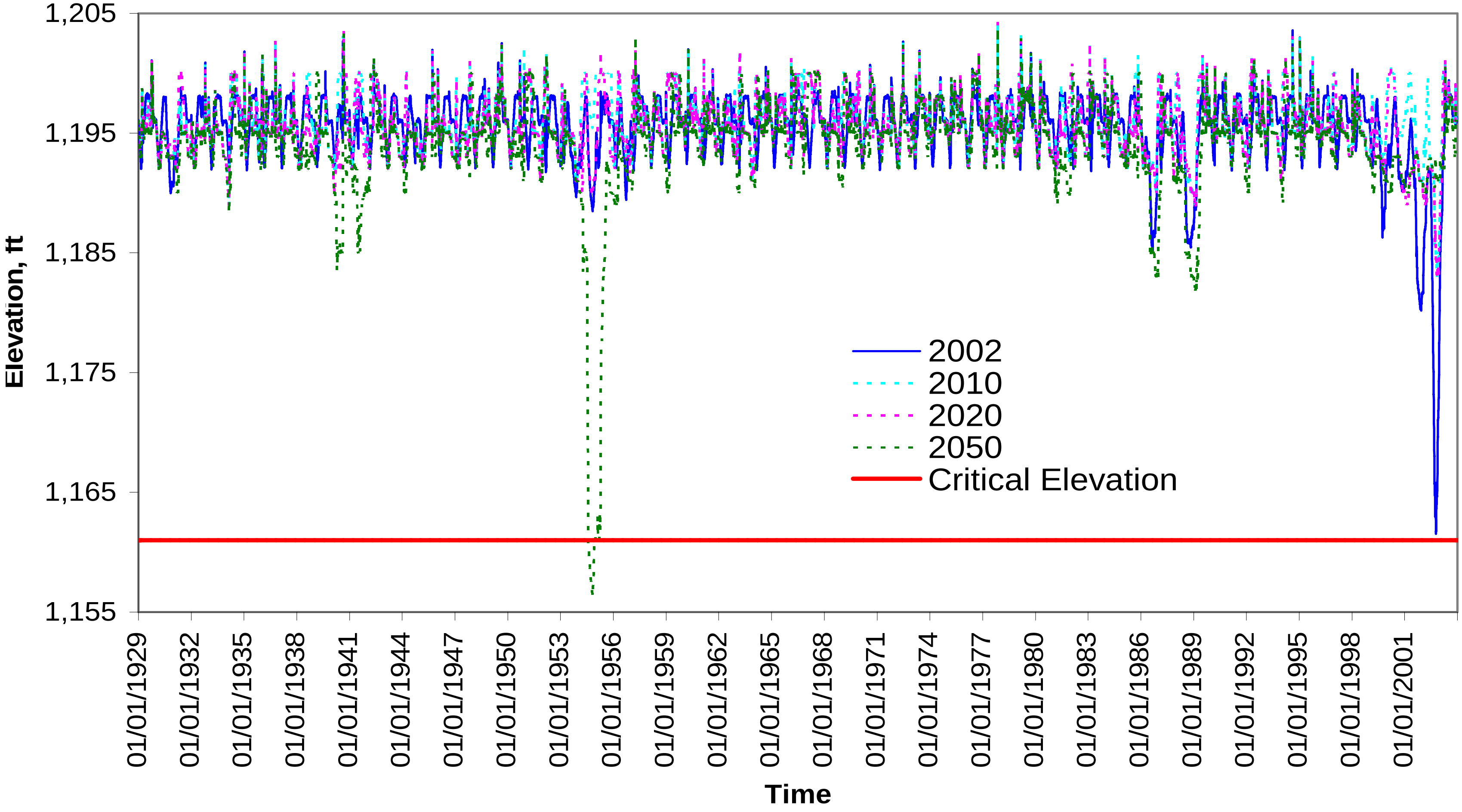


Figure 3-38: Lake James at Bridgewater Elevation Profiles for High Demands

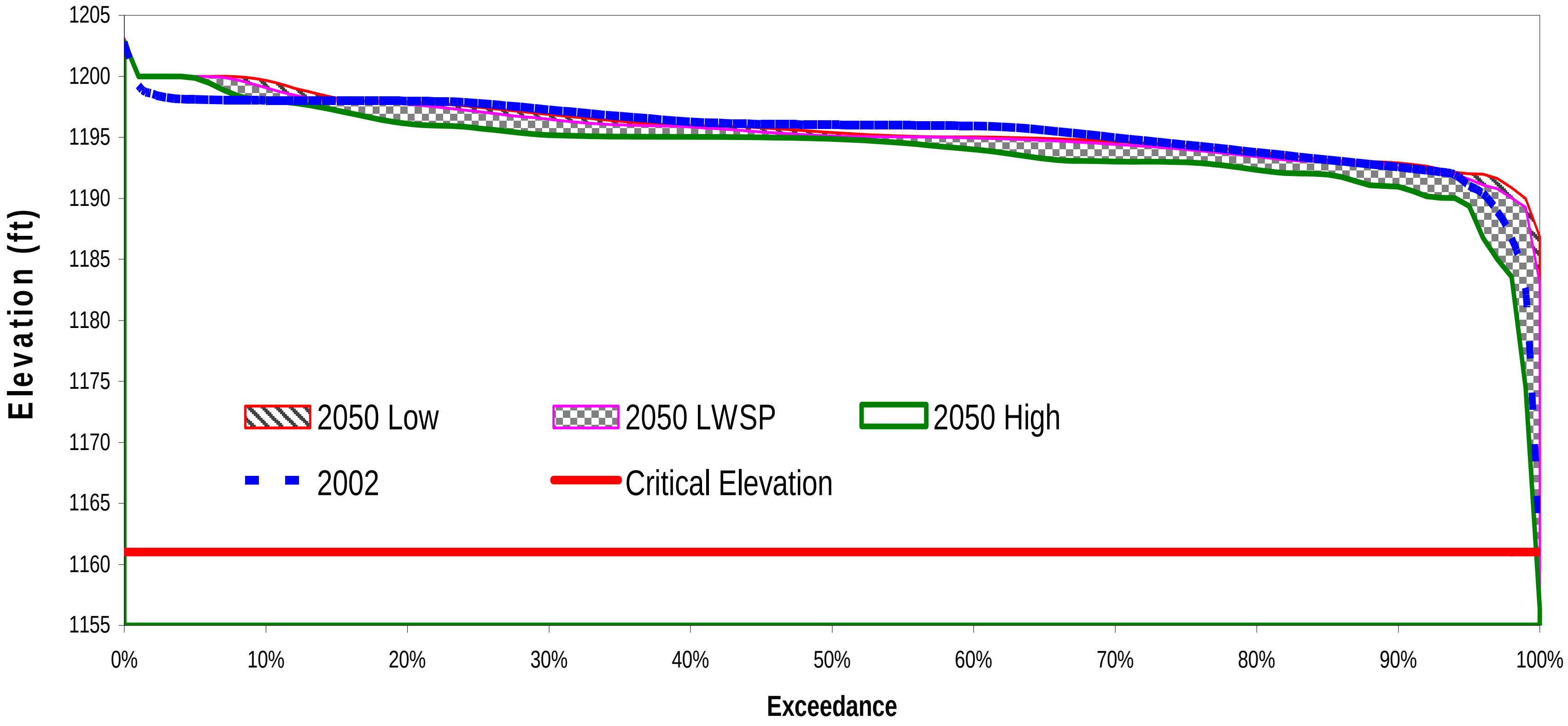


Figure 3-39: Lake James at Bridgewater Elevation Duration Plots

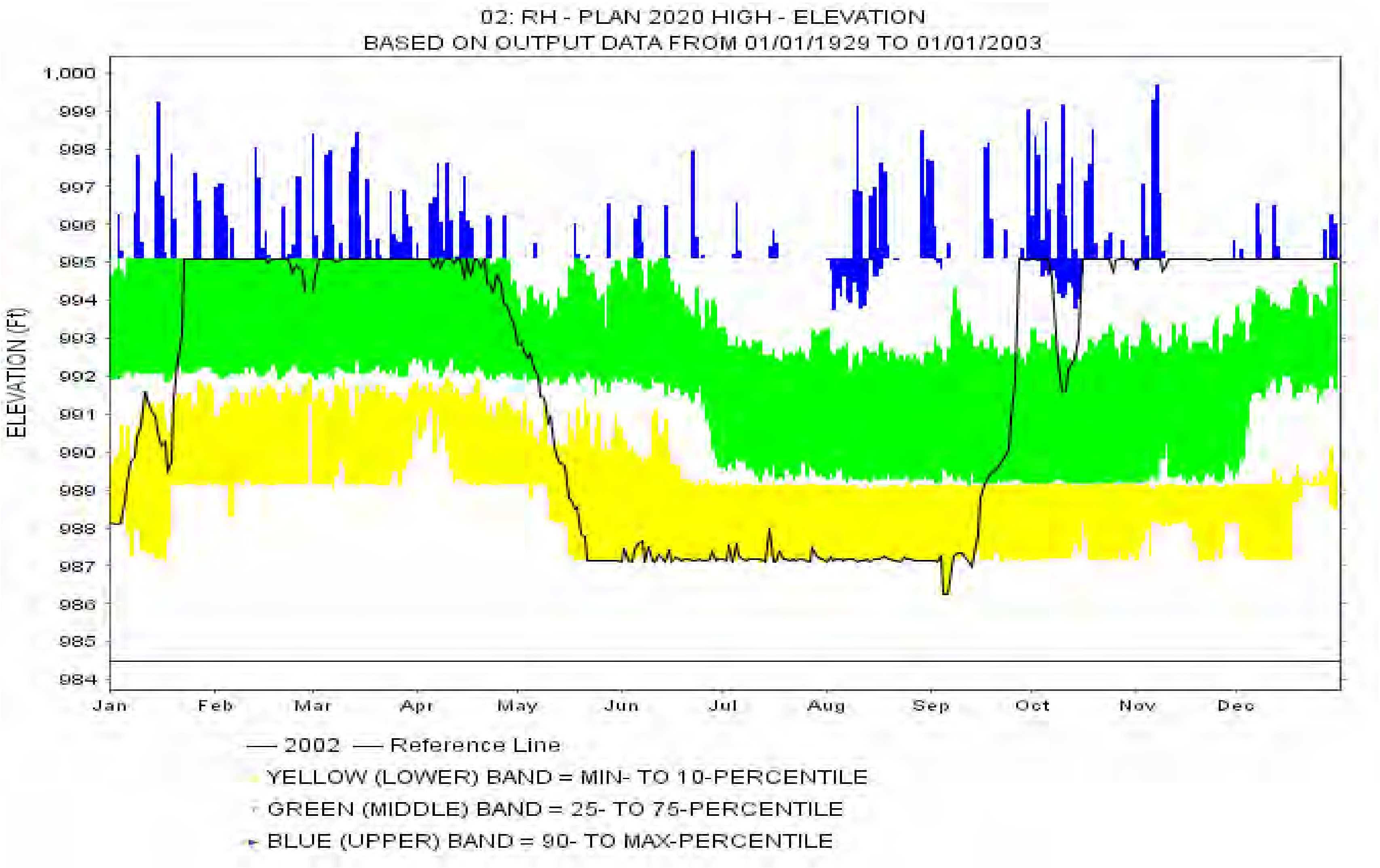


Figure 3-40: Lake Rhodhiss Elevation Percentiles for 2020 High Demand

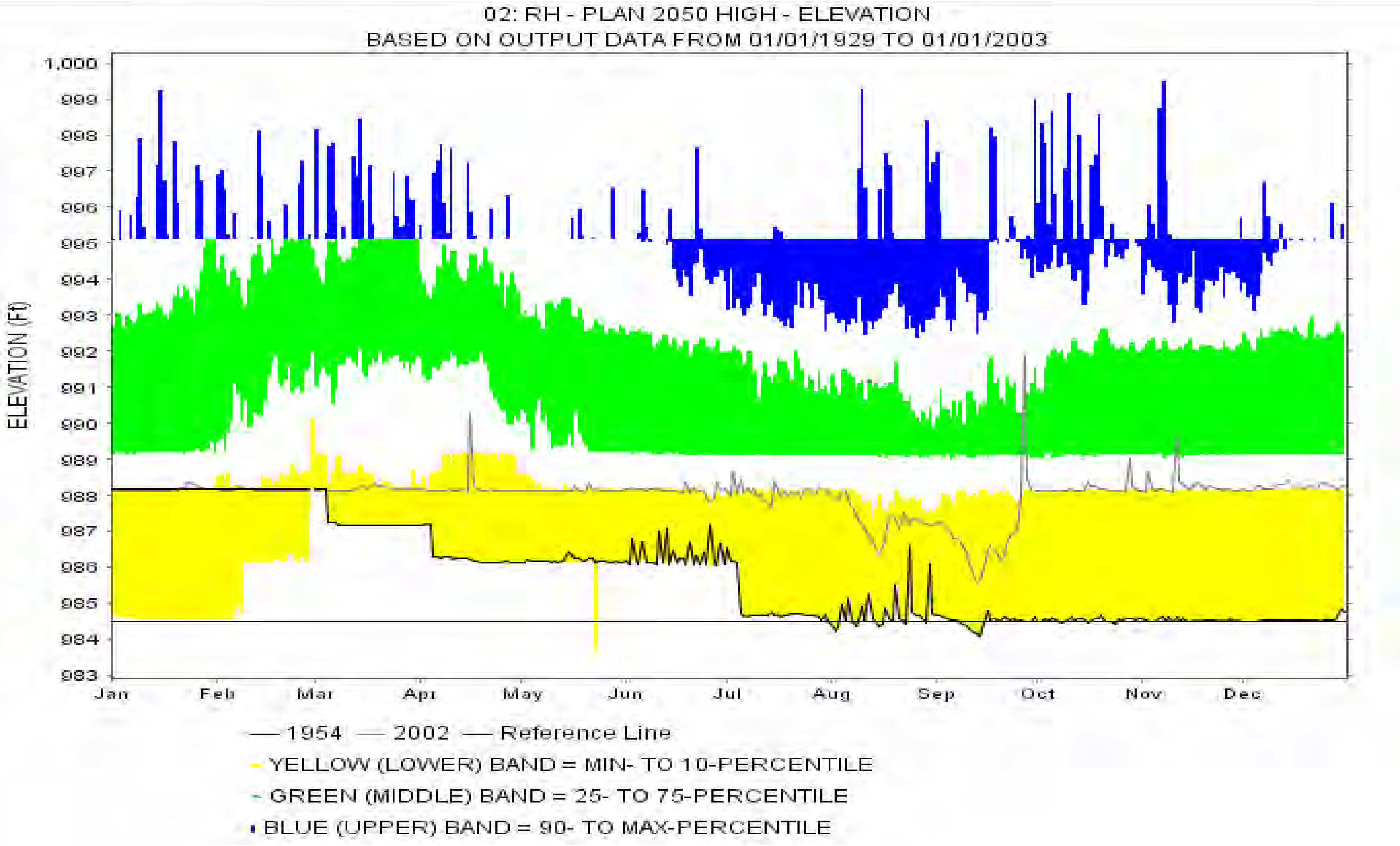


Figure 3-41: Lake Rhodhiss Elevation Percentiles for 2050 High Demand

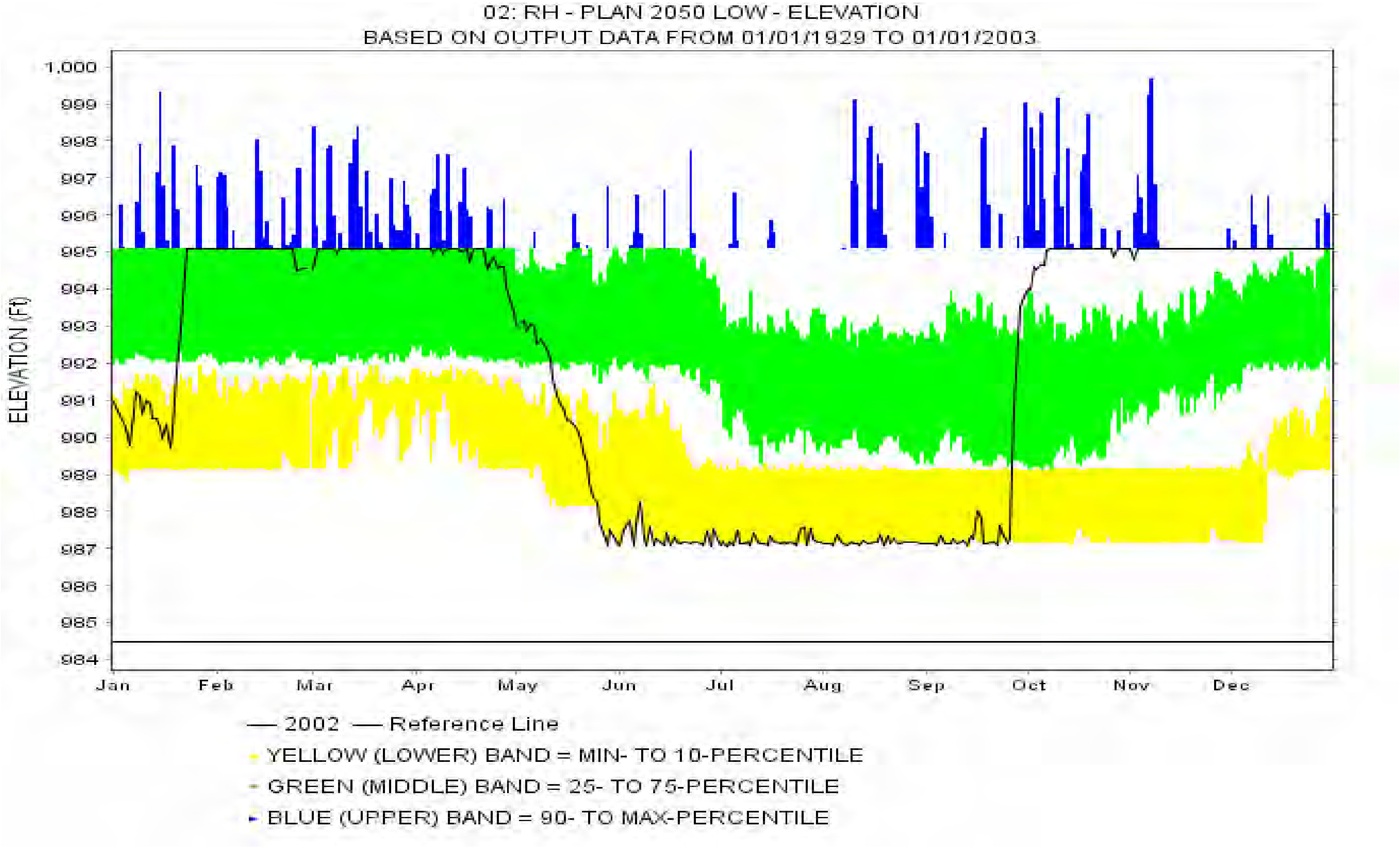


Figure 3-42: Lake Rhodhiss Elevation Percentiles for 2050 Low Demand

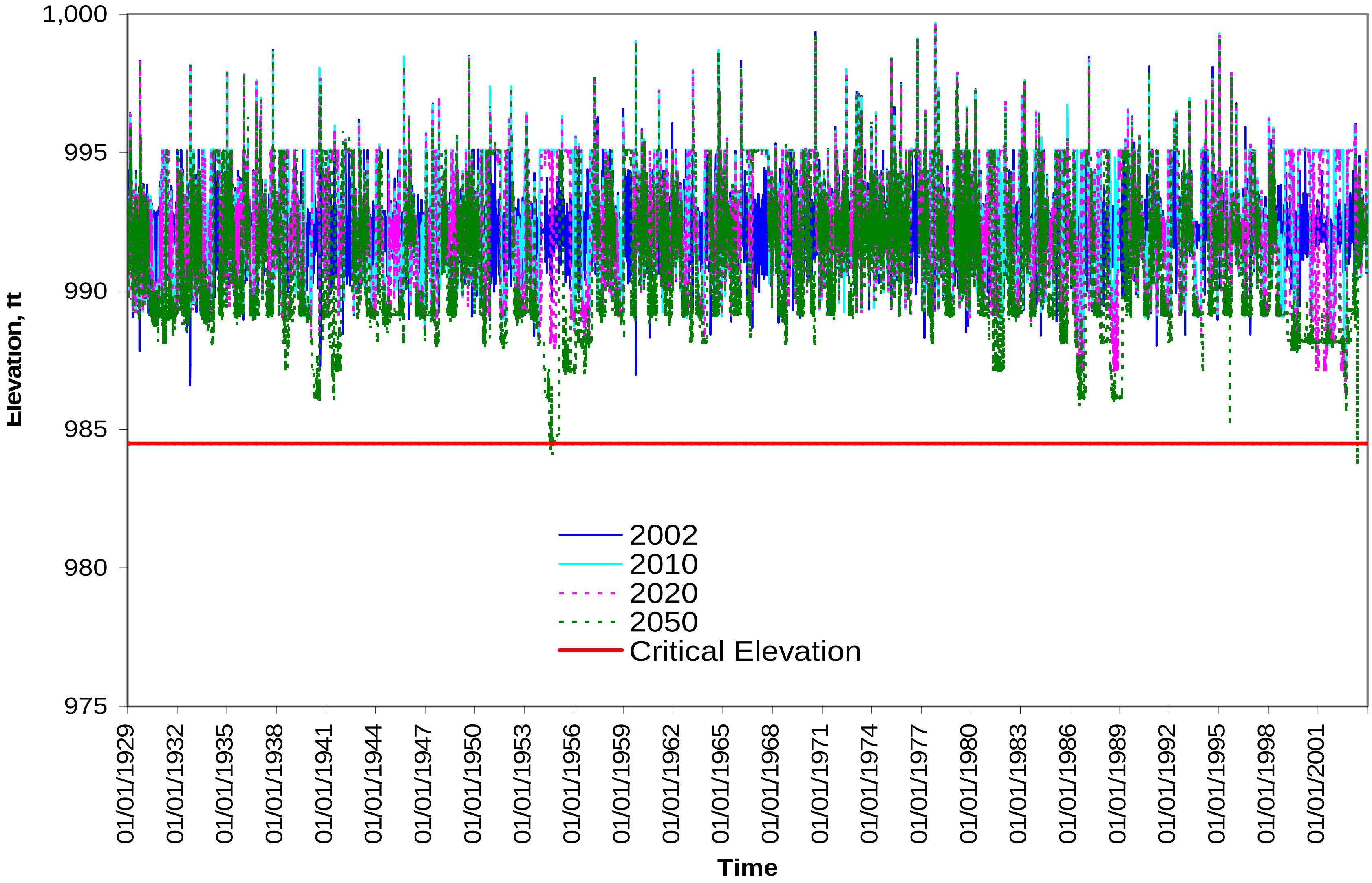


Figure 3-43: Lake Rhodhiss Elevation Profiles for High Demands

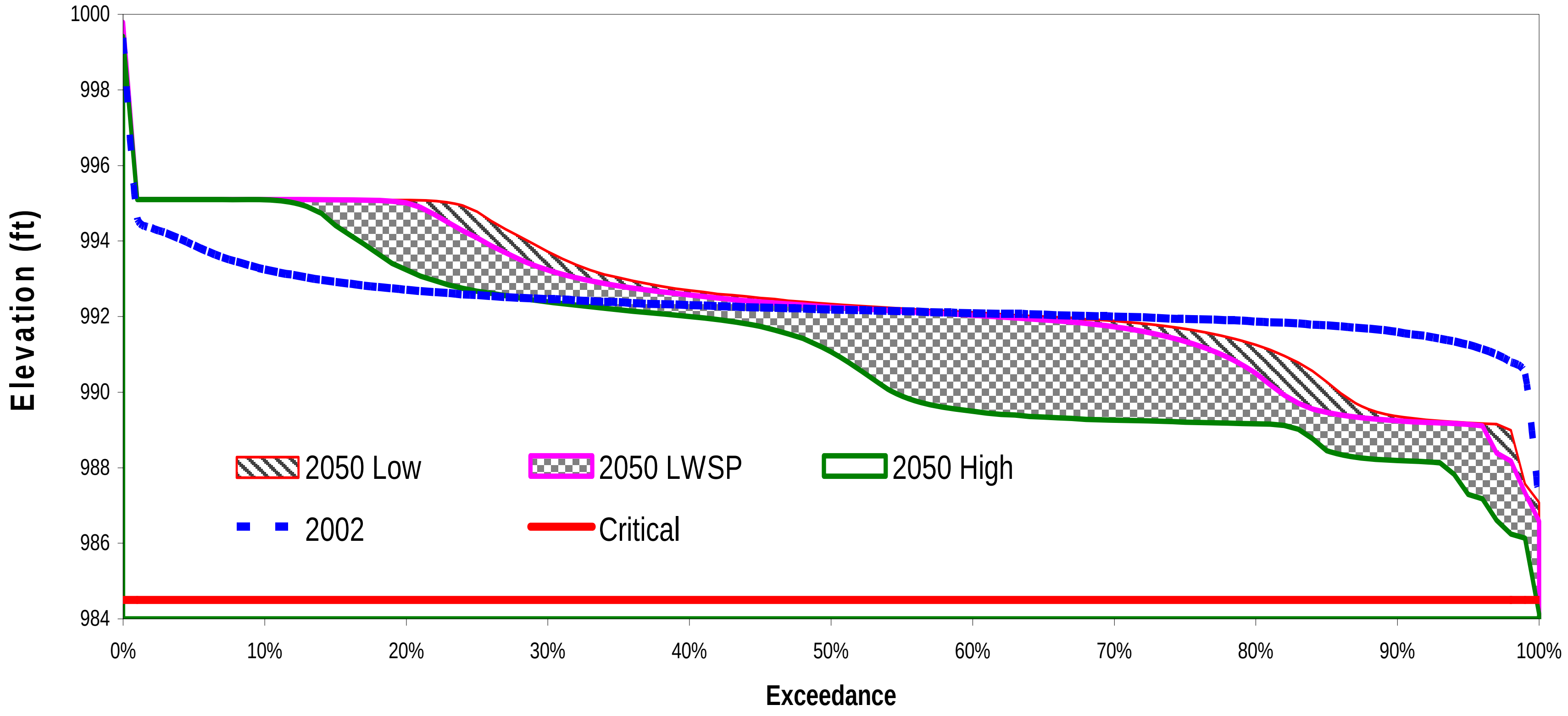


Figure 3-44: Lake Rhodhiss Elevation Duration Plots

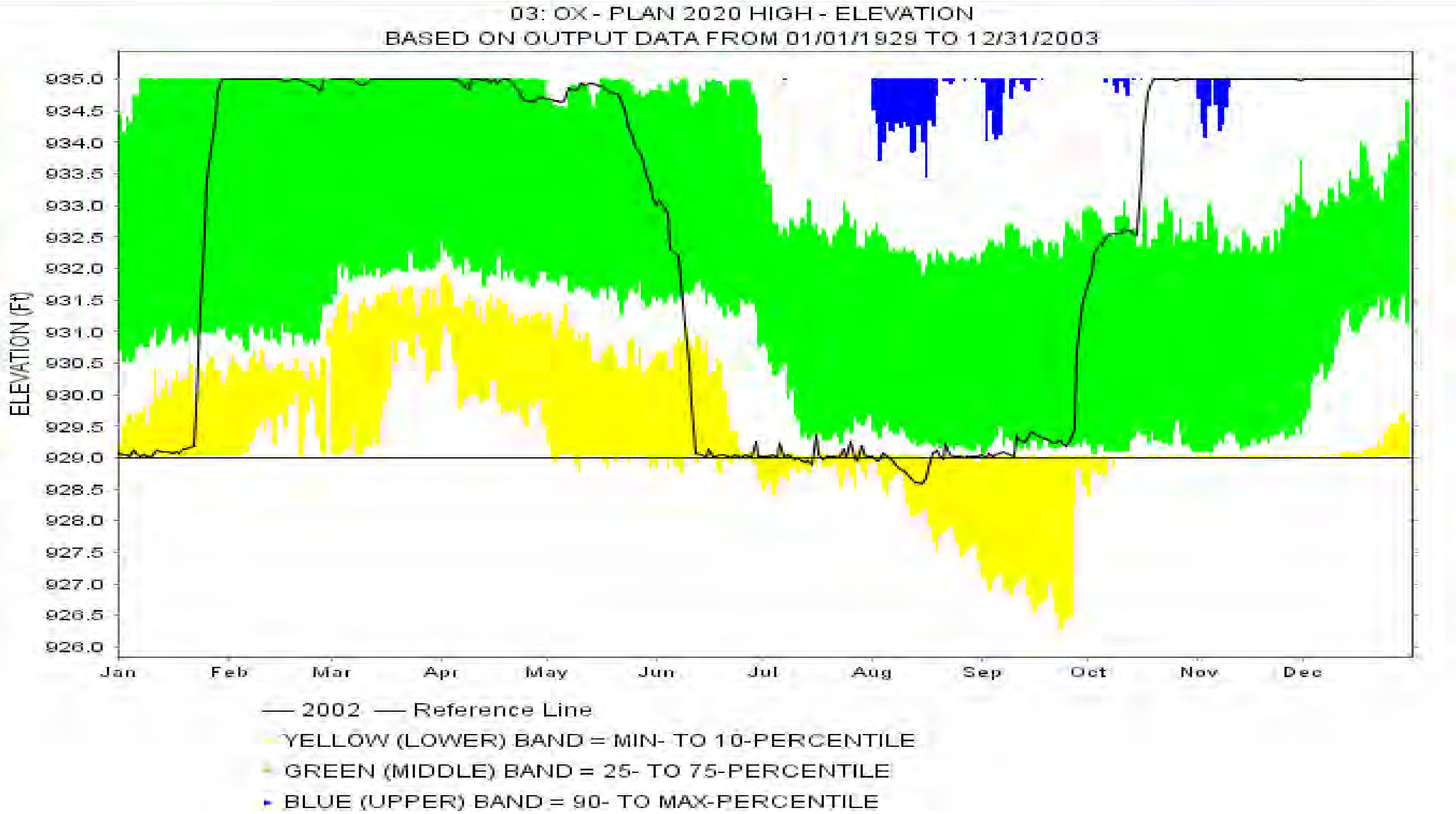


Figure 3-45: Lake Hickory at Oxford Elevation Percentiles for 2020 High Demand

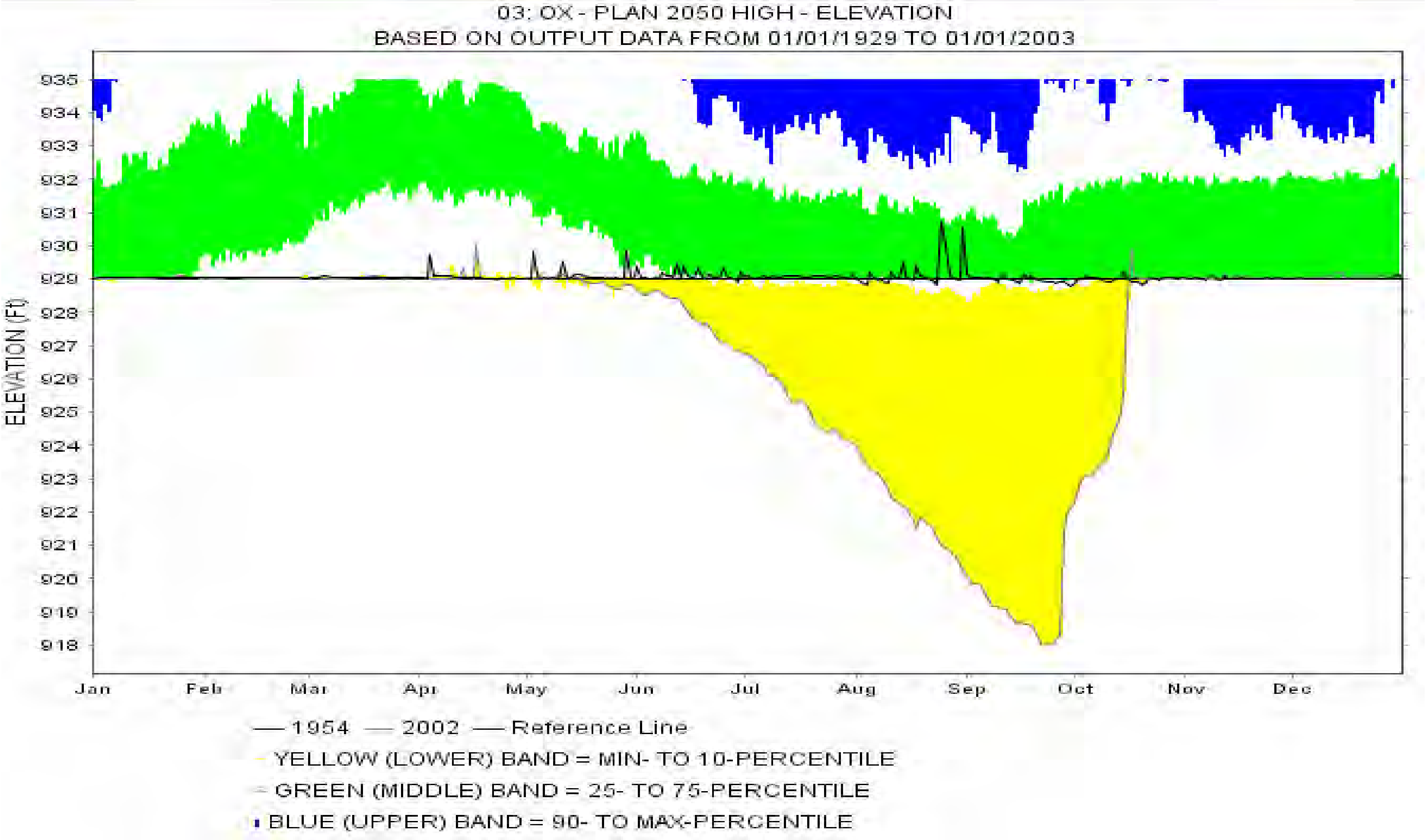


Figure 3-46: Lake Hickory at Oxford Elevation Percentiles for 2050 High Demand

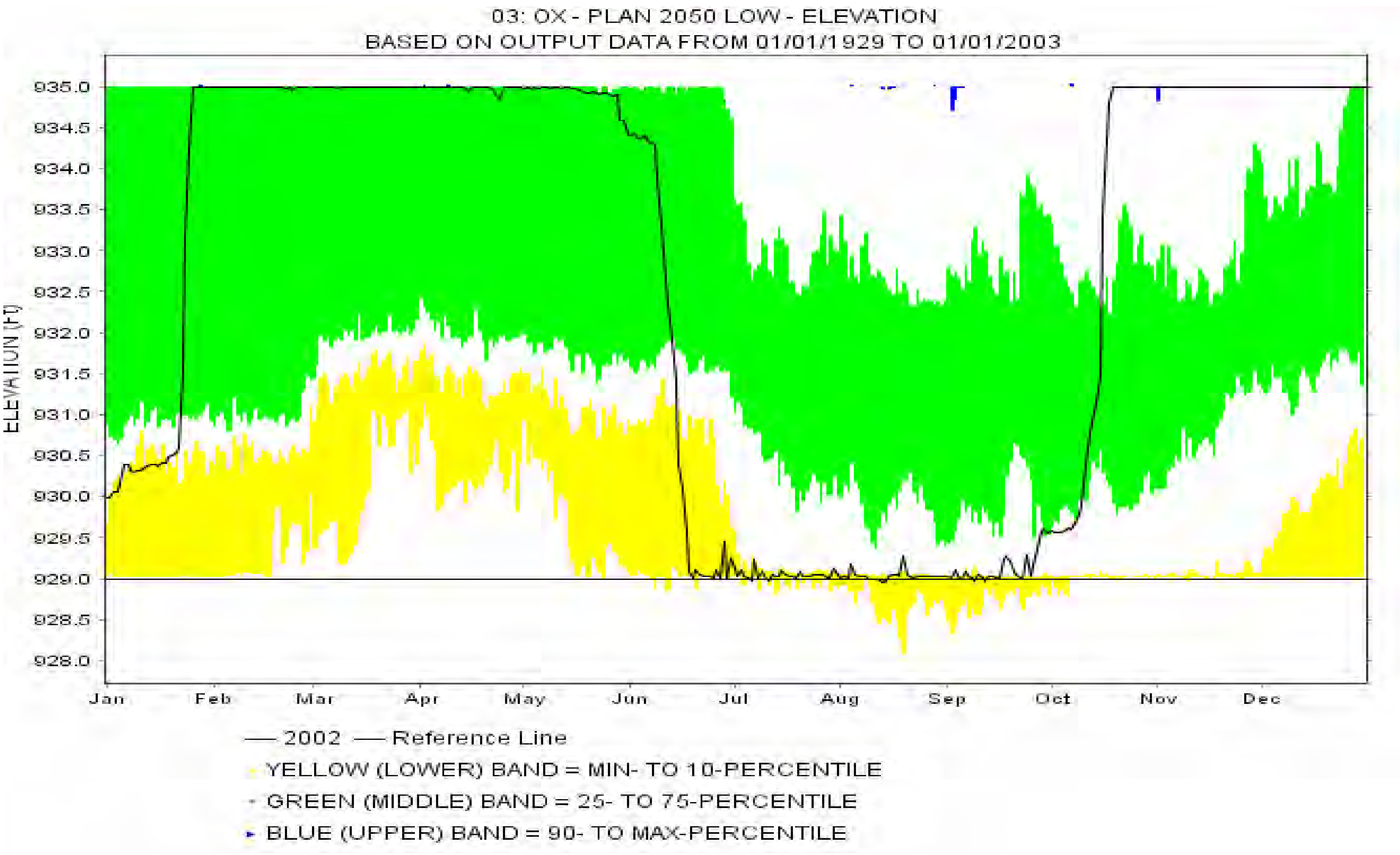


Figure 3-47: Lake Hickory at Oxford Elevation Percentiles for 2050 Low Demand

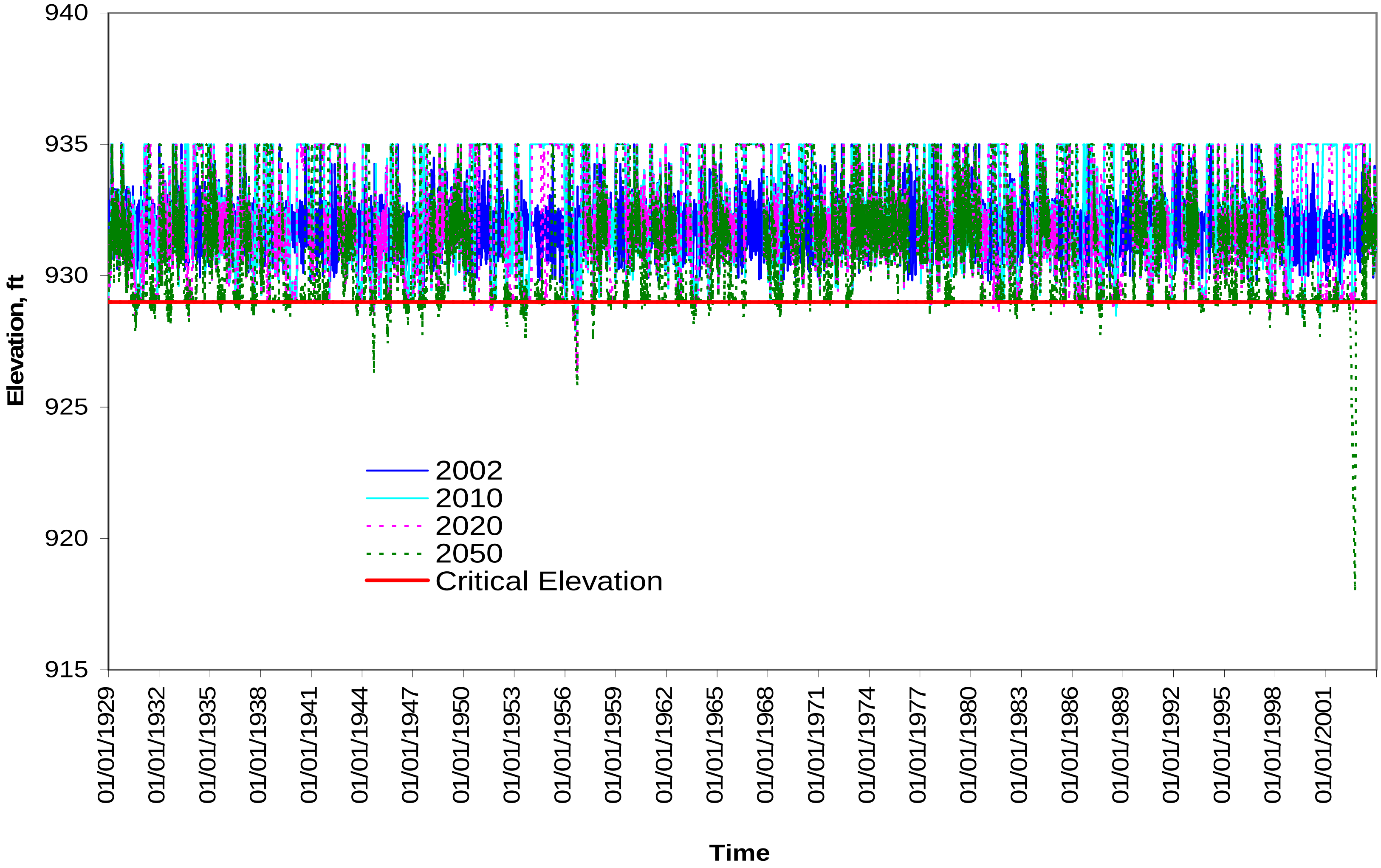


Figure 3-48: Lake Hickory at Oxford Plant Elevation Profiles

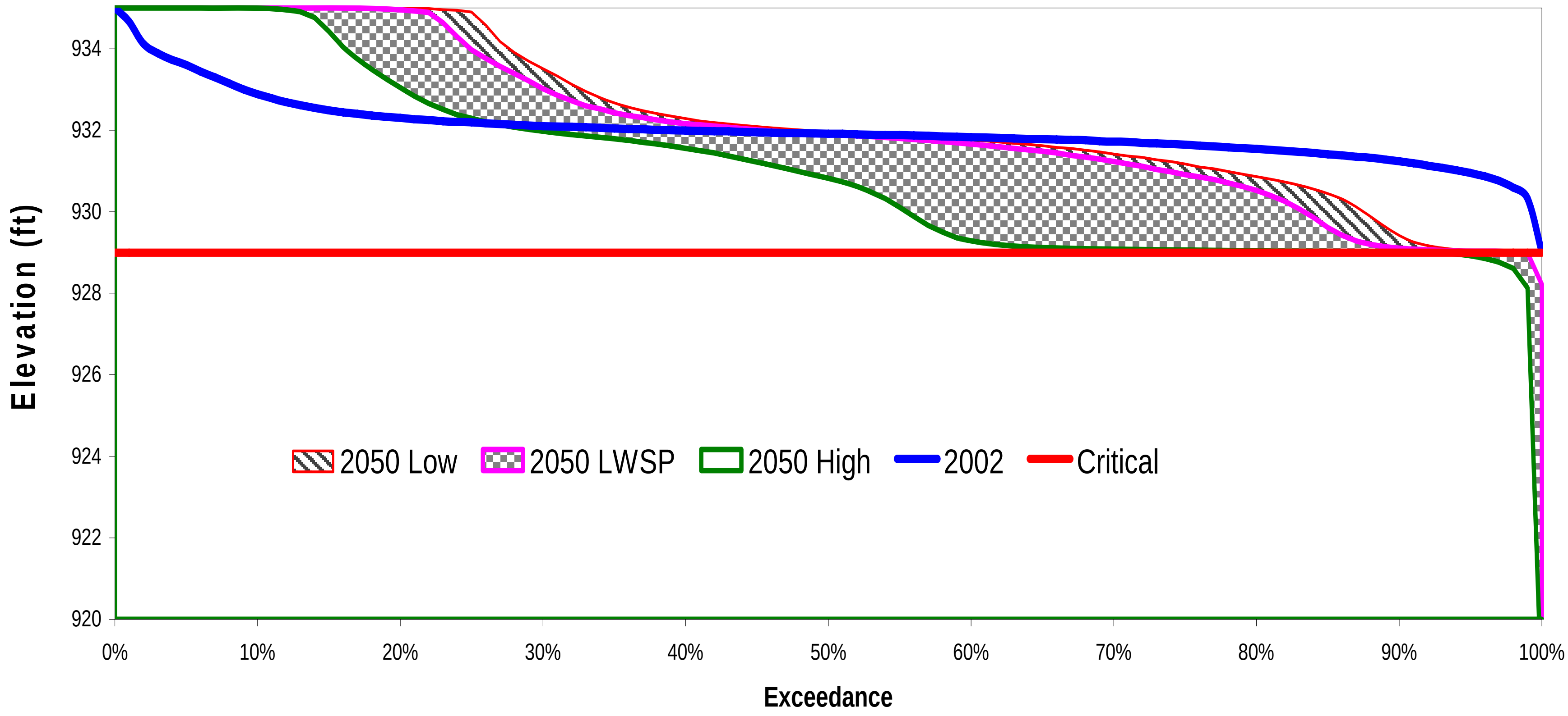


Figure 3-49: Lake Hickory Elevation Duration Plots at Oxford Plant

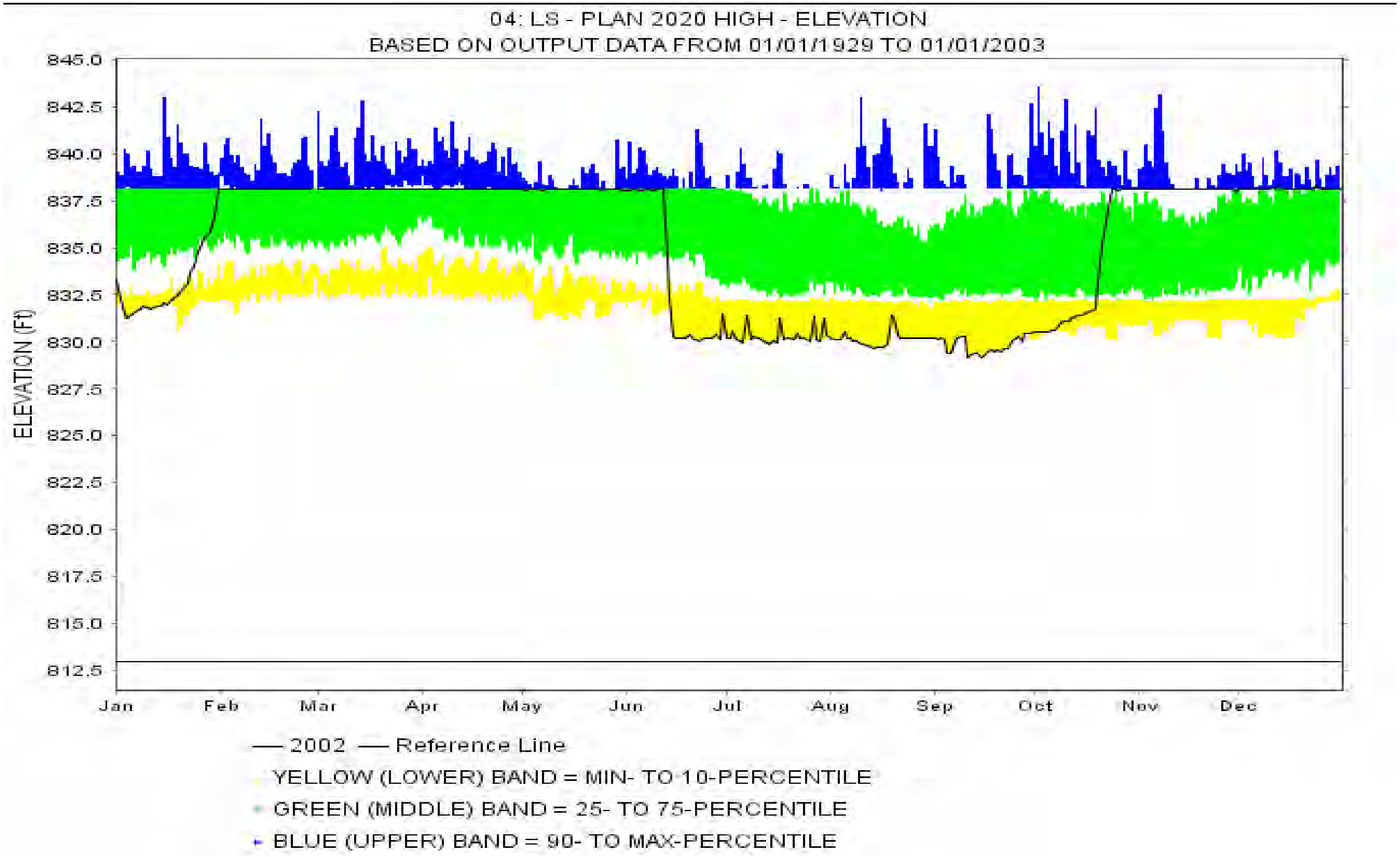


Figure 3-50: Lake Lookout Shoals Elevation Percentiles for 2020 High Demand

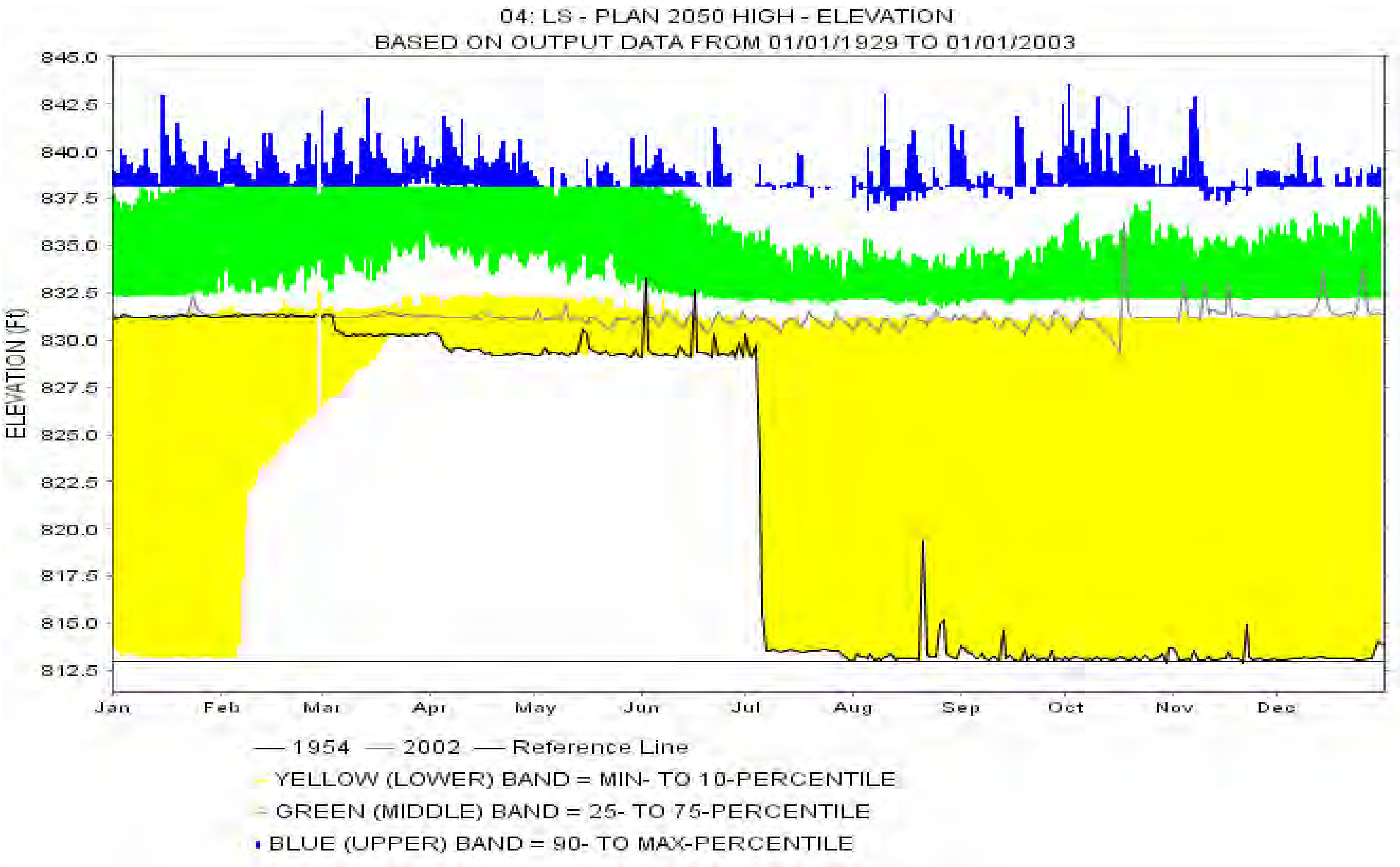


Figure 3-51: Lake Lookout Shoals Elevation Percentiles for 2050 High Demand

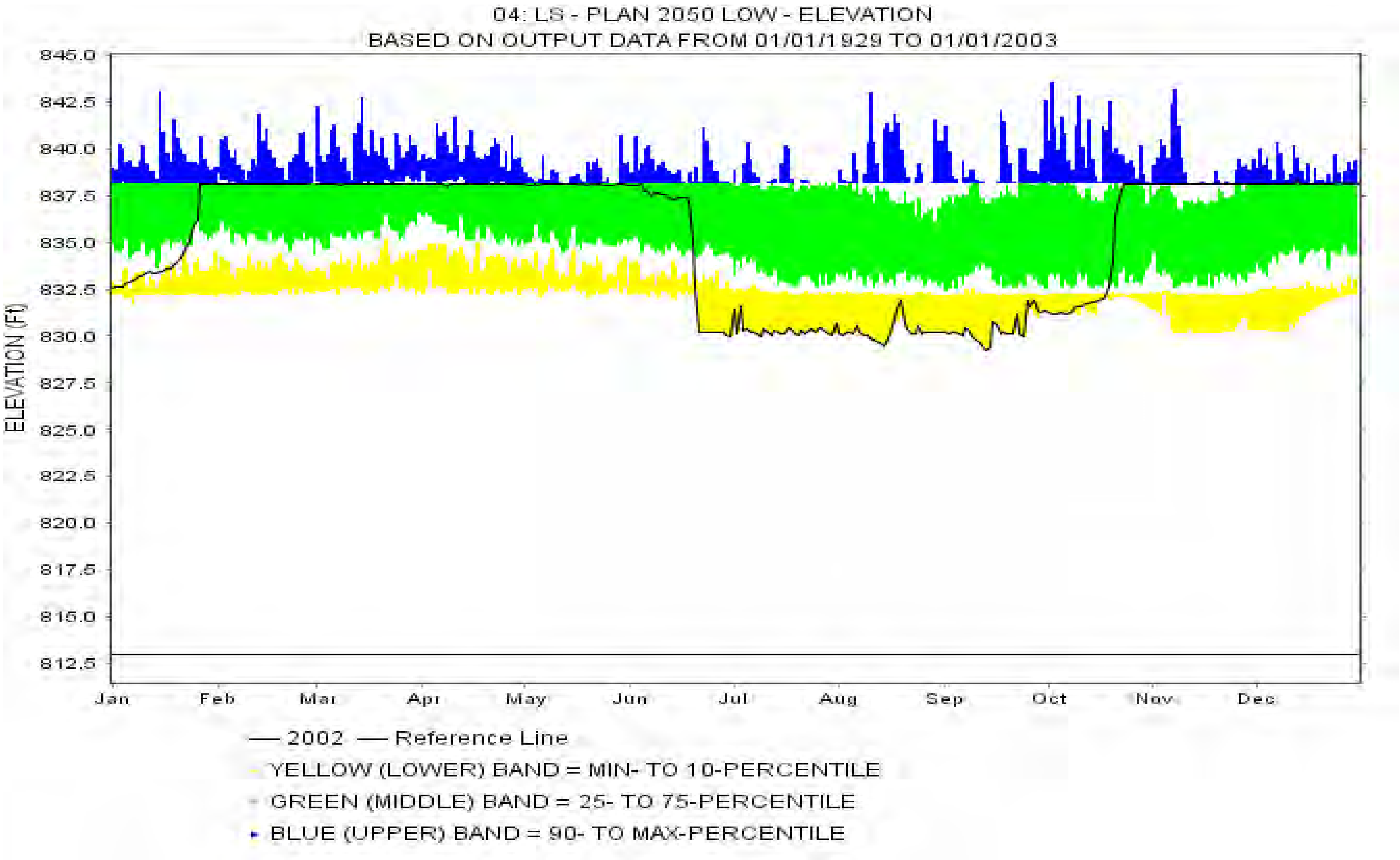


Figure 3-52: Lookout Shoals Elevation Percentiles for 2050 Low Demand

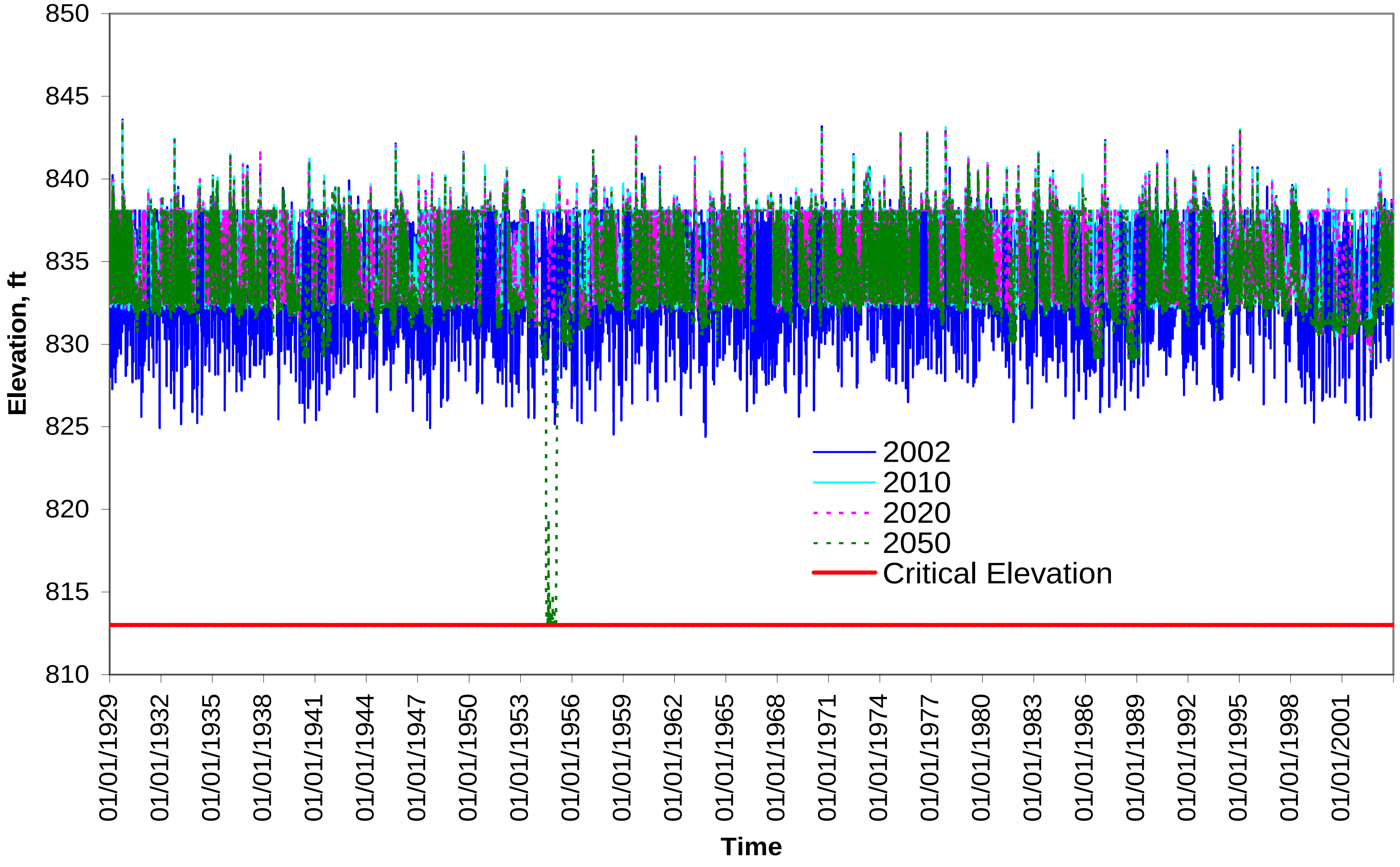


Figure 3-53: Lake Lookout Shoals Elevation Profiles

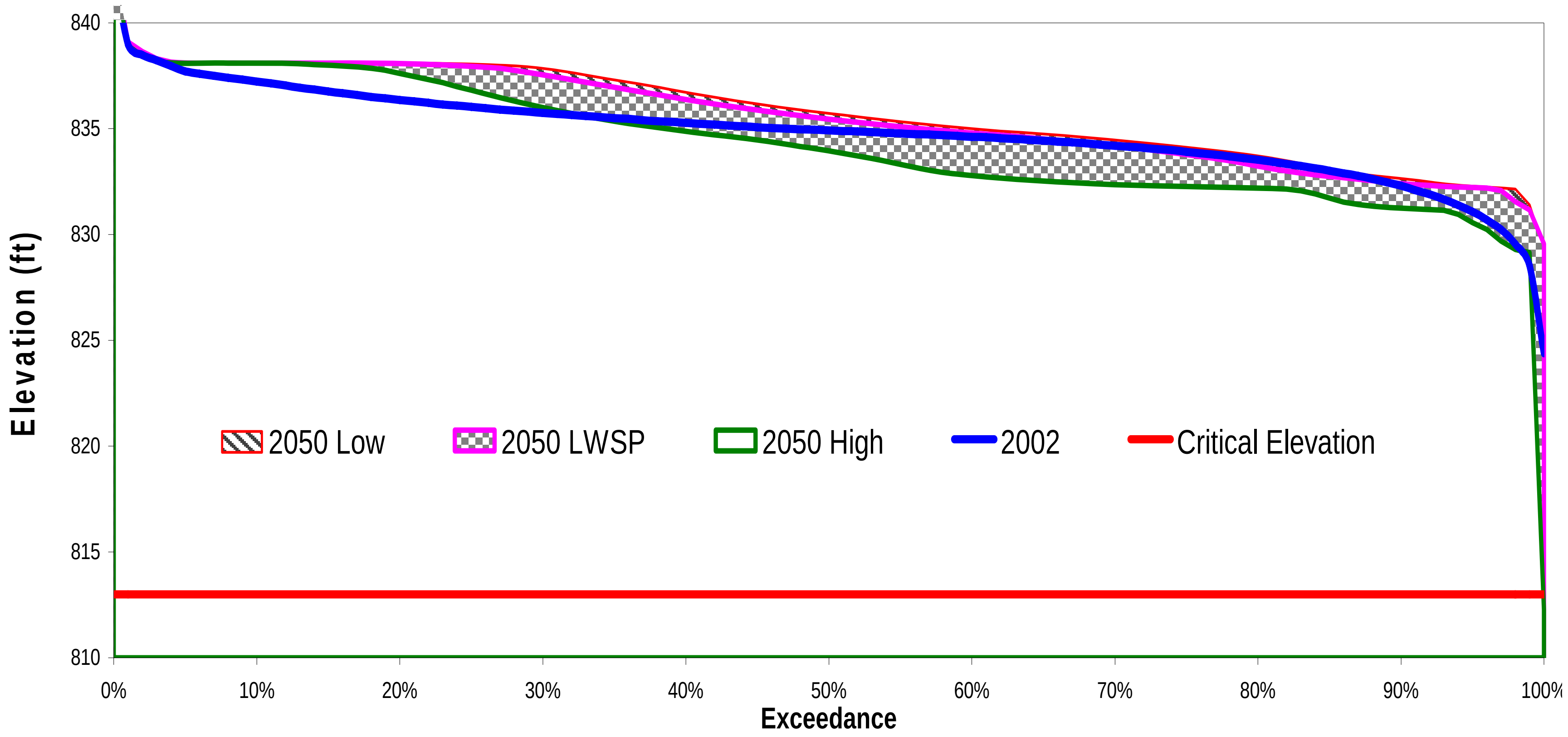


Figure 3-54: Lake Lookout Shoals Elevation Duration Plots

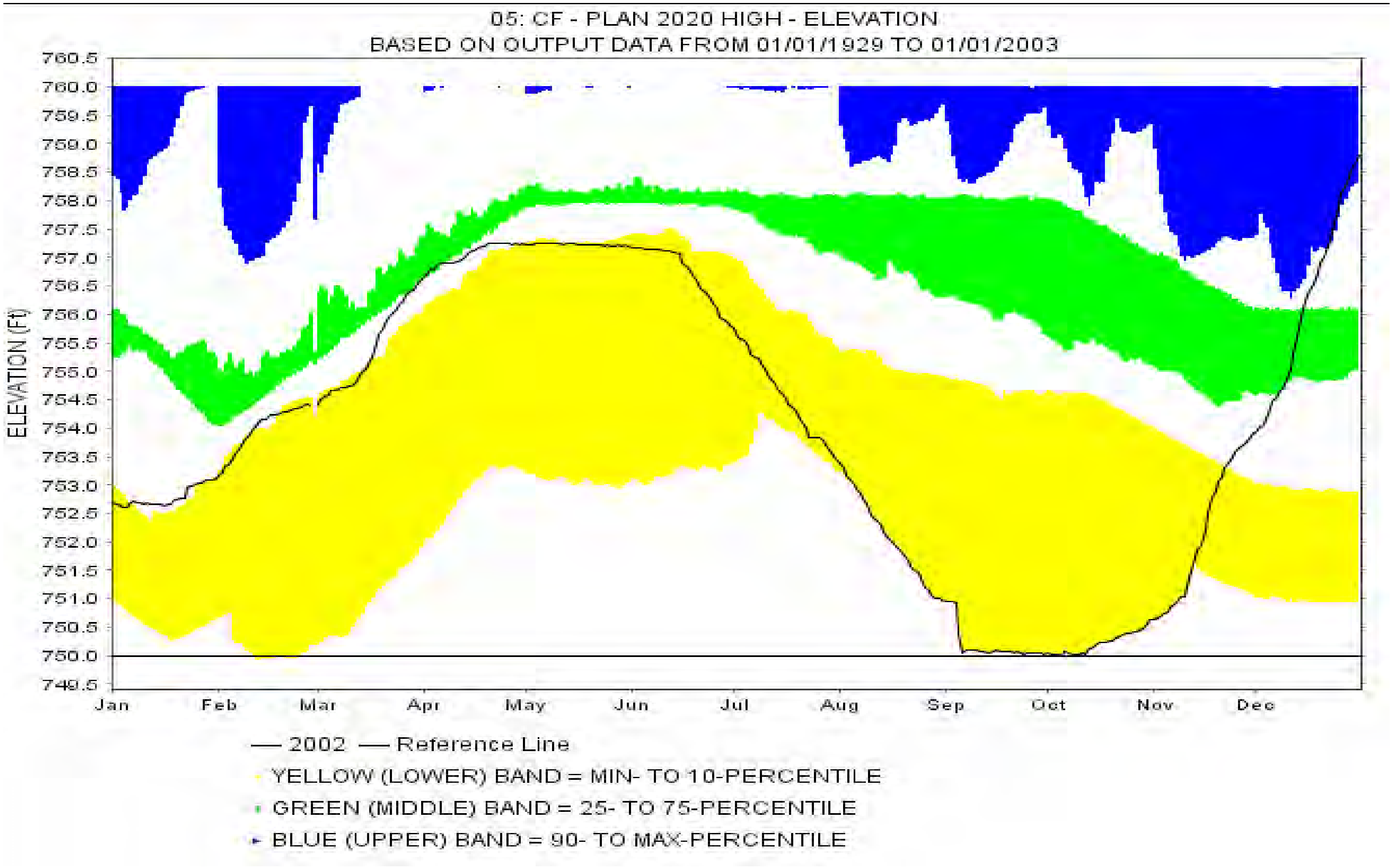


Figure 3-55: Lake Norman at Cowans Ford Elevation Percentiles for 2020 High Demand

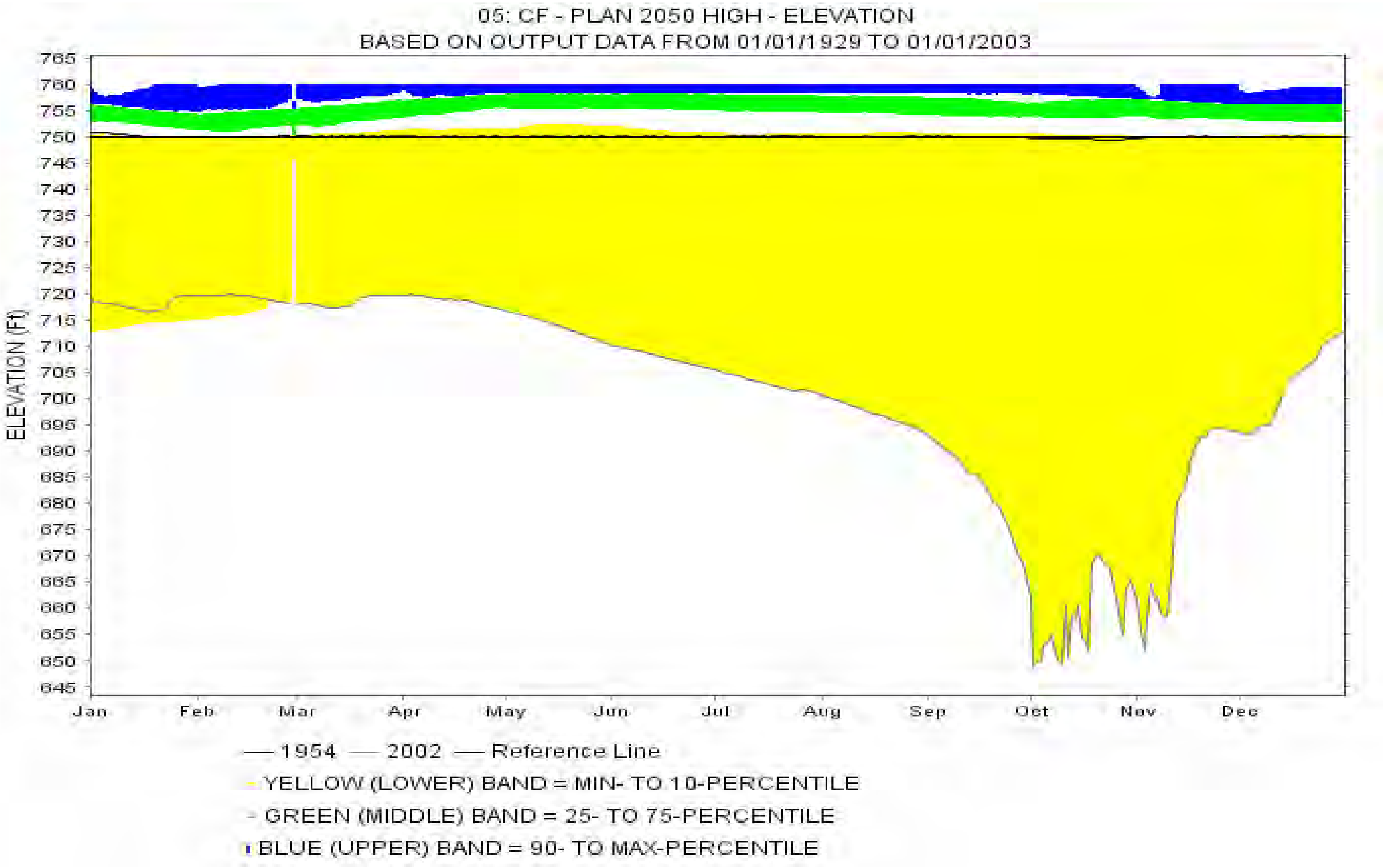


Figure 3-56: Lake Norman at Cowans Ford Elevation Percentiles for 2050 High Demand

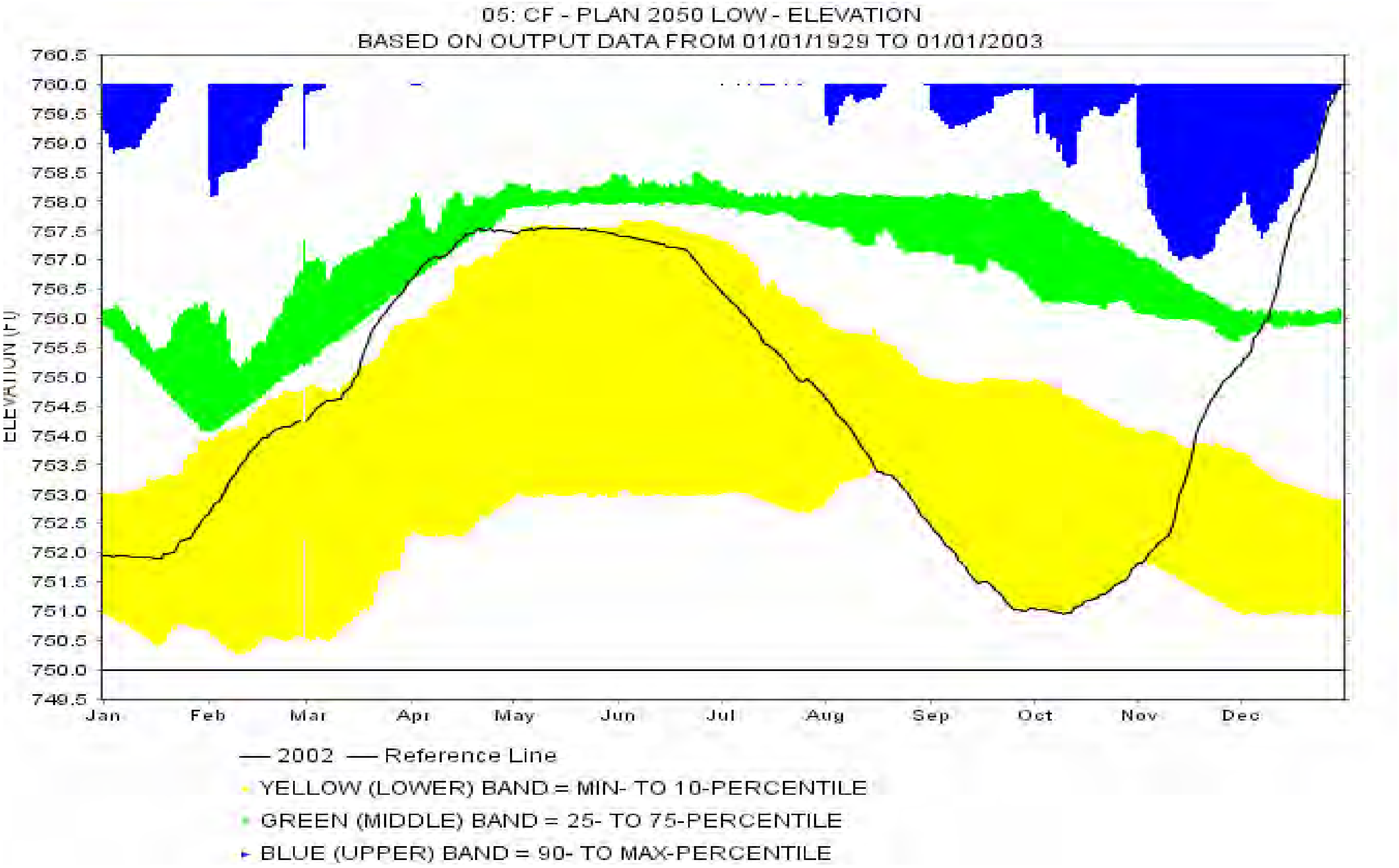


Figure 3-57: Lake Norman at Cowans Ford Elevation Percentiles for 2050 Low Demand

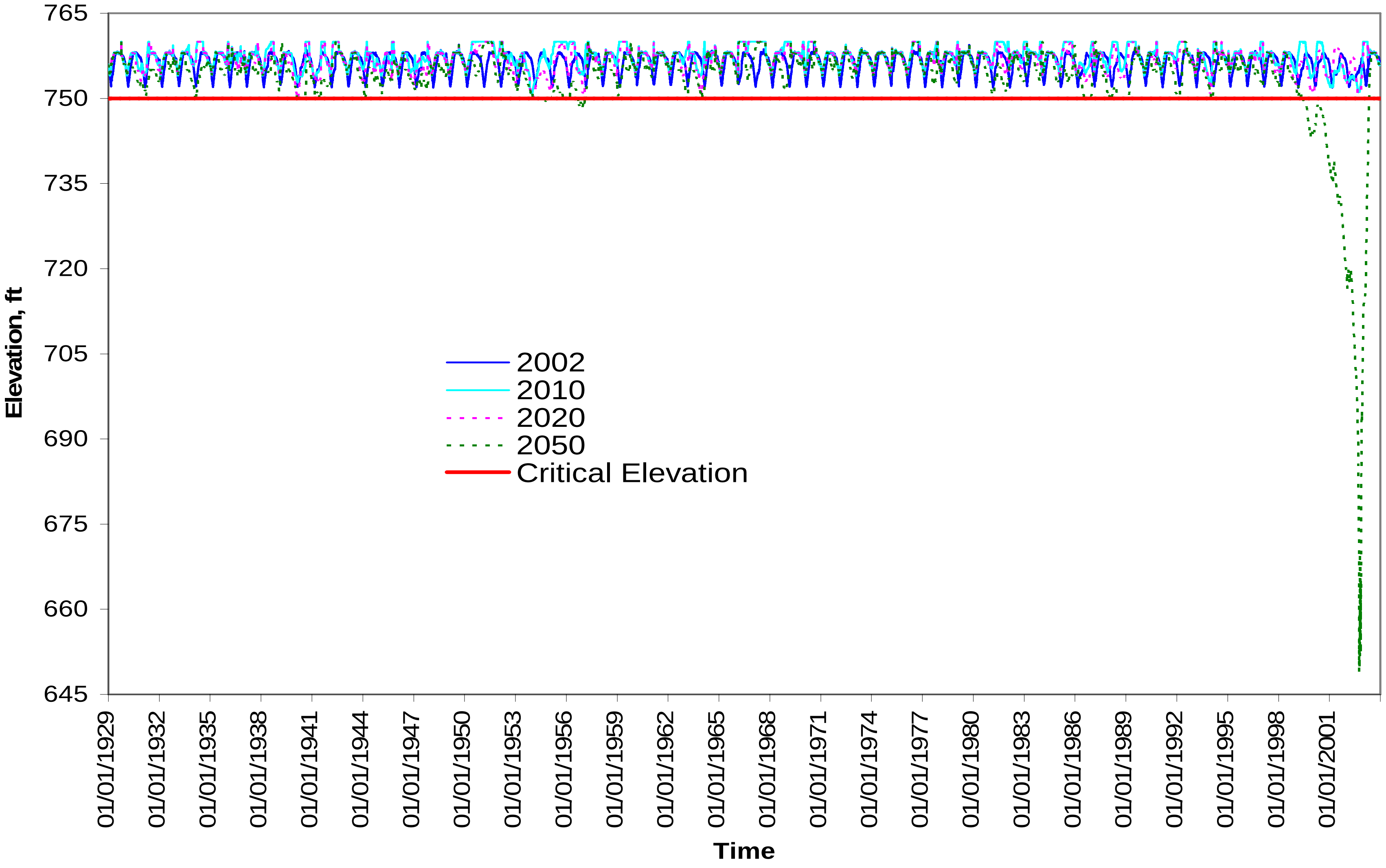


Figure 3-58: Lake Norman at Cowans Ford Elevation Profiles

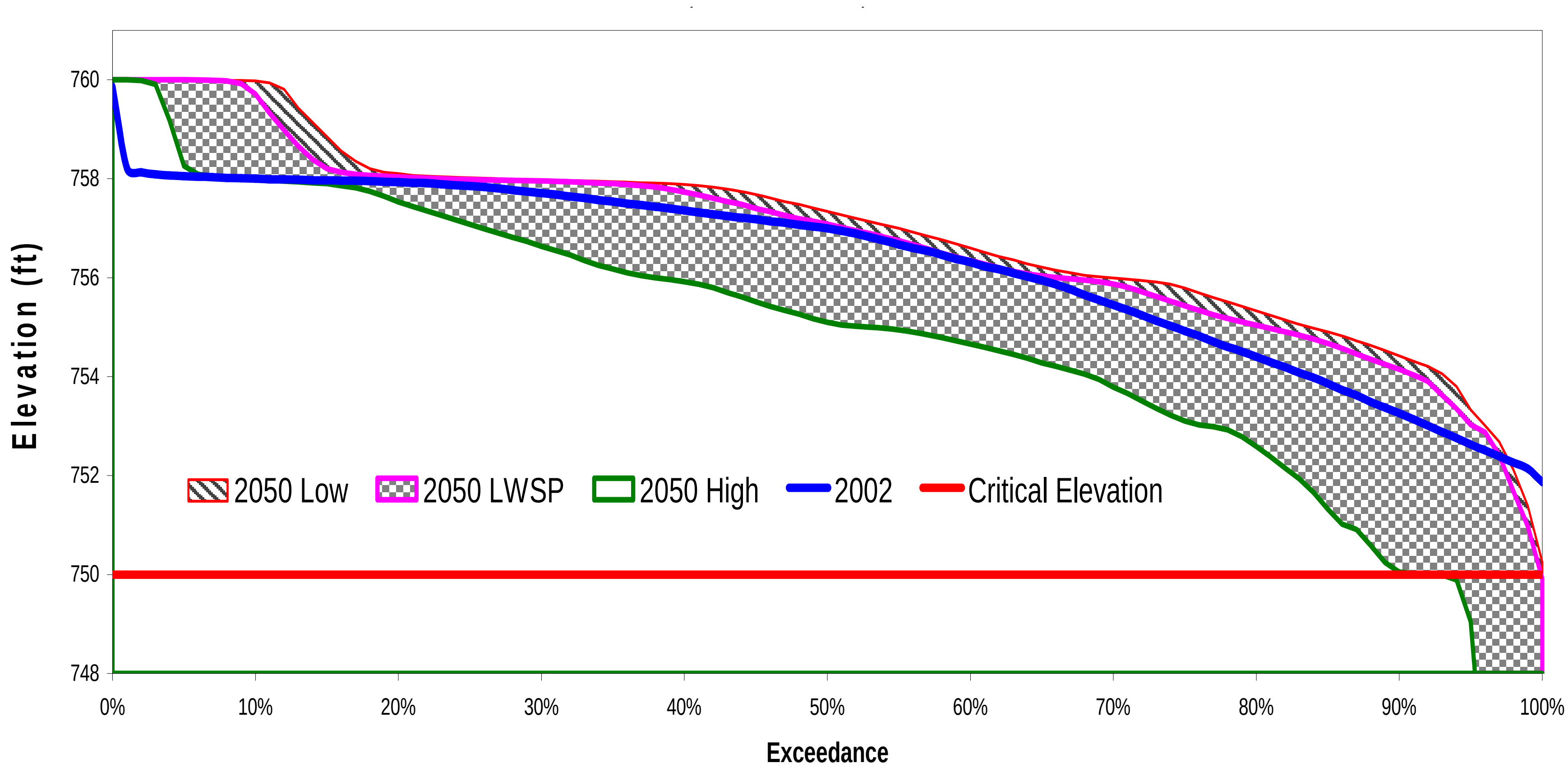


Figure 3-59: Lake Norman at Cowans Ford Elevation duration Plots

Figure 3-61 shows that Mountain Island normal elevations are below critical almost all the time except for a few weeks during the late winter or early spring for the 2050 High demand. Figure 3-63 is the elevation profile, where most of the times for the 2050 High demand the elevations were below critical. The same is true for WY as shown in Figure 3-66 through Figure 3-68.

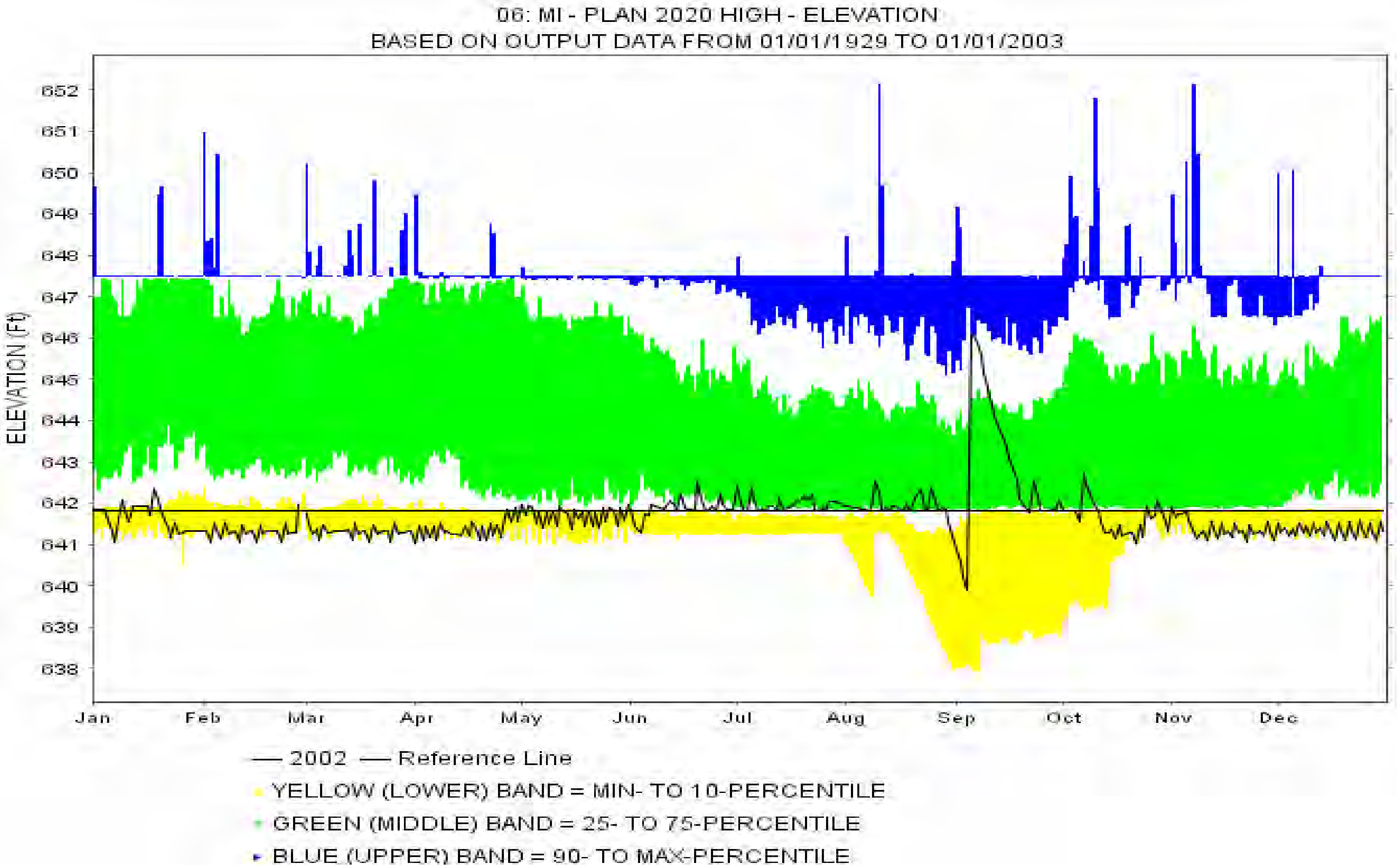


Figure 3-60: Lake Mountain Island Elevation Percentiles for 2020 High Demand

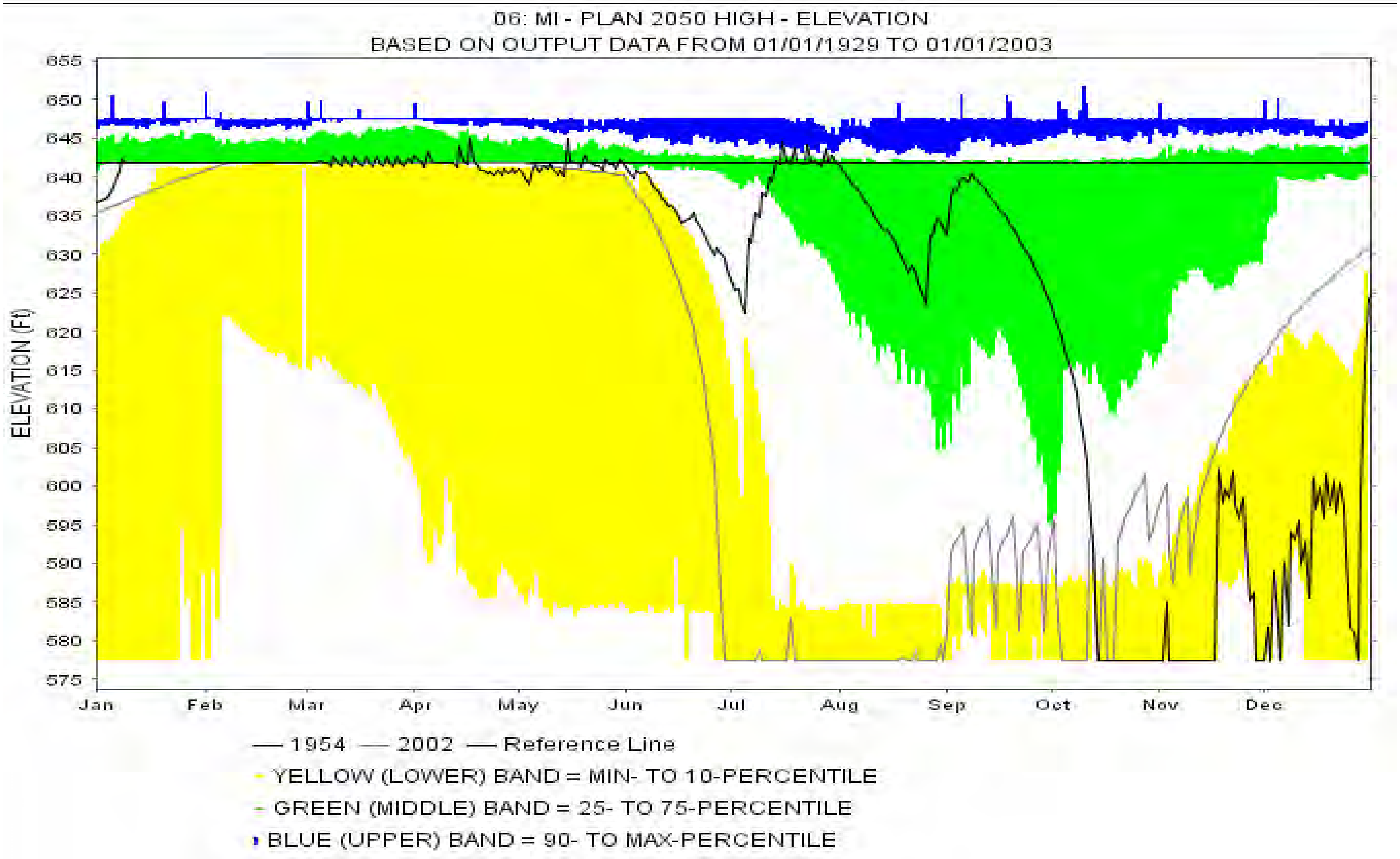


Figure 3-61: Lake Mountain Elevation Percentiles for 2050 High Demand

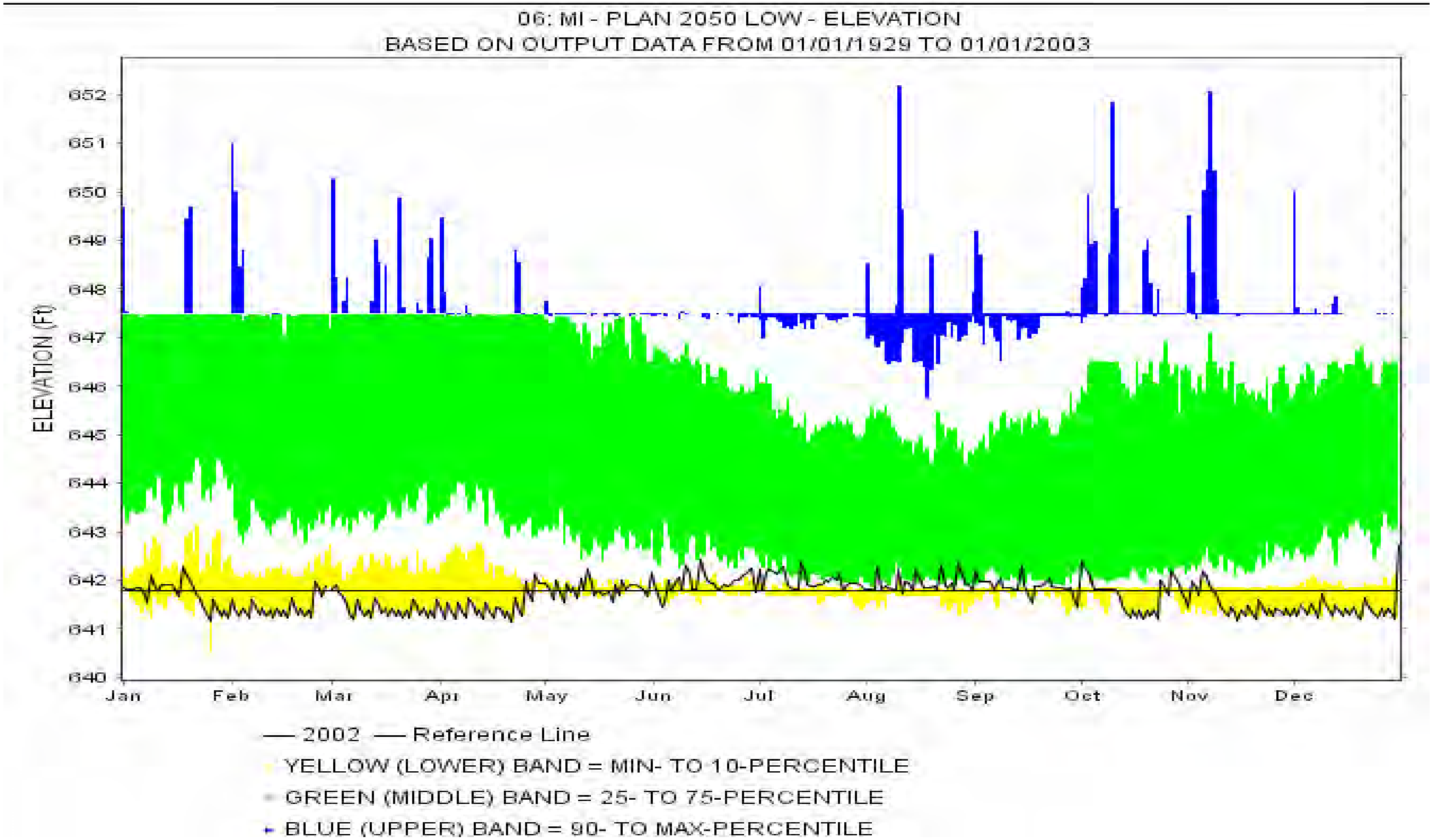


Figure 3-62: Lake Mountain Island Elevation Percentiles for 2050 Low Demand

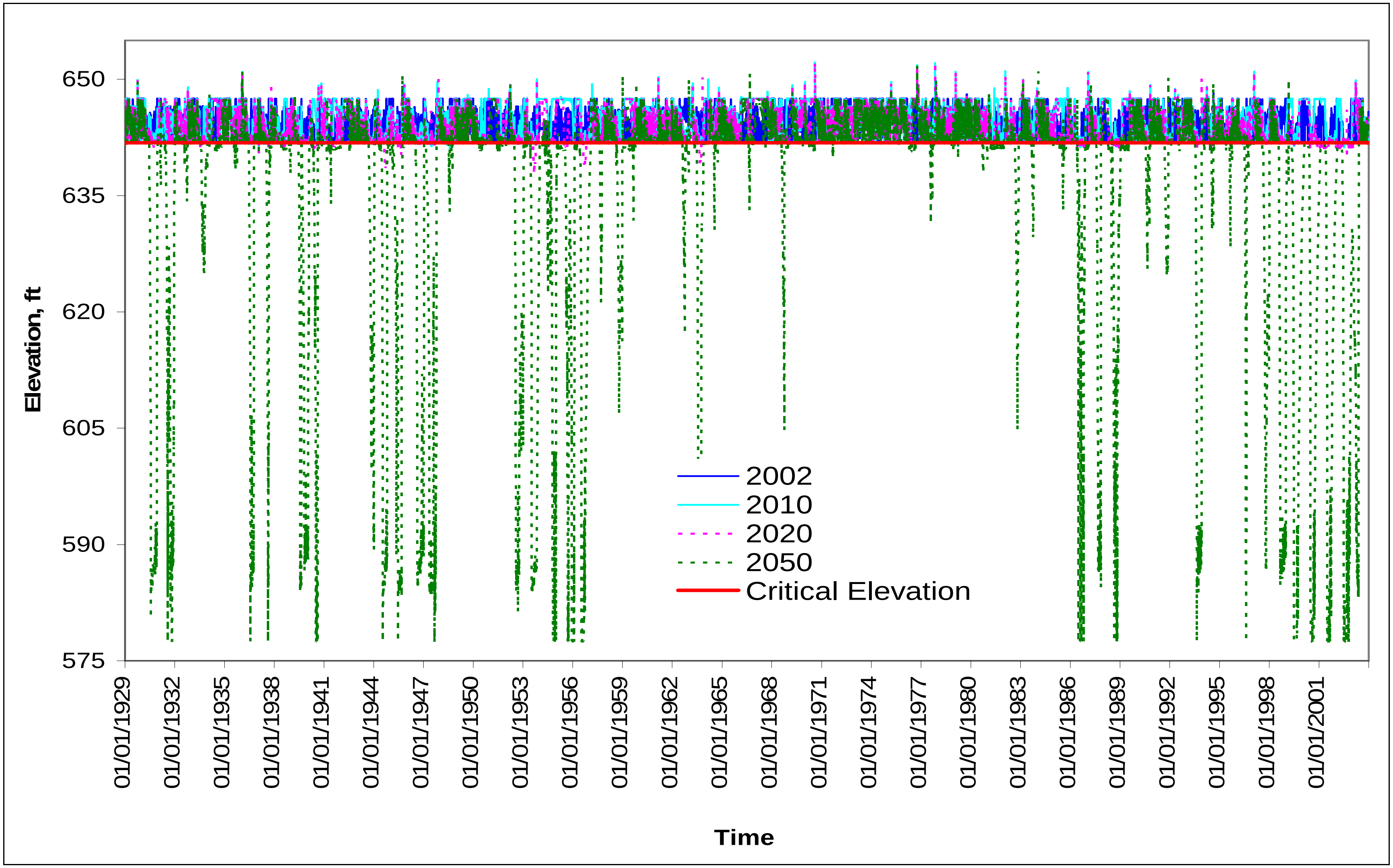


Figure 3-63: Lake Mountain Island Elevation Profiles

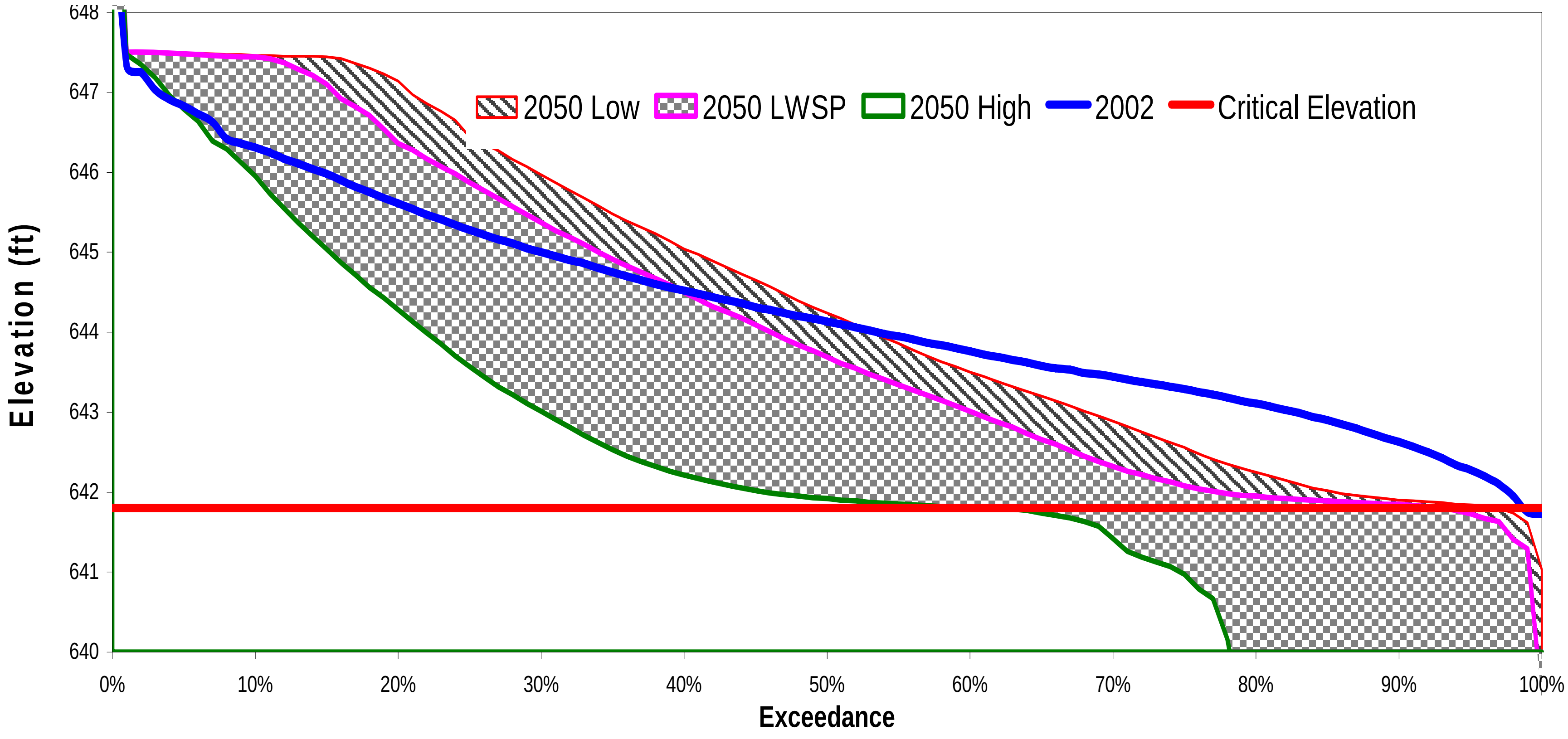


Figure 3-64: Lake Mountain Island Elevation Duration Plots

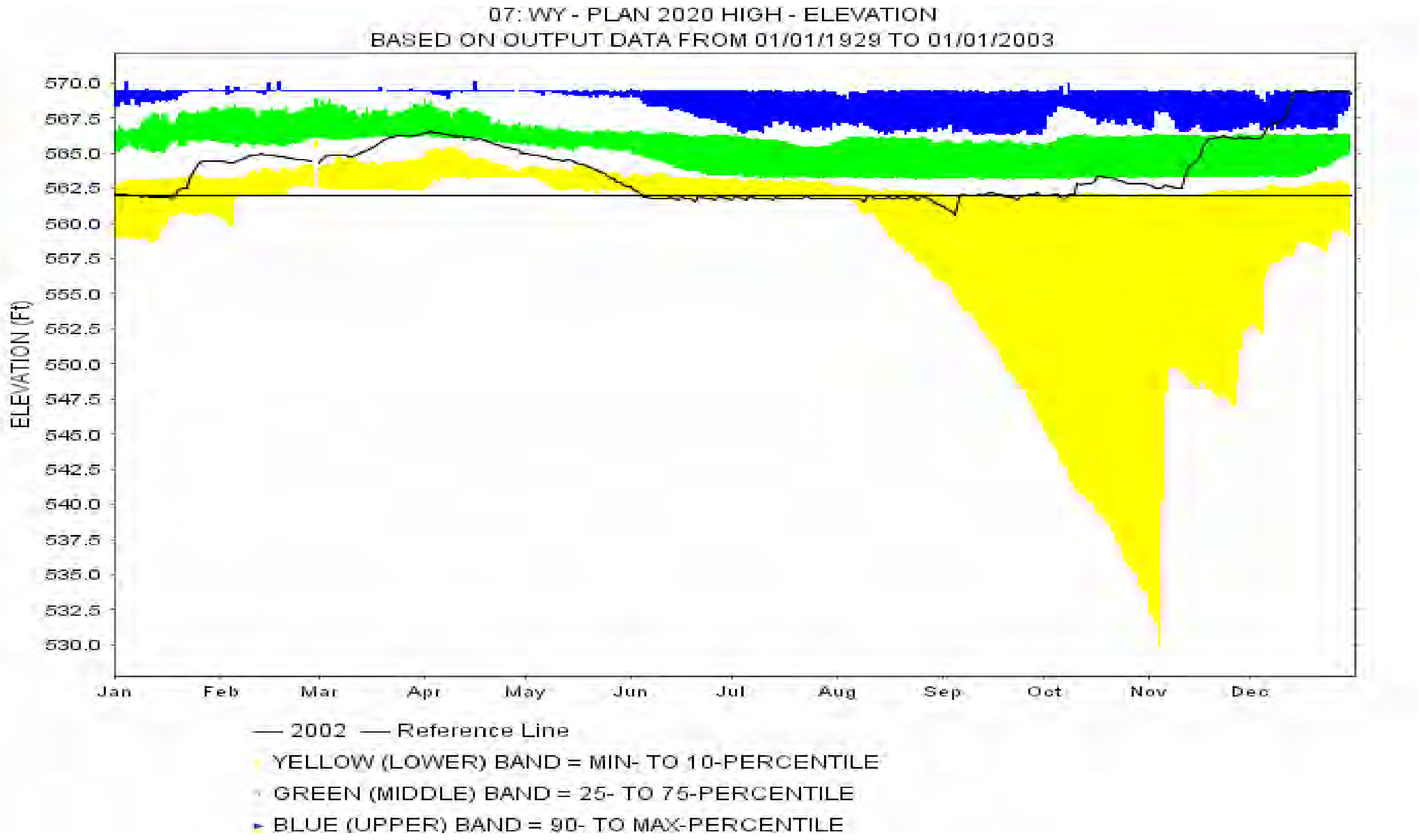


Figure 3-65: Lake Wylie Elevation Percentiles for 2020 High Demand

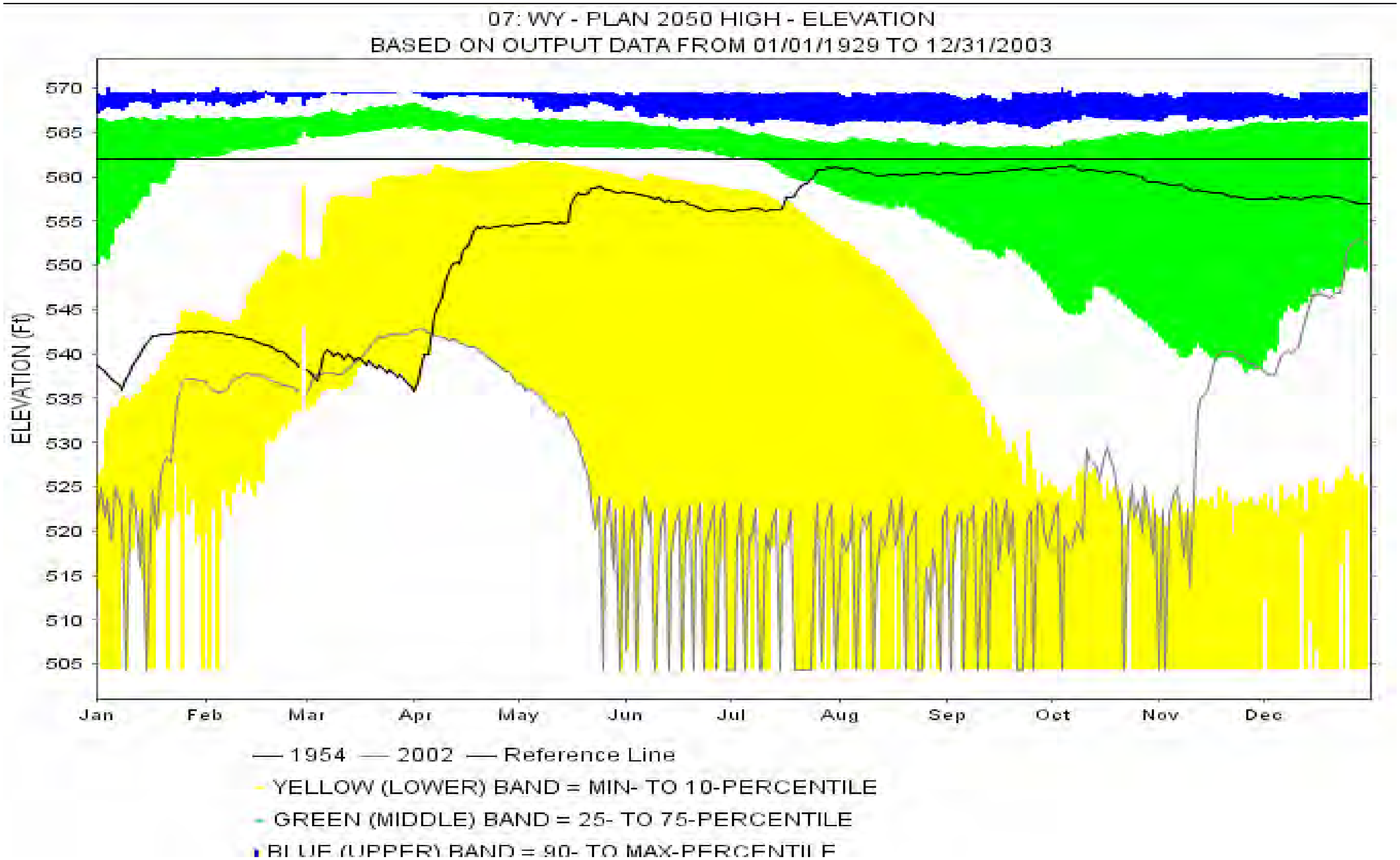


Figure 3-66: Lake Wylie Elevation Percentiles for 2050 High Demand

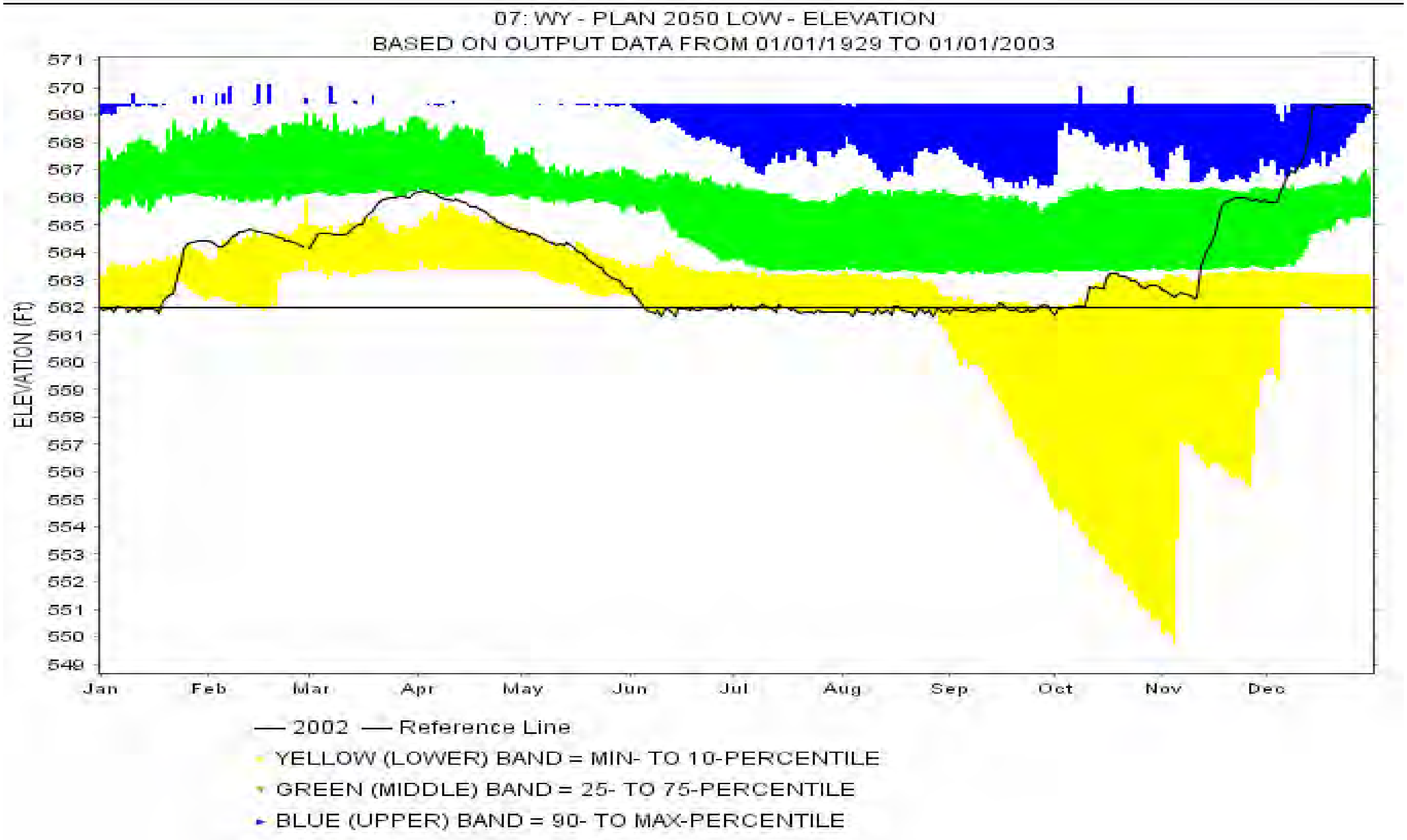


Figure 3-67: Lake Wylie Elevation Percentiles for 2050 Low Demand

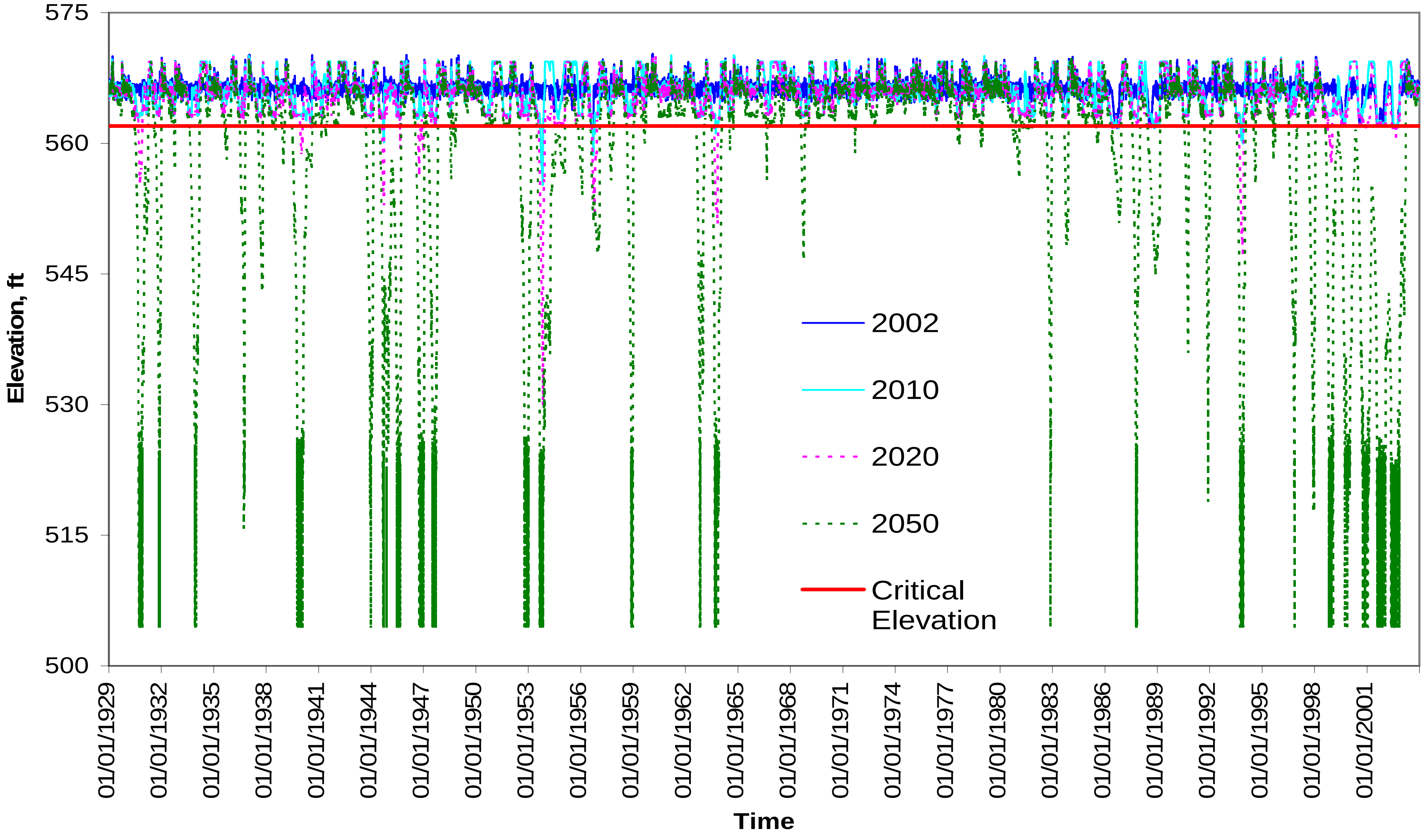


Figure 3-68: Lake Wylie Elevation Profile

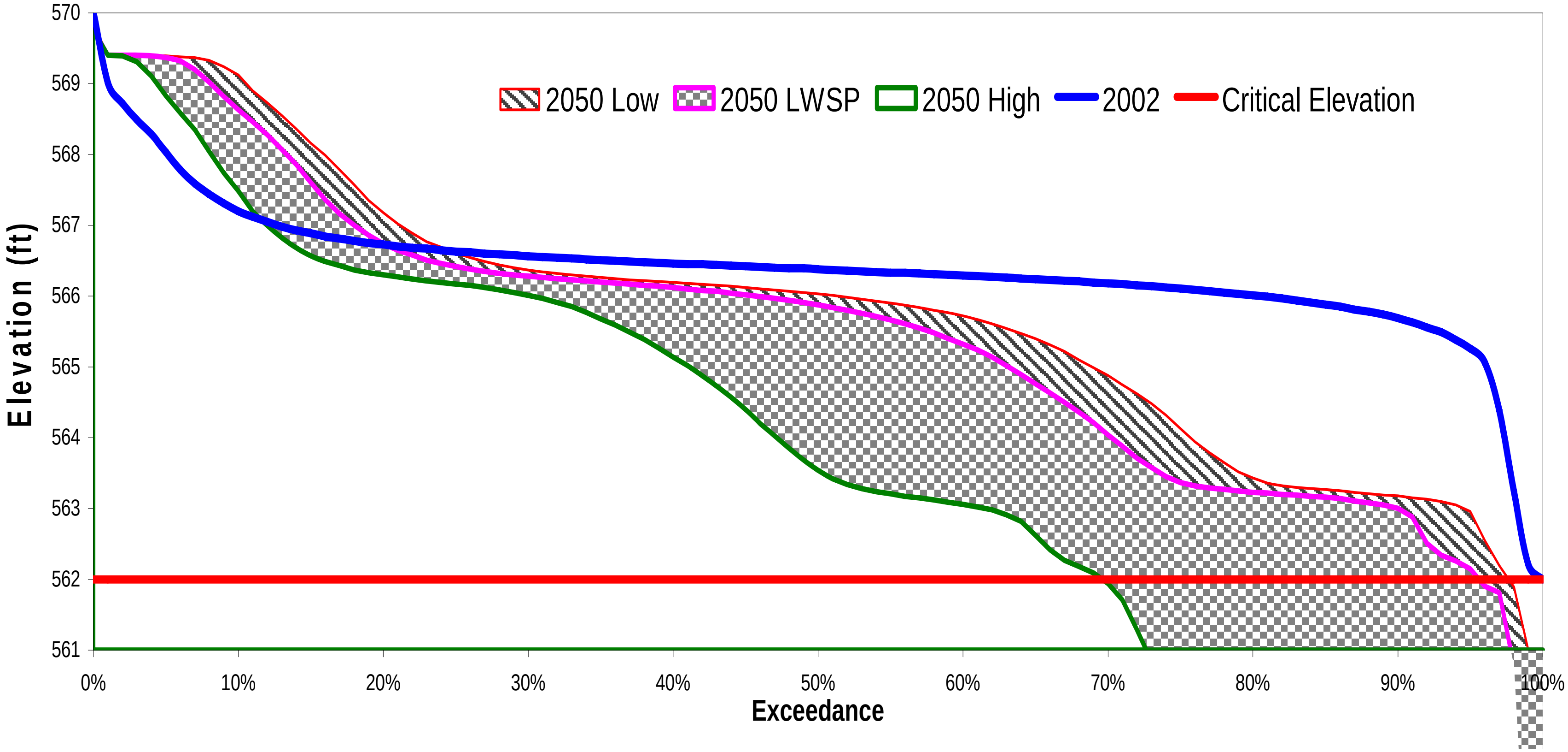


Figure 3-69: Lake Wylie Elevation Duration Plots

Section 3.2 Drought Management

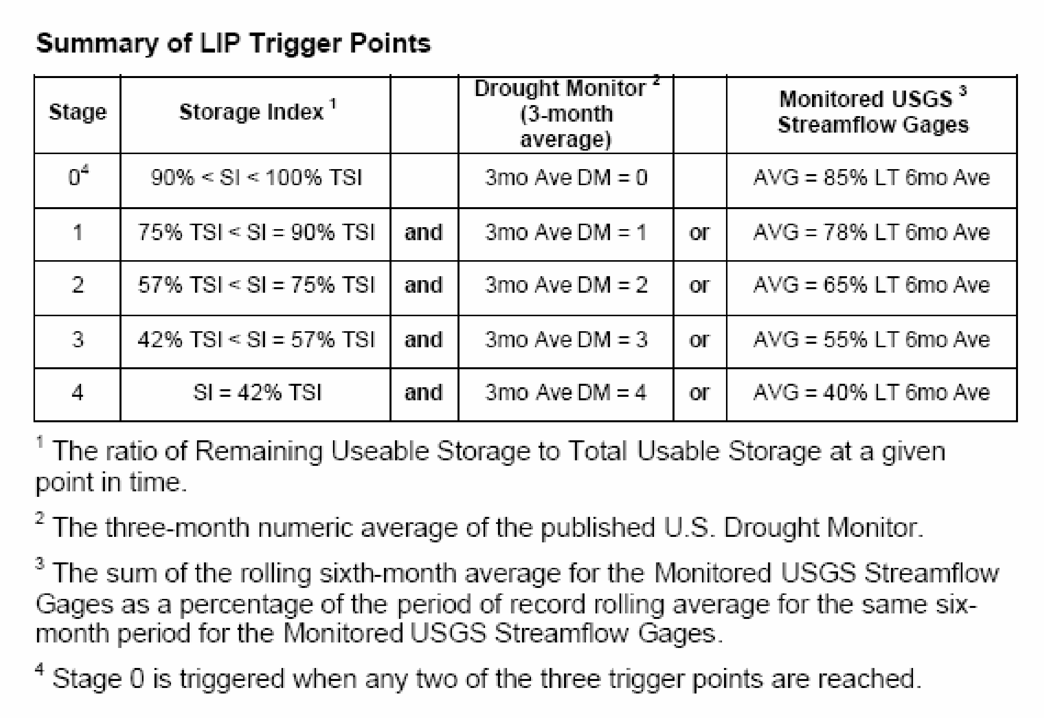
(e) Drought Contingency Plans/LIP

During the relicensing process, Duke Energy formulated a procedure to manage the river system during any drought or low flow condition. The inflows in the streams and the storage condition of the reservoirs determine the overall condition for the entire river system. This formulated procedure is called Low Inflow Protocol or LIP. The purpose of the LIP is to establish a procedure for reductions in water use by providing trigger points and procedures for how the Catawba River system plants will be operated by Duke Energy, as well as water withdrawal reduction measures for other water users during the period of low inflow or drought.

During periods of normal inflow, reservoir levels will be maintained within a prescribed Normal Operating Range. During times when inflow is not adequate to meet all of the normal demands for water and maintain reservoirs levels as normally targeted, Duke Energy will progressively reduce hydroelectric power generation. If the hydrologic conditions continue to worsen, reaching various trigger points, Duke Energy will continue to declare progressive stages of Low Inflow Conditions starting from stage 0 to stage 4, stage 0 being the beginning of drought or low inflow watch and stage 4 being the most extreme drought condition. Each progressive stage will call for greater reductions in water releases and withdrawals and allow additional use of the available water storage inventory.

The trigger points that will be checked on a monthly basis for various stages are summarized below in Table 3-13. The specific triggers required to enter successive stages are defined in the procedure for each stage.

Table 3-13: LIP Trigger Points with Operational Guidelines for Catawba System[43]



Summary of LIP Trigger Points

Stage	Storage Index [1]		Drought Monitor [2] (3-month average)		Monitored USGS [3] Streamflow Gages
0[4]	90% < SI < 100% TSI		3mo Ave DM = 0		AVG = 85% LT 6mo Ave
1	75% TSI < SI = 90% TSI	and	3mo Ave DM = 1	or	AVG = 78% LT 6mo Ave
2	57% TSI < SI = 75% TSI	and	3mo Ave DM = 2	or	AVG = 65% LT 6mo Ave
3	42% TSI < SI = 57% TSI	and	3mo Ave DM = 3	or	AVG = 55% LT 6mo Ave
4	SI = 42% TSI	and	3mo Ave DM = 4	or	AVG = 40% LT 6mo Ave

[1] The ratio of Remaining Useable Storage to Total Usable Storage at a given point in time.

[2] The three-month numeric average of the published U.S. Drought Monitor.

[3] The sum of the rolling sixth-month average for the Monitored USGS Streamflow Gages as a percentage of the period of record rolling average for the same six-month period for the Monitored USGS Streamflow Gages.

[4] Stage 0 is triggered when any two of the three trigger points are reached.

In order to ensure continuous improvement of the LIP and its implementation throughout the new license term, the LIP will be re-evaluated and modified periodically. The details of the procedures are available in the final version of the LIP document in Appendix D1_LIP Document. These proposed LIP conditions will be in effect during any drought situation in the new licensed condition of the reservoir operation and will be officially effective after the renewal of the license in 2008.

(a) Water Conservation

North Carolina General Statute G.S. 143-355(l) requires all units of local government that provide or plan to provide public water service to prepare a Local Water Supply Plan. In addition to units of local governments, all community water systems having 1,000 connections or serving more than 3,000 people in North Carolina are required to prepare a Local Water Supply Plan. A Local Water Supply Plan is an assessment of community water supply needs and the ability of a water system to meet those needs. As part of the Local Water Supply Plan, water systems are required to include a description of how water system will respond to drought and other water shortage emergencies and continue to meet essential public water supply needs during the emergency. This portion of the plan is called

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[43] Duke Energy, June 2006, LIP Document

Table 3-14: Catawba Basin Public Water Supply System Status during Drought

PWSID	Water System	Basin	County	Conservation Program	WSRP	Voluntary 1998 - 2002 (month)	Mandatory 1998 - 2002 (month)
01-02-010	Taylorsville	Catawba River (03-1)	Alexander		Yes	1	0
01-02-020	Alexander County WD	Catawba River (03-1)	Alexander	Yes	Yes	0	0
01-02-035	Bethlehem WD	Catawba River (03-1)	Alexander		Yes	6	0
01-06-104	Linville Land Harbor	Catawba River (03-1)	Avery	Yes	Yes	0	0
01-12-010	Valdese	Catawba River (03-1)	Burke	Yes	Yes	2	0
01-12-015	Morganton	Catawba River (03-1)	Burke		Yes	0	0
01-12-040	Triple Community WC	Catawba River (03-1)	Burke	Yes	Yes	8	0
01-12-045	Drexel	Catawba River (03-1)	Burke			0	0
01-12-060	Icard Township WC	Catawba River (03-1)	Burke	Yes		0	0
01-12-065	Burke County	Catawba River (03-1)	Burke			0	0
01-12-103	Brentwood WA	Catawba River (03-1)	Burke			0	0
01-12-104	Brentwood WC	Catawba River (03-1)	Burke			0	0
01-14-010	Lenoir	Catawba River (03-1)	Caldwell		Yes	6	0
01-14-025	Baton WC	Catawba River (03-1)	Caldwell		Yes	5	0
01-14-030	Granite Falls	Catawba River (03-1)	Caldwell		Yes	4	0
01-14-035	Rhodhiss	Catawba River (03-1)	Burke			0	0
01-14-040	Sawmills	Catawba River (03-1)	Caldwell			0	0
01-14-045	Caldwell County W	Catawba River (03-1)	Caldwell			3	0
01-14-046	Caldwell County S	Catawba River (03-1)	Caldwell			3	0
01-14-047	Caldwell County SE	Catawba River (03-1)	Caldwell			0	0
01-14-048	Caldwell County N	Catawba River (03-1)	Caldwell			3	0
01-18-010	Hickory	South Fork Catawba River (03-2)	Catawba	Yes	Yes	0	0
01-18-015	Newton	South Fork Catawba River (03-2)	Catawba		Yes	0	0
01-18-020	Conover	Catawba River (03-1)	Catawba		Yes	3	0
01-18-025	Longview	Catawba River (03-1)	Catawba		Yes	5	0
01-18-030	Maiden	South Fork Catawba River (03-2)	Catawba	Yes	Yes	5	0
01-18-035	Claremont	Catawba River (03-1)	Catawba		Yes	0	0
01-18-040	Catawba	Catawba River (03-1)	Catawba			0	0
01-36-010	Gastonia	Catawba River (03-1)	Gaston		Yes	2	0
01-36-015	Belmont	Catawba River (03-1)	Gaston	Yes		0	0
01-36-020	Mount Holly	Catawba River (03-1)	Gaston	Yes	Yes	4	0
01-36-025	Bessemer City	South Fork Catawba River (03-2)	Gaston		Yes	8	1
01-36-030	Cherryville	South Fork Catawba River (03-2)	Gaston	Yes		27	6
01-36-034	Ranlo	Catawba River (03-1)	Gaston			0	0
01-36-035	Stanley	South Fork Catawba River (03-2)	Gaston			0	0
01-36-040	Cramerton	South Fork Catawba River (03-2)	Gaston		Yes	0	0
01-36-045	McAdenville	South Fork Catawba River (03-2)	Gaston			0	0
01-36-060	Lowell	South Fork Catawba River (03-2)	Gaston	Yes		0	0
01-36-065	Dallas	South Fork Catawba River (03-2)	Gaston		Yes	1	0
01-36-075	High Shoals	South Fork Catawba River (03-2)	Gaston			3	1
01-49-015	Mooresville	Catawba River (03-1)	Iredell	Yes	Yes	3	0
01-55-010	Lincolnton Water System	South Fork Catawba River (03-2)	Lincoln	Yes		3	0
01-55-035	Lincoln County	Catawba River (03-1)	Lincoln	Yes		3	0
01-56-010	Marion	Catawba River (03-1)	Mcdowell	Yes	Yes	0	0
01-56-025	Old Fort	Catawba River (03-1)	Mcdowell		Yes	0	0
01-60-010	Charlotte Mecklenburg Utilities	Catawba River (03-1)	Mecklenburg	Yes	Yes	26	0
01-90-413	Union County	Catawba River (03-1)	Union		Yes	2	0
20-18-004	Southeastern Catawba County WD	Catawba River (03-1)	Catawba			6	0

a Water Shortage Response Plan (WSRP). Table 3-14 indicates the water systems with a water shortage response plan. In the Local Water Supply Plan questionnaire, we asked water systems do they have an active water conservation public education program. This allows us to determine which systems actively provide water conservation information to their customers. Table 3-14 indicates the water systems with an active water conservation program. The table also indicates the number of months each water system was in each level of drought during the 1998 through 2002 drought period.

(b) Local vs. State Roles

Water supply systems in North Carolina are numerous and diverse, the best place to address water shortages and drought response is at the local level. To provide guidance to local systems, the Division of Water Resources has developed a Water Shortage Response Handbook along with Water Shortage Response Plan Template for public water supply systems in North Carolina. The handbook emphasizes the need for local officials and the local community to develop a plan to deal with a drought or other water shortage. The handbook describes how a community can implement a multi-level drought response plan. Having a water shortage response plan, including a drought ordinance, allows a community to respond to water shortages early and to avoid the need for more stringent measures later.

A Drought Response Plan has been adopted by North Carolina agencies to provide a systematic means of assessing and responding to the impact of drought on water supply. The assessment system calls for representatives from state and federal agencies to form task forces that use a broad range of data sources to evaluate and assess water availability and drought impacts and distribute the information to water system managers. The response system deals with water supply needs across the state. When needed, recommendations are made to seek legislative or federal assistance. The Drought Management Advisory Council (DMAC) is a working group of various federal and state agencies with expertise in the areas of water resources, climatology, agriculture, public health, and emergency management. The DMAC, chaired by the Water Supply Planning Section, Division of Water Resources, oversees North Carolina’s response to water shortage situations. The DMAC routinely monitors climatological and other drought related information, including precipitation, streamflows, ground water levels, soil moisture, reservoir levels, water supply and demand, and other drought data.

During an extended drought, the DMAC keeps the State Emergency Response Team apprised of any water needs, identifies and recommends ways to meet those needs, ensures inter-agency coordination, identifies potential drought mitigation measures, and determines when to deactivate as water shortages subside.

Section 3.3 Data Management Needs

(a) Surface Water

The basin contains many USGS gage stations to monitor the stream flow and stage conditions along with other useful parameters. Those gage stations encompass major tributaries across the basin. Several of them are unregulated sites, most are on the regulated portion of the streams. However, there are few more streams in the upper sub basins or upstream of few tributaries that do not have any gage stations. It would have been more useful if there were few more gages on those streams as identified and labeled in violet in the Figure 3-70 below.

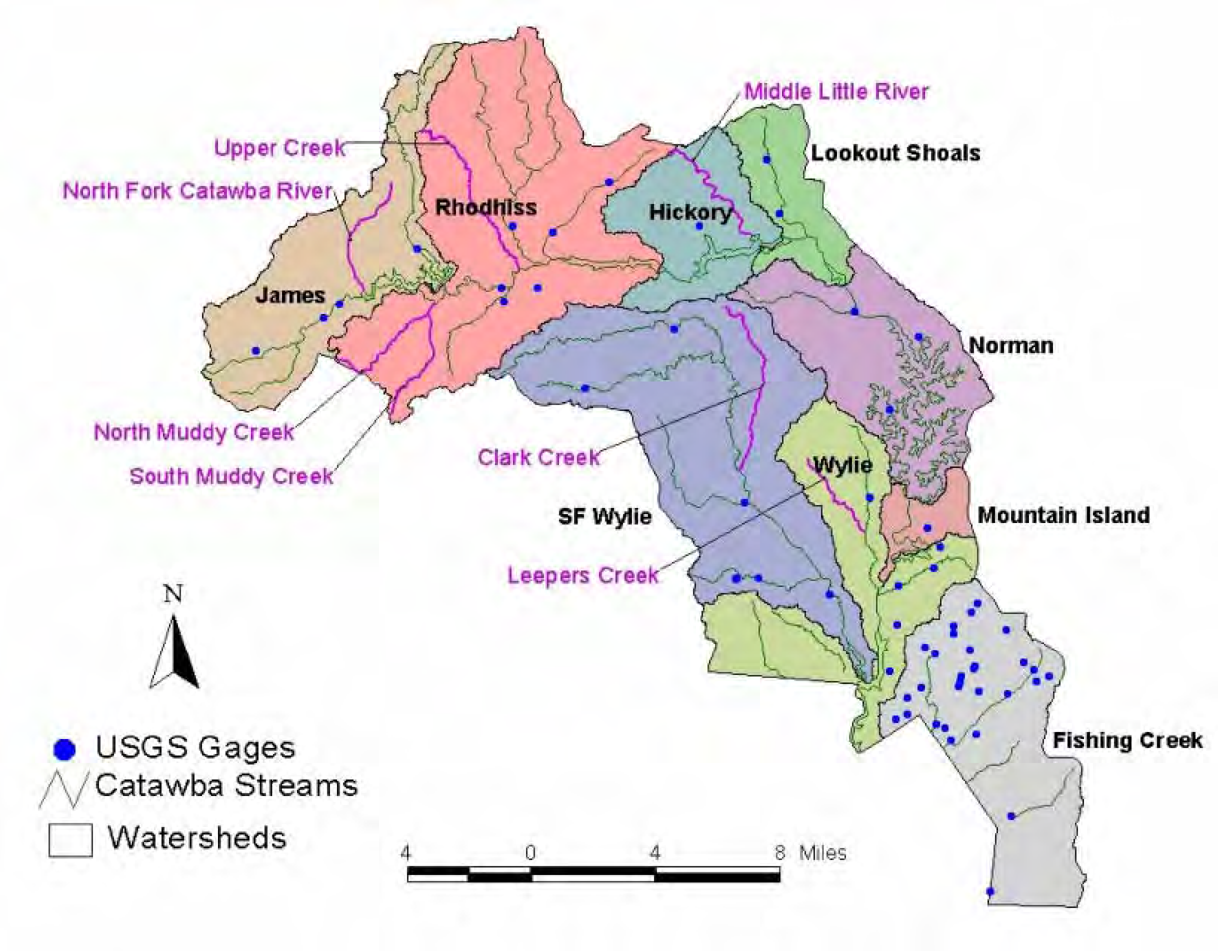

Figure 3-70 Locations of Streams with no Gage Stations

(b) Groundwater

While we enjoy access to four wells currently to assess the impacts of drought on ground water conditions, more monitoring wells that give us complete geographic coverage of the Catawba River Basin is a must. An additional six to eight wells distributed in the basin will provide that geographic coverage.

Chapter 4 - References

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Appendices

Appendix A

Glossary of Terms and Acronyms

ac-ft	acre feet
cfs	cubic feet per second
CHEOPS	Computer Hydro- Electric Operations and Planning Software
CMU	Charlotte Mecklenburg Utility
CTS	Cooperating Technical State
C-W	Catawba Wateree
DWR	Division of Water Resoureces
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FIRMS	Flood Insurance Rate Maps
HDR	HDR, Inc - an architectural, engineering and consulting firm
HUCS	Hydrologic Unit Codes
ITRIB	Inflows in Tributary
LWSP	Local Water Supply Plan
mgd	million gallon per day
MSA	Metropolitan Statistical Area
NFIP	National Flood Insurance Program
WWTPS	Waste Water Treatment Plants
SDC	State Data Center

Appendix B

Projection Methodology

All of the projections in this report reflect potential population growth and water demand scenarios through the year 2050. The intentions of the projections are to provide an approximation of future conditions, not to be absolutes. Projections for both population and water demand are presented in Chapters 1 and 2. These, along with the projections calculated for wastewater returns, are detailed in Appendix C.

Five different water demand projections were calculated for the purpose of developing a range of high and low projections to be used in the basin model: average growth rate projections, 1970 to 2030 trend projections, 2000 to 2030 trend projections, 2002 LWSP future service area population projections, and 2002 LWSP future demand projections. The average growth rate projections are based on the work done by HDR Engineering, Inc for the Duke Power Water Supply Study (2006). The 1970 to 2030 trend projections and the 2000 to 2030 trend projections are based on historic county population figures from the US Census Bureau and county population projections developed by the SDC. The 2002 LWSP future service area population projections and the 2002 LWSP future demand projections are based on the population and demand projections provided in the 2002 LWSPs.

Population Projections

The population projections presented in the county descriptions in Chapter 1 for individual community water systems were taken directly from the 2002 Local Water Supply Plans (LWSPs). The 2002 LWSPs are presented in conjunction with the State Data Center (SDC) population projection for each county. For an in-depth discussion of the SDC's methodology, please refer to the State Demographics Unit website (www.demog.state.nc.us). The SDC projections used were those that were available at the time of publication for Catawba River Basin Plan, prior to those published in July of 2005. Since the Division had begun the projection modeling process before the July SDC projections were published, it elected not to use the more recent figures.

In order to compute the five sets of water demand projections for each community water system, five different sets of population projections were also necessary. Several steps were necessary in order to calculate a community water system's service area population projection based on the SDC county population projections. First the projections needed to be protracted over a greater period of time, since the SDC only projected out to 2030 and we needed the projections to extend to 2050. A simple regression analysis showed that the best way to extend the projections was to use a third degree polynomial equation, rather than simply calculating a linear extension. Two third degree polynomial equations were developed, one representing the population growth trend from 2000 to 2030 and the other representing the population growth trend from 1970 to 2030. The equations were then modified by replacing the constant in each equation (the base population for each county) with the 2002 community water system population, as reported in the 2002 LWSPs. This allowed these same trends to be projected onto the service populations for each of the community water systems.

The HDR projections that were calculated for the Duke Power Water Supply Study were initially calculated only for independent community water systems that either withdraw water from or discharge wastewater into the Catawba River basin. Dependent systems that purchase all of their water from other systems or discharge all of their wastewater through another system were accounted for in these calculations. However, for the purposes of this report, all of the systems needed to have projections calculated, because HDR used average growth rates in order to calculate their initial projections. DWR used the same average growth rates and applied them individually to each dependent system and removed the values from the independent systems that accounted for the dependent systems.

Water Demand Projections

All five projections were calculated by separating water demand into four categories: residential, commercial, industrial, and institutional. These are categories that the community water systems divided their water demands into in the 2002 LWSPs.

The average growth rate projection used the method and growth rates developed by HDR for the Duke Power Water Supply Study. The equation takes the 2002 customer numbers from each of the four categories and multiplies it by one plus the appropriate average growth rate raised to an exponent of the number of years between the base year (in this case, 2002) and the projection year. Two growth rates were used; one was applied to the residential and commercial connections to the water system in 2002 and the other to the industrial and institutional connections to the water system in 2002. These were translated into total water demand by category by multiplying the number of connections by the average demand per connection per year that was reported in 2002 LWSPs. The percentage of unaccounted-for and system process water was maintained as a constant throughout the projection period. Water sales to other systems were projected using the average growth rate for residential and commercial demand.

For the 1970 to 2030 trend projection, 2000 to 2030 trend projection, and the LWSP future service population projection, projections were calculated as described above for the average growth rate projection, excluding the residential component. In the cases of the 1970 to 2030 and the 2000 to 2030 trend projections, the same trends used for the population projections were applied to the number of residential connections from the 2002 LWSPs. For the LWSP future service population projection, the population projections from the 2002 LWSP were added to the average growth rate projections for commercial, industrial, and institutional demand. The 2002 LWSPs project service population but not the number of residential connections, therefore the number of connections was derived by determining the average number of persons per residential connection in 2002 and dividing the population projections by that number. Once the number of connections was determined for all three of these projections, it was multiplied by the average demand per connection for each year projected in the 2002 LWSPs. Again, the percentage of unaccounted-for and system process water was held constant throughout the projection period and the sales to other systems were projected using the average growth rate for residential and commercial demands only.

The 2002 LWSP future demand projection is simply the demand projections, as required by reporting systems in their 2002 LWSPs. While the DWR provided guidance for these calculations upon request, each projection acquired through the 2002 LWSPs contain a certain amount of expected variability between each system's calculation methodologies. Every community water system in the Catawba River basin was required to submit demand projections that were broken down into the aforementioned four categories of water use at ten-year intervals from 2010 to 2050. Unaccounted-for water and service area demand were also included in these projections.

In order to develop the demand range, the projections for all community water systems and the industrial, institutional, and agricultural projections calculated by HDR were added together for each drainage area; so that each drainage area had five sets of demand projections. Three of the five projections were compared to determine the highest and lowest projected demands for each year. For example, if the 1970-2030 projection was higher in 2010, then it was used as the highest projection in the range for that year; however, if the LWSP future service population projection had the highest number for 2020, then it was used as the highest projection for that year. Neither the highest nor the lowest projections in the range were necessarily calculated by the same projection methodologies.

The two projections that were not included in this last process, the 2002 LWSP projections and the average growth rate projections based on HDR's projections for the Duke Power Water Supply Study, are represented separately on each chart in the drainage area section.

Wastewater Discharge Projections

In order to run the model for the Catawba River basin, wastewater discharge projections needed to be calculated as well. Since wastewater projections were not calculated as part of the 2002 LWSPs, the only reference available on which to base these projections were the ratios of wastewater to water demand from the LWSPs. This ratio was calculated for both the 2002 and 1997 LWSPs[1] to generate a percentage from these two numbers. The percentage was then applied to the demand projections presented in the 2002 LWSPs for each of the community water systems in the Catawba River basin.

The resulting wastewater discharge projections were grouped by their withdrawal drainage area and added together by the discharge drainage area, along with the agricultural, industrial, and institutional discharge projections calculated by HDR for the Duke Power Water Supply Study (2006). For example, Lake James has nine major withdrawals (not including the Duke Energy facility located on the lake); projections for the eight that discharge wastewater to Lake James were added together, while the one discharge to Lake Rhodhiss was kept separate.

The discharge amounts by withdrawal drainage area were then used to track the movement of water through the Catawba River. Percentages were calculated to represent the amount of water withdrawn from one drainage area and discharged to another. The percentages were then applied to each set of withdrawal projections run through the model.

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[1] This was done because 2002 was the year of a major drought and the ratio could have been affected by this.

Appendix C

County Water Supply Projections

Owner	Alexander County WD
System	Alexander County WD
Facility	
Data Source	2002 LWSP
PWSID #	01-02-020
Data Reference Date	November 15, 2005
Data Source Notes	

2002 LWSP DATA

2002 Water Use Data		Calc from Mo#	
	mgd	mgd	% AvAnnUse
02 AvAnnUse	0.73	0.729	
02 AvAnnDis	0.01325	**0.013**	
02 Unacct For	0.033		0.045
02 Sys Process	0		0.000
		Combined Unacct and Sys Proc	0.045
		# used in demand calc Table #1	**0.04521**

2002 LWSP Demand Projections								**% Increase Per Decade**					
	2002	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
Resid	0.614	0.706	0.812	0.918	1.028	1.151	1.289			0.150	0.131	0.120	0.120
Com	0.083	0	0.11	0.124	0.139	0.156	0.175			0.000	0.127	0.121	0.122
Indust	0	0	0	0	0	0	0.000			0.000	0.000	0.000	0.000
Instit	0	0	0	0	0	0	0.000			0.000	0.000	0.000	0.000
Backwash	0	0	0	0	0	0	0.000			0.000	0.000	0.000	0.000
Unacct	0.033	0.036	0.04	0.044	0.048	0.053	0.053			0.111	0.100	0.091	0.104
Sales Contracts	0	0	0	0	0	0	0.000			0.000	0.000	0.000	0.000
Fut Sales Contracts	0	0	0	0	0	0	0			0.000	0.000	0.000	0.000
Total Sales	0	0	0	0	0	0	0			0.000	0.000	0.000	0.000
Total Demand	0.73	0.742	0.962	1.086	1.215	1.36	1.517						

Service Pop relationship to previous period 1.152 1.130 1.115 1.115 1.115

2002 LWSP Demand and Wastewater Tables									
2002 Demand		**2002**	**2010**	**2020**	**2030**	**2040**	**2050**		
(6-A Y-R pop)	Service Pop	8,634	9,946	11,458	12,948	14,437	16,097		
(7-A 6)	Tot SAD	0.73	0.742	0.962	1.086	1.215	1.36		
(7-A 9)	Tot Demand	0.730	0.742	0.962	1.086	1.215	1.360		
Pop/# per household	Connections	3,554	4,094	4,716	5,330	5,943	6,626		
2002 Wastewater		Enter info from 4-B in LWSP in beige cells - NOTE MODEL NODE							
NPDES/Name of Receiver	Permit Cap	Ann Ave Dis	Rec Strm	Sub-basin	% AvAnnDis	% AvAnnUse	Return Node		
#1 City of Hickory	2	0.012			90.65%	1.65%			
#2					0.00%	0.00%			
#3					0.00%	0.00%			
#4					0.00%	0.00%			
#5					0.00%	0.00%			
#6					0.00%	0.00%			
#7					0.00%	0.00%			
Total		**0.012**			0.906	0.016			

	2002 LWSP Demand Projections					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
	9,946	11,458	12,948	14,437	16,097	17,948
Estimated SAD	0.742	0.962	1.086	1.215	1.360	1.522
0.73	0.742	0.962	1.086	1.215	1.360	1.522
	2002 LWSP Wastewater Projections					
	(AvAnnDisch/AvAnnSAD (D46:D52/D41) x Est SAD above L41:Q41)					
#1 City of Hickory	0.012	0.016	0.018	0.020	0.022	0.025
#2	0.000	0.000	0.000	0.000	0.000	0.000
#3	0.000	0.000	0.000	0.000	0.000	0.000
#4	0.000	0.000	0.000	0.000	0.000	0.000
#5	0.000	0.000	0.000	0.000	0.000	0.000
#6	0.000	0.000	0.000	0.000	0.000	0.000
#7	0.000	0.000	0.000	0.000	0.000	0.000

2002 Source Water Table							
Enter info from 3-A, 3-D, and/or 3-F from LWSP in beige cells				NOTE MODEL NODE			
Source	ADWithdrawal	#days	ADD	Avail Sup	% AvAnnUse		Withdrawal Node
Hickory	0.73	365	0.730	2	1.001		
			0.000		0.000		
			0.000		0.000		
			0.000		0.000		
			0.000		0.000		
Total			0.730	2	1.00		

2002 Monthly Pattern						
Enter monthly average daily use (2-E) and average daily discharge (4-A) from LWSP in beige cells						
Month	2002 Mon Ave Use mgd	2002 % of AAUse	2002 Mon Ave Disch mgd	2002 % of AADisc	Calculated Mon Disch mg	Calculated Mon Use
Jan	0.692	94.88%	0.013	98.20%	0.403	21.452
Feb	0.891	122.17%	0.015	113.31%	0.420	24.948
Mar	0.592	81.17%	0.01	75.54%	0.310	18.352
Apr	0.552	75.69%	0.01	75.54%	0.300	16.560
May	0.599	82.13%	0.011	83.09%	0.341	18.569
Jun	0.687	94.20%	0.012	90.65%	0.360	20.610
Jul	0.926	126.97%	0.018	135.97%	0.558	28.706
Aug	0.853	116.96%	0.016	120.86%	0.496	26.443
Sep	0.899	123.26%	0.017	128.41%	0.510	26.970
Oct	0.781	107.08%	0.014	105.75%	0.434	24.211
Nov	0.699	95.84%	0.013	98.20%	0.390	20.970
Dec	0.594	81.44%	0.01	75.54%	0.310	18.414

Population Projections

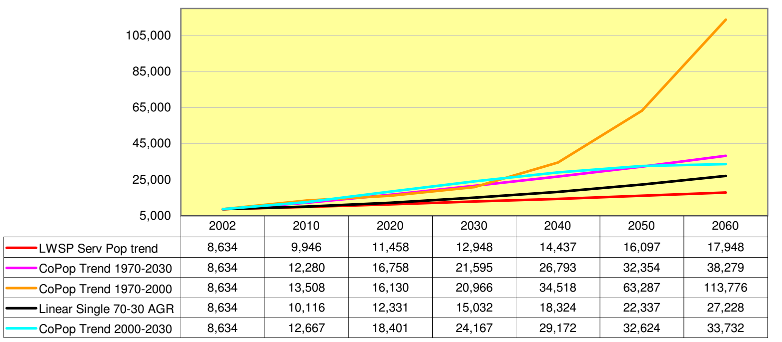
County Name:	Alexander

County Population								
Index Numbers				0	10	20	30	
	0	10	20	30	40	50	60	
Source	1970	1980	1990	2000	2010	2020	2030	
State Data Center (SDC)	19,466	24,999	27,544	33,603	38,742	44,546	50,223	From County Pop Worksheet
Annual Inc in decade		553.3	254.5	605.9	513.9	580.4	567.7	
AGR from first yr of decade		0.0284	0.0102	0.0220	0.0153	0.0150	0.0127	

Population Comparisons								
Index Numbers	SDC 1970-2030	40	50	60	70	80	90	
Index Numbers	SDC 2000-2030	10	20	30	40	50	60	
		2010	2020	2030	2040	2050	2060	
2002 Population by Residential Connection		10,116	12,331	15,032	18,324	22,337	27,228	Assumed same rate of growth between 2040 and 2050
2002 LWSP Service Population		9,946	11,458	12,948	14,437	16,097	17,948	as between 2050 and 2060
OSP County Population		38,742	44,546	50,223	54,981	44,342	50,340	Extended using cubic polynomial equation
LWSP Service Pop % of SDC County Pop		0.256723969	0.257217259	0.257810167	0.262581619	0.363023353	0.356530797	

Service Area Population								
Index Numbers	0	8	18	28	38	48	58	
	2002	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	
LWSP Serv Pop trend	8,634	9,946	11,458	12,948	14,437	16,097	17,948	Linear function based on LWSP Projections
CoPop Trend 1970-2030	8,634	12,280	16,758	21,595	26,793	32,354	38,279	Cubic polynomial equation based on SDC county
CoPop Trend 1970-2000	8,634	13,508	16,130	20,966	34,518	63,287	113,776	population projections
Linear Single 70-30 AGR	8,634	10,116	12,331	15,032	18,324	22,337	27,228	Linear function based on average growth rates
CoPop Trend 2000-2030	8,634	12,667	18,401	24,167	29,172	32,624	33,732	Cubic polynomial equation based on SDC county population projections

Estimated Service Population 2002-2060



	2002	2010	2020	2030	2040	2050	2060
LWSP Serv Pop trend	8,634	9,946	11,458	12,948	14,437	16,097	17,948
CoPop Trend 1970-2030	8,634	12,280	16,758	21,595	26,793	32,354	38,279
CoPop Trend 1970-2000	8,634	13,508	16,130	20,966	34,518	63,287	113,776
Linear Single 70-30 AGR	8,634	10,116	12,331	15,032	18,324	22,337	27,228
CoPop Trend 2000-2030	8,634	12,667	18,401	24,167	29,172	32,624	33,732

DEMAND PROJECTIONS

Enter connection and demand for residential, commercial, industrial and institutional water use (2-D) from LWSP in beige cells

Average Growth Rates		Res/Com AGR	0.02000	0.02000	0.02000	0.02000	0.02000	0.02000
	Inf Adjusted GSF	Indust/Instit AGR	**0.0166**	**0.0166**	**0.0166**	**0.0166**	**0.0166**	**0.0166**

Estimates of Future Demands based on above AGRs applied to #of Customers * 02 gpd/cust

Use Type	02Con'cts/Dem'd	per connect	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Resid Cust #	3,399	2.540	3,982	4,855	5,918	7,214	8,793	10,719
Resid Demand	0.614	181	0.719	0.877	1.069	1.303	1.588	1.936
Comm Cust #	155		182	221	270	329	401	489
Comm Demand	0.083	535	0.097	0.119	0.145	0.176	0.215	0.262
Indust Cust #	0		0	0	0	0	0	0
Indust Demand	0	0	0.000	0.000	0.000	0.000	0.000	0.000
Instit Cust #	0		0	0	0	0	0	0
Instit Demand	0	0	0.000	0.000	0.000	0.000	0.000	0.000
(Service Area Demand) SAD	0.730		0.855	1.043	1.271	1.549	1.889	2.302
Sales to Others	0		0.000	0.000	0.000	0.000	0.000	0.000
Total Cust #	3554		4164	5076	6188	7543	9194	11208
Linear AGR based estimate	**0.730**		**0.855**	**1.043**	**1.271**	**1.549**	**1.889**	**2.302**
Adjusted LWSP SAD + Est Sales Line 39			**0.742**	**0.962**	**1.086**	**1.215**	**1.360**	**1.522**

Enter system name and average daily sale based on 365 (366) days (2-G) from LWSP in beige cells (adjust projections as needed)

Projections for purchasers that have an LWSP should be compared to data in their LWSP (add method of estimation note)

Sales to other systems

	mgd	expire	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
Sales to Others	0		0.000	0.000	0.000	0.000	0.000	0.000

Notes:

Withdrawal Estimations

	% of AvAnn Use							
Source	% of AvAnn Use	**Yield Limit**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Hickory	100%		0.856	1.044	1.272	1.551	1.890	2.304
0	0%		0.000	0.000	0.000	0.000	0.000	0.000
0	0%		0.000	0.000	0.000	0.000	0.000	0.000
0	0.000		0	0	0	0	0	0
0	0.000		0	0	0	0	0	0

Assumptions:

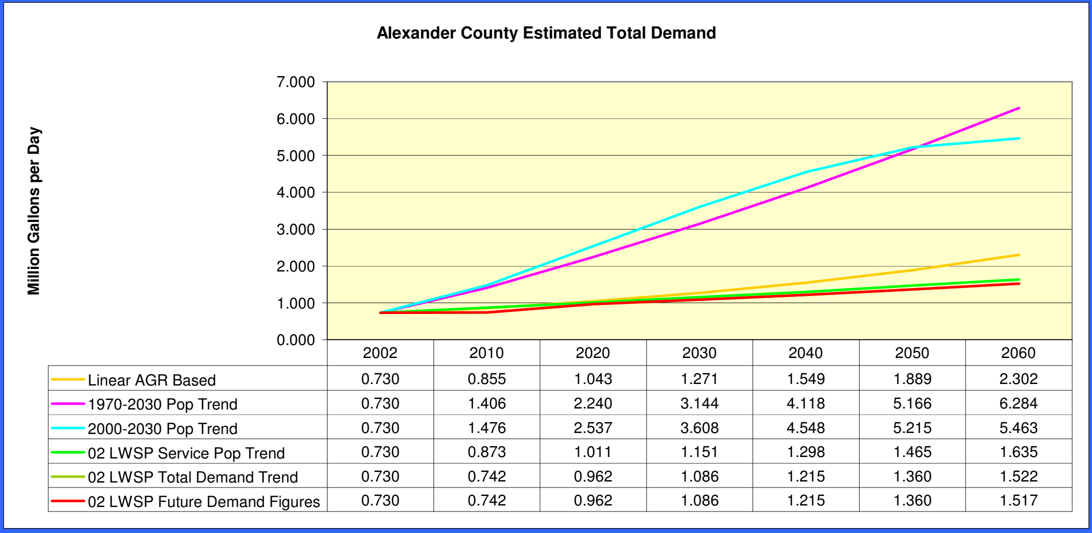
Future Demands 1970-2030 OSP County Pop Trend Equation for Resid Connections								
			8	**18**	**28**	**38**	**48**	**58**
Use Type	**2002**	per connect	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Resid Cust #	3399	2.540	7045	11523	16360	21558	27119	33044
Resid Demand	0.614	181	1.273	2.082	2.955	3.894	4.899	5.969
Comm Cust #	155		182	221	270	329	401	489
Comm Demand	0.083	535	0	0	0	0	0	0
Indust Cust #	0		0	0	0	0	0	0
Indust Demand	0	0	0	0	0	0	0	0
Instit Cust #	0		0	0	0	0	0	0
Instit Demand	0	0	0	0	0	0	0	0
SAD	0.730		1.406	2.240	3.144	4.118	5.166	6.284
Sales to Others	0		0.000	0.000	0.000	0.000	0.000	0.000
Total Cust #	3554		7227	11745	16630	21887	27520	33533
Combined Unacc & Syst Proc	0.04521		0.036	0.04	0.044	0.048	0.053	0.053
1970-2030 Pop Trend	**0.730**		**1.406**	**2.240**	**3.144**	**4.118**	**5.166**	**6.284**

Future Demands 2000-2030 OSP County Pop Trend Equation for Resid Connections for Residential Demand								
			8	**18**	**28**	**38**	**48**	**58**
Use Type	**2002**	per connect	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Resid Cust #	3399	2.540	7,432	13,166	18,932	23,937	27,389	28,497
Resid Demand	0.614	181	1.342	2.378	3.420	4.324	4.948	5.148
Comm Cust #	155		182	221	270	329	401	489
Comm Demand	0.083	535	0	0	0	0	0	0
Indust Cust #	0		0	0	0	0	0	0
Indust Demand	0	0	0	0	0	0	0	0
Instit Cust #	0		0	0	0	0	0	0
Instit Demand	0	0	0	0	0	0	0	0
SAD	0.73		1.476	2.537	3.608	4.548	5.215	5.463
Sales to Others	0		0.000	0.000	0.000	0.000	0.000	0.000
Total Cust #	3554		7613	13387	19202	24266	27790	28986
Combined Unacc & Syst Proc	0.04521		0.036	0.04	0.044	0.048	0.053	0.053
2000-2030 Pop Trend	**0.730**		**1.476**	**2.537**	**3.608**	**4.548**	**5.215**	**5.463**

Estimates of Future Demands based on 02 LWSP Service Pop. Trend Equation for Residential Demand								
			8	**18**	**28**	**38**	**48**	**58**
Use Type	**2002**	per connect	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Resid Cust #	3399	2.540	4094	4716	5330	5943	6626	7309
Resid Demand	0.614	181	0.740	0.852	0.963	1.073	1.197	1.320
Comm Cust #	155		182	221	270	329	401	489
Comm Demand	0.083	535	0	0	0	0	0	0
Indust Cust #	0		0	0	0	0	0	0
Indust Demand	0	0	0	0	0	0	0	0
Instit Cust #	0		0	0	0	0	0	0
Instit Demand	0	0	0	0	0	0	0	0
SAD	0.73		0.873	1.011	1.151	1.298	1.465	1.635
Sales to Others	0		0.000	0.000	0.000	0.000	0.000	0.000
Total Cust #	3554		4276	4938	5600	6272	7027	7798
Combined Unacc & Syst Proc	0.04521		0.036	0.04	0.044	0.048	0.053	0.053
02 LWSP Serv. Pop Trend	**0.730**		**0.873**	**1.011**	**1.151**	**1.298**	**1.465**	**1.635**

Estimates of Future Demands based 2002 LWSP future demand information								
			8	**18**	**28**	**38**	**48**	**58**
Use Type	2002	per connect	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Resid Cust #	3399	2.540	3,908	4,495	5,082	5,691	6,372	7,134
Resid Demand	0.614	181	0.706	0.812	0.918	1.028	1.151	1.289
Comm Cust #	155		0	205	232	260	291	327
Comm Demand	0.083	535	0.000	0.110	0.124	0.139	0.156	0.175
Indust Cust #	0		0	0	0	0	0	0
Indust Demand	0	0	0	0	0	0	0	0
Instit Cust #	0		0	0	0	0	0	0
Instit Demand	0	0	0.000	0.000	0.000	0.000	0.000	0.000
Backwash	0		0.000	0.000	0.000	0.000	0.000	0.000
Unaccounted-for	0.033		0.036	0.040	0.044	0.048	0.053	0.053
SAD	0.730		**0.742**	**0.962**	**1.086**	**1.215**	**1.360**	**1.517**
Sales contracts	0		0.000	0.000	0.000	0.000	0.000	0.000
Total Demand	**0.730**		**0.742**	**0.962**	**1.086**	**1.215**	**1.360**	**1.517**

Estimated Total Demand							
	2002	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Linear AGR Based	0.730	0.855	1.043	1.271	1.549	1.889	2.302
1970-2030 Pop Trend	0.730	1.406	2.240	3.144	4.118	5.166	6.284
2000-2030 Pop Trend	0.730	1.476	2.537	3.608	4.548	5.215	5.463
02 LWSP Service Pop Trend	0.730	0.873	1.011	1.151	1.298	1.465	1.635
02 LWSP Total Demand Trend	0.730	0.742	0.962	1.086	1.215	1.360	1.522
02 LWSP Future Demand Figures	0.730	0.742	0.962	1.086	1.215	1.360	1.517


Alexander County Estimated Total Demand

	2002	2010	2020	2030	2040	2050	2060
Linear AGR Based	0.730	0.855	1.043	1.271	1.549	1.889	2.302
1970-2030 Pop Trend	0.730	1.406	2.240	3.144	4.118	5.166	6.284
2000-2030 Pop Trend	0.730	1.476	2.537	3.608	4.548	5.215	5.463
02 LWSP Service Pop Trend	0.730	0.873	1.011	1.151	1.298	1.465	1.635
02 LWSP Total Demand Trend	0.730	0.742	0.962	1.086	1.215	1.360	1.522
02 LWSP Future Demand Figures	0.730	0.742	0.962	1.086	1.215	1.360	1.517

Owner	Bethlehem WD
System	Bethlehem WD
Facility	
Data Source	2002 LWSP
PWSID #	01-02-035
Data Reference Date	November 15, 2005
Data Source Notes	

2002 LWSP DATA

2002 Water Use Data		Calc from Mo#	
	mgd	mgd	% AvAnnUse
02 AvAnnUse	0.447	0.441	
02 AvAnnDis	0.013	**0.013**	
02 Unacct For	0.041		0.092
02 Sys Process	0		0.000
Combined Unacct and Sys Proc			0.092
# used in demand calc Table #1			**0.09172**

2002 LWSP Demand Projections								**% Increase Per Decade**					
	2002	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
Resid	0.364	0.429	0.507	0.583	0.658	0.744	0.841			0.182	0.150	0.129	0.131
Com	0.042	0.046	0.051	0.056	0.062	0.068	0.075			0.109	0.098	0.107	0.097
Indust	0	0	0	0	0	0	0.000			0.000	0.000	0.000	0.000
Instit	0	0	0	0	0	0	0.000			0.000	0.000	0.000	0.000
Backwash	0	0	0	0	0	0	0.000			0.000	0.000	0.000	0.000
Unacct	0.041	0.045	0.05	0.054	0.058	0.064	0.064			0.111	0.080	0.074	0.103
Sales Contracts	0	0	0	0	0	0	0.000			0.000	0.000	0.000	0.000
Fut Sales Contracts	0	0	0	0	0	0	0			0.000	0.000	0.000	0.000
Total Sales	0	0	0	0	0	0	0			0.000	0.000	0.000	0.000
Total Demand	0.447	0.52	0.608	0.693	0.778	0.876	0.980						

Service Pop relationship to previous period 1.180 1.150 1.130 1.130 1.130

2002 LWSP Demand and Wastewater Tables							
2002 Demand		**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
(6-A Y-R pop)	Service Pop	4,613	5,443	6,423	7,386	8,346	9,431
(7-A 6)	Tot SAD	0.447	0.52	0.608	0.693	0.778	0.876
(7-A 9)	Tot Demand	0.447	0.520	0.608	0.693	0.778	0.876
Total # of connections	Connections	1,865	2,201	2,597	2,986	3,374	3,813

2002 Wastewater		Enter info from 4-B in LWSP in beige cells - NOTE MODEL NODE					
NPDES/Name of Receiver	Permit Cap	Ann Ave Disc	Rec Strm	Sub-basin	% AvAnnDis	% AvAnnUse	Return Node
Hickory	0	0.12			906.46%	27.24%	
#2					0.00%	0.00%	
#3					0.00%	0.00%	
#4					0.00%	0.00%	
#5					0.00%	0.00%	
#6					0.00%	0.00%	
#7					0.00%	0.00%	
Total		**0.12**			9.065	0.272	

	2002 LWSP Demand Projections					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
	5,443	6,423	7,386	8,346	9,431	10,657
Estimated SAD	0.520	0.608	0.693	0.778	0.876	0.986
0.447	0.520	0.608	0.693	0.778	0.876	0.986
	2002 LWSP Wastewater Projections					
	(AvAnnDisch/AvAnnSAD (D46:D52/D41) x Est SAD above L41:Q41)					
Hickory	0.140	0.163	0.186	0.209	0.235	0.265
#2	0.000	0.000	0.000	0.000	0.000	0.000
#3	0.000	0.000	0.000	0.000	0.000	0.000
#4	0.000	0.000	0.000	0.000	0.000	0.000
#5	0.000	0.000	0.000	0.000	0.000	0.000
#6	0.000	0.000	0.000	0.000	0.000	0.000
#7	0.000	0.000	0.000	0.000	0.000	0.000

2002 Source Water Table							
Enter info from 3-A, 3-D, and/or 3-F from LWSP in beige cells				NOTE MODEL NODE			
Source	ADWithdrawa	#days	ADD	Avail Sup	% AvAnnUse		Withdrawal Node
Hickory	0.447	365	0.447	2	1.015		
			0.000		0.000		
			0.000		0.000		
			0.000		0.000		
			0.000		0.000		
Total			0.447	2	1.01		

2002 Monthly Pattern						
Enter monthly average daily use (2-E) and average daily discharge (4-A) from LWSP in beige cells						
Month	2002 Mon Ave Use mgd	2002 % of AAUse	2002 Mon Ave Disch mgd	2002 % of AADisch	Calculated Mon Disch mg	Calculated Mon Use
Jan	0.442	100.33%	0.013	98.20%	0.403	13.702
Feb	0.487	110.54%	0.015	113.31%	0.420	13.636
Mar	0.320	72.64%	0.01	75.54%	0.310	9.920
Apr	0.332	75.36%	0.01	75.54%	0.300	9.960
May	0.363	82.40%	0.011	83.09%	0.341	11.253
Jun	0.412	93.52%	0.012	90.65%	0.360	12.360
Jul	0.602	136.65%	0.018	135.97%	0.558	18.662
Aug	0.546	123.94%	0.016	120.86%	0.496	16.926
Sep	0.565	128.25%	0.017	128.41%	0.510	16.950
Oct	0.471	106.91%	0.014	105.75%	0.434	14.601
Nov	0.418	94.88%	0.013	98.20%	0.390	12.540
Dec	0.332	75.36%	0.01	75.54%	0.310	10.292

Population Projections

County Name: Alexander

County Population

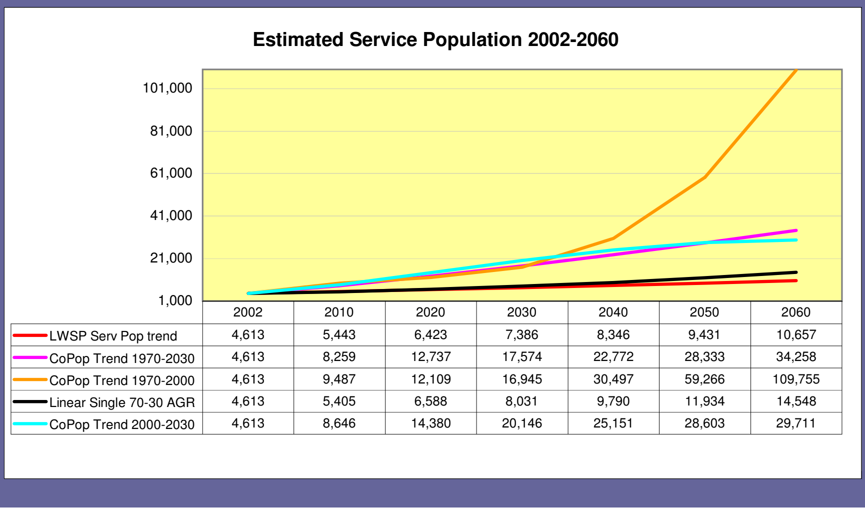
Index Numbers	0	10	20	0 30	10 40	20 50	30 60	
Source	1970	1980	1990	2000	2010	2020	2030	
State Data Center (SDC)	19,466	24,999	27,544	33,603	38,742	44,546	50,223	From County Pop Worksheet
Annual Inc in decade		553.3	254.5	605.9	513.9	580.4	567.7	
AGR from first yr of decade		0.0284	0.0102	0.0220	0.0153	0.0150	0.0127	

Population Comparisons

Index Numbers	SDC 1970-2030	40	50	60	70	80	90	
Index Numbers	SCD 2000-2030	10	20	30	40	50	60	
		2010	2020	2030	2040	2050	2060	
2002 Population by Residential Connectio		5,405	6,588	8,031	9,790	11,934	14,548	Assumed same rate of growth between 2040 and 2050 as
2002 LWSP Service Population		5,443	6,423	7,386	8,346	9,431	10,657	between 2050 and 2060
OSP County Population		38,742	44,546	50,223	38,708	44,342	50,340	Extended using cubic polynomial equation
LWSP Service Pop % of OSP County Pop		0.140493521	0.14418803	0.147064094	0.215614343	0.212690144	0.21170018	
LWSP Service Pop % of FRB County Pop		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	

Service Area Population

Index Numbers	0	8	18	28	38	48	58	
	2002	2010	2020	2030	2040	2050	2060	
LWSP Serv Pop trend	4,613	5,443	6,423	7,386	8,346	9,431	10,657	Linear function based on LWSP Projections
CoPop Trend 1970-2030	4,613	8,259	12,737	17,574	22,772	28,333	34,258	Cubic polynomial equation based on SDC county
CoPop Trend 1970-2000	4,613	9,487	12,109	16,945	30,497	59,266	109,755	population projections
Linear Single 70-30 AGR	4,613	5,405	6,588	8,031	9,790	11,934	14,548	Linear function based on average growth rates
CoPop Trend 2000-2030	4,613	8,646	14,380	20,146	25,151	28,603	29,711	Cubic polynomial equation based on SDC county population projections



	2002	2010	2020	2030	2040	2050	2060
LWSP Serv Pop trend	4,613	5,443	6,423	7,386	8,346	9,431	10,657
CoPop Trend 1970-2030	4,613	8,259	12,737	17,574	22,772	28,333	34,258
CoPop Trend 1970-2000	4,613	9,487	12,109	16,945	30,497	59,266	109,755
Linear Single 70-30 AGR	4,613	5,405	6,588	8,031	9,790	11,934	14,548
CoPop Trend 2000-2030	4,613	8,646	14,380	20,146	25,151	28,603	29,711

DEMAND PROJECTIONS

Enter connection and demand for residential, commercial, industrial and institutional water use (2-D) from LWSP in beige cells

Average Growth Rates	Res/Com AGR	0.02000	0.02000	0.02000	0.02000	0.02000	0.02000	AGR to get from 1970 to 2030 SDC #s from COUNTY POP worksheet
	Inf Adjusted GSPndust/Instit AGR	0.0166	0.0166	0.0166	0.0166	0.0166	0.0166	or NC from HDR's Catawba Water Supply Plan 2004

Estimates of Future Demands based on above AGRs applied to #of Customers * 02 gpd/cust

Use Type	02Con'cts/Dem'd	per connect	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Resid Cust #	1,845	2.500	2,162	2,635	3,212	3,916	4,773	5,818
Resid Demand	0.364	197	0.426	0.520	0.634	0.773	0.942	1.148
Comm Cust #	20		23	29	35	42	52	63
Comm Demand	0.042	2100	0.049	0.060	0.073	0.089	0.109	0.132
Indust Cust #	0		0	0	0	0	0	0
Indust Demand	0	0	0.000	0.000	0.000	0.000	0.000	0.000
Instit Cust #	0		0	0	0	0	0	0
Instit Demand	0	0	0.000	0.000	0.000	0.000	0.000	0.000
(Service Area Demand) SAD	0.447		0.524	0.638	0.778	0.949	1.156	1.410
Sales to Others	0		0.000	0.000	0.000	0.000	0.000	0.000
Total Cust #	1865		2185	2664	3247	3958	4825	5882
Linear AGR based estimate	**0.447**		**0.524**	**0.638**	**0.778**	**0.949**	**1.156**	**1.410**
Adjusted LWSP SAD + Est Sales Line 39			**0.520**	**0.608**	**0.693**	**0.778**	**0.876**	**0.986**

Enter system name and average daily sale based on 365 (366) days (2-G) from LWSP in beige cells (adjust projections as needed)

Projections for purchasers that have an LWSP should be compared to data in their LWSP (add method of estimation note)

Sales to other systems

	mgd	expire	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
Sales to Others	0		0.000	0.000	0.000	0.000	0.000	0.000

Notes:

Withdrawal Estimations

	% of AvAnn Use							
Source	% of AvAnn Use	**Yield Limit**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Hickory	101%		0.531	0.648	0.790	0.963	1.173	1.430
0	0%		0.000	0.000	0.000	0.000	0.000	0.000
0	0%		0.000	0.000	0.000	0.000	0.000	0.000
0	0.000		0	0	0	0	0	0
0	0.000		0	0	0	0	0	0

Assumptions:

Future Demands 1970-2030 OSP County Pop Trend Equation for Resid Connections

			8	18	28	38	48	58
Use Type	2002	per connect	2010	2020	2030	2040	2050	2060
Resid Cust #	1845	2.500	5491	9969	14806	20004	25565	31490
Resid Demand	0.364	197	1.083	1.967	2.921	3.947	5.044	6.213
Comm Cust #	20		23	29	35	42	52	63
Comm Demand	0.042	2100	0	0	0	0	0	0
Indust Cust #	0		0	0	0	0	0	0
Indust Demand	0	0	0	0	0	0	0	0
Instit Cust #	0		0	0	0	0	0	0
Instit Demand	0	0	0	0	0	0	0	0
SAD	0.447		1.178	2.077	3.048	4.094	5.216	6.409
Sales to Others	0		0.000	0.000	0.000	0.000	0.000	0.000
Total Cust #	1865		5515	9998	14841	20046	25616	31553
Combined Unacc & Syst Proc	0.09172		0.045	0.05	0.054	0.058	0.064	0.064
1970-2030 Pop Trend	**0.447**		**1.178**	**2.077**	**3.048**	**4.094**	**5.216**	**6.409**

Future Demands 2000-2030 OSP County Pop Trend Equation for Resid Connections for Residential Demand

			8	18	28	38	48	58
Use Type	2002	per connect	2010	2020	2030	2040	2050	2060
Resid Cust #	1845	2.500	5,878	11,612	17,378	22,383	25,835	26,943
Resid Demand	0.364	197	1.160	2.291	3.428	4.416	5.097	5.316
Comm Cust #	20		23	29	35	42	52	63
Comm Demand	0.042	2100	0	0	0	0	0	0
Indust Cust #	0		0	0	0	0	0	0
Indust Demand	0	0	0	0	0	0	0	0
Instit Cust #	0		0	0	0	0	0	0
Instit Demand	0	0	0	0	0	0	0	0
SAD	0.447		1.254	2.401	3.556	4.563	5.270	5.512
Sales to Others	0		0.000	0.000	0.000	0.000	0.000	0.000
Total Cust #	1865		5901	11641	17413	22425	25887	27007
Combined Unacc & Syst Proc	0.09172		0.045	0.05	0.054	0.058	0.064	0.064
2000-2030 Pop Trend	**0.447**		**1.254**	**2.401**	**3.556**	**4.563**	**5.270**	**5.512**

Estimates of Future Demands based on 02 LWSP Service Pop. Trend Equation for Residential Demand

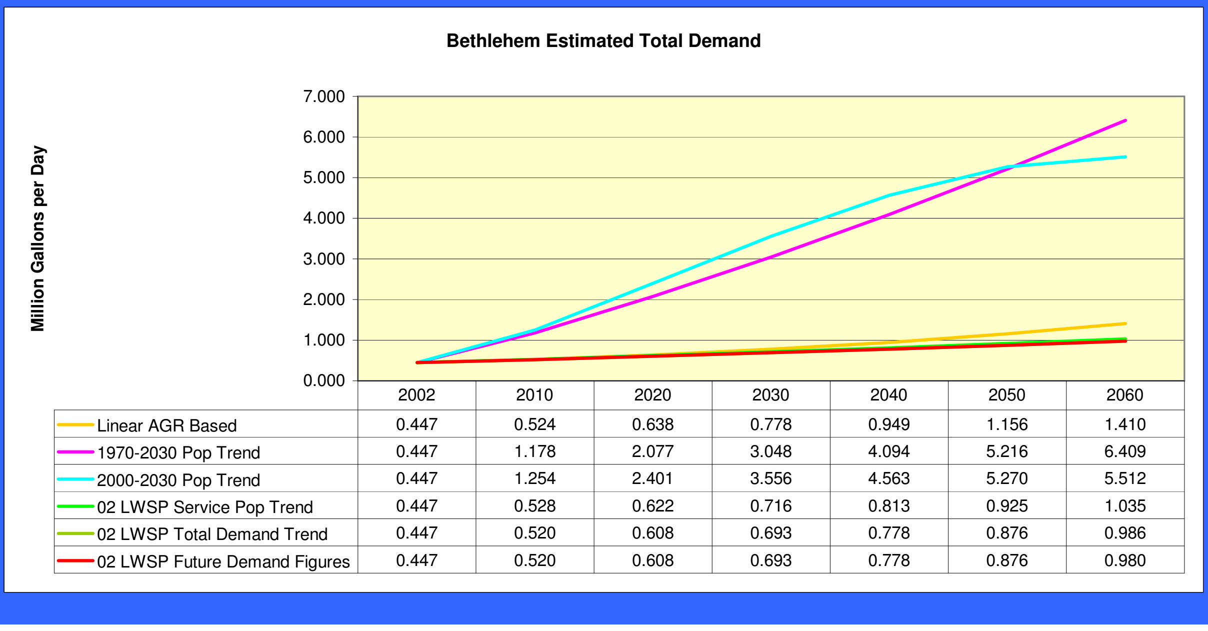
			8	18	28	38	48	58
Use Type	2002	per connect	2010	2020	2030	2040	2050	2060
Resid Cust #	1845	2.500	2201	2597	2986	3374	3813	4252
Resid Demand	0.364	197	0.434	0.512	0.589	0.666	0.752	0.839
Comm Cust #	20		23	29	35	42	52	63
Comm Demand	0.042	2100	0	0	0	0	0	0
Indust Cust #	0		0	0	0	0	0	0
Indust Demand	0	0	0	0	0	0	0	0
Instit Cust #	0		0	0	0	0	0	0
Instit Demand	0	0	0	0	0	0	0	0
SAD	0.447		0.528	0.622	0.716	0.813	0.925	1.035
Sales to Others	0		0.000	0.000	0.000	0.000	0.000	0.000
Total Cust #	1865		2224	2625	3021	3417	3865	4315
Combined Unacc & Syst Proc	0.09172		0.045	0.05	0.054	0.058	0.064	0.064
02 LWSP Serv. Pop Trend	**0.447**		**0.528**	**0.622**	**0.716**	**0.813**	**0.925**	**1.035**

Estimates of Future Demands based 2002 LWSP future demand information

			8	18	28	38	48	58
Use Type	2002	per connect	2010	2020	2030	2040	2050	2060
Resid Cust #	1845	2.500	2,174	2,570	2,955	3,335	3,771	4,264
Resid Demand	0.364	197	0.429	0.507	0.583	0.658	0.744	0.841
Comm Cust #	20		22	24	27	30	32	36
Comm Demand	0.042	2100	0.046	0.051	0.056	0.062	0.068	0.075
Indust Cust #	0		0	0	0	0	0	0
Indust Demand	0	0	0	0	0	0	0	0
Instit Cust #	0		0	0	0	0	0	0
Instit Demand	0	0	0.000	0.000	0.000	0.000	0.000	0.000
Backwash	0		0.000	0.000	0.000	0.000	0.000	0.000
Unaccounted-for	0.041		0.045	0.050	0.054	0.058	0.064	0.064
SAD	0.447		**0.520**	**0.608**	**0.693**	**0.778**	**0.876**	**0.980**
Sales contracts	0		0.000	0.000	0.000	0.000	0.000	0.000
Total Demand	**0.447**		**0.520**	**0.608**	**0.693**	**0.778**	**0.876**	**0.980**

Estimated Total Demand

	2002	2010	2020	2030	2040	2050	2060
Linear AGR Based	0.447	0.524	0.638	0.778	0.949	1.156	1.410
1970-2030 Pop Trend	0.447	1.178	2.077	3.048	4.094	5.216	6.409
2000-2030 Pop Trend	0.447	1.254	2.401	3.556	4.563	5.270	5.512
02 LWSP Service Pop Trend	0.447	0.528	0.622	0.716	0.813	0.925	1.035
02 LWSP Total Demand Trend	0.447	0.520	0.608	0.693	0.778	0.876	0.986
02 LWSP Future Demand Figures	0.447	0.520	0.608	0.693	0.778	0.876	0.980



Owner	Energy United
System	Energy United
Facility	
Data Source	2002 LWSP
PWSID #	01-02-015
Data Reference Date	November 15, 2005
Data Source Notes	

2002 LWSP DATA

2002 Water Use Data		Calc from Mo#	
	mgd	mgd	% AvAnnUse
02 AvAnnUse	1.706	1.471	
02 AvAnnDis	0.06258333	**0.063**	
02 Unacct For	0.304		0.178
02 Sys Process	0.05		0.029
Combined Unacct and Sys Proc			0.208
# used in demand calc Table #1			**0.20750**

2002 LWSP Demand Projections								**% Increase Per Decade**					
	2002	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
Resid	0.485	0.65	0.91	1.1	1.4	1.7	2.064			0.400	0.209	0.273	0.214
Com	0.03	0.04	0.06	0.08	0.1	0.12	0.144			0.500	0.333	0.250	0.200
Indust	0.1	0.15	0.2	0.25	0.3	0.35	0.408			0.333	0.250	0.200	0.167
Instit	0.04	0.06	0.08	0.1	0.12	0.14	0.163			0.333	0.250	0.200	0.167
Backwash	0.05	0.075	0.01	0.015	0.018	0.02	0.020			-0.867	0.500	0.200	0.111
Unacct	0.304	0.45	0.6	0.8	1	1.2	1.200			0.333	0.333	0.250	0.200
Sales Contracts	1.544	1.544	1.544	1.544	1.544	1.544	1.544			0.000	0.000	0.000	0.000
Fut Sales Contracts	0	0.9	0.9	0.9	0.5	0	0			0.000	0.000	-0.444	-1.000
Total Sales	1.544	2.444	2.444	2.444	2.044	1.544	1.544			0.000	0.000	-0.164	-0.245
Total Demand	2.553	3.869	4.304	4.789	4.982	5.074	5.544						

Service Pop relationship to previous period 1.400 1.286 1.222 1.182 1.182

2002 LWSP Demand and Wastewater Tables							
2002 Demand		**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
(6-A Y-R pop)	Service Pop	9,906	12,600	17,640	22,680	27,720	32,760
(7-A 6)	Tot SAD	1.009	1.425	1.86	2.345	2.938	3.53
(7-A 9)	Tot Demand	2.553	3.869	4.304	4.789	4.982	5.074
Total # of connections	Connections	3,931	5,000	7,000	9,000	11,000	13,000

	2002 LWSP Demand Projections					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
	12,600	17,640	22,680	27,720	32,760	38,716
Estimated SAD	1.425	1.860	2.345	2.938	3.530	4.241
1.706	3.869	4.304	4.789	4.982	5.074	5.168

2002 Wastewater		Enter info from 4-B in LWSP in beige cells - NOTE MODEL NODE					
NPDES/Name of Receiver	Permit Cap	Ann Ave Disc	Rec Strm	Sub-basin	% AvAnnDis	% AvAnnUse	Return Node
#1					0.00%	0.00%	
#2					0.00%	0.00%	
#3					0.00%	0.00%	
#4					0.00%	0.00%	
#5					0.00%	0.00%	
#6					0.00%	0.00%	
#7					0.00%	0.00%	
Total		0			0.000	0.000	

	2002 LWSP Wastewater Projections					
	(AvAnnDisch/AvAnnSAD (D46:D52/D41) x Est SAD above L41:Q41)					
#1	0.000	0.000	0.000	0.000	0.000	0.000
#2	0.000	0.000	0.000	0.000	0.000	0.000
#3	0.000	0.000	0.000	0.000	0.000	0.000
#4	0.000	0.000	0.000	0.000	0.000	0.000
#5	0.000	0.000	0.000	0.000	0.000	0.000
#6	0.000	0.000	0.000	0.000	0.000	0.000
#7	0.000	0.000	0.000	0.000	0.000	0.000

2002 Source Water Table							
Enter info from 3-A, 3-D, and/or 3-F from LWSP in beige cells				NOTE MODEL NODE			
Source	ADWithdrawa	#days	ADD	Avail Sup	% AvAnnUse		Withdrawal Node
South Yadkin River	1.6	365	1.600	2	1.088		
Alexander County	0.106	365	0.106	0	0.072		
			0.000		0.000		
			0.000		0.000		
			0.000		0.000		
Total			1.706	2	1.16		

2002 Monthly Pattern						
Enter monthly average daily use (2-E) and average daily discharge (4-A) from LWSP in beige cells						
Month	2002 Mon Ave Use mgd	2002 % of AAUse	2002 Mon Ave Disch mgd	2002 % of AADisch	Calculated Mon Disch mg	Calculated Mon Use
Jan	1.382	93.93%	0.067	107.16%	2.077	42.842
Feb	1.413	96.04%	0.066	105.56%	1.848	39.564
Mar	1.382	93.93%	0.06	95.96%	1.860	42.842
Apr	1.506	102.36%	0.071	113.56%	2.130	45.180
May	1.523	103.52%	0.06	95.96%	1.860	47.213
Jun	1.653	112.35%	0.064	102.36%	1.920	49.590
Jul	1.376	93.53%	0.054	86.37%	1.674	42.656
Aug	0.829	56.35%	0.046	73.57%	1.426	25.699
Sep	1.609	109.36%	0.056	89.57%	1.680	48.270
Oct	1.682	114.33%	0.062	99.16%	1.922	52.142
Nov	1.729	117.52%	0.071	113.56%	2.130	51.870
Dec	1.585	107.73%	0.074	118.36%	2.294	49.135

Population Projections

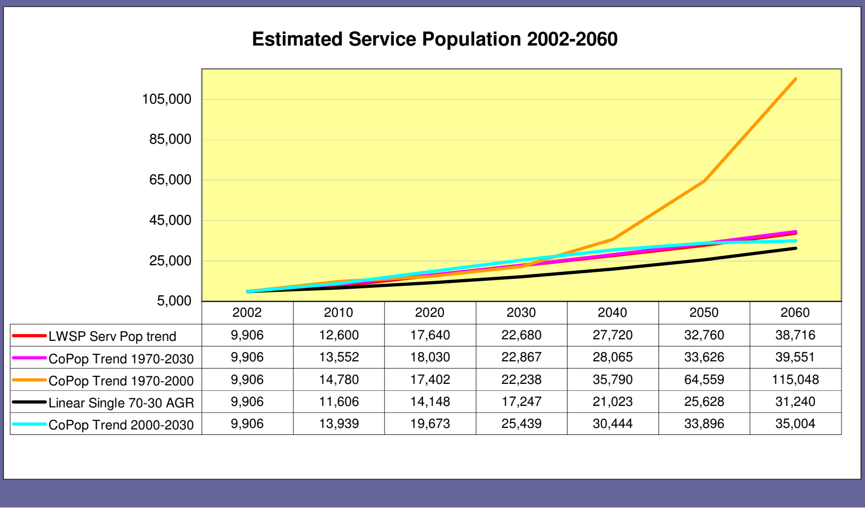
County Name:	Alexander

County Population								
Index Numbers				0	10	20	30	
	0	10	20	30	40	50	60	
Source	1970	1980	1990	2000	2010	2020	2030	
State Data Center (SDC)	19,466	24,999	27,544	33,603	38,742	44,546	50,223	From County Pop Worksheet
Annual Inc in decade		553.3	254.5	605.9	513.9	580.4	567.7	
AGR from first yr of decade		0.0284	0.0102	0.0220	0.0153	0.0150	0.0127	

Population Comparisons							
Index Numbers SDC 1970-2030	40	50	60	70	80	90	
Index Numbers SDC 2000-2030	10	20	30	40	50	60	
	2010	2020	2030	2040	2050	2060	
2002 Population by Residential Connectio	11,606	14,148	17,247	21,023	25,628	31,240	Assumed same rate of growth between 2040 and 2050 as between 2050 and 2060
2002 LWSP Service Population	12,600	17,640	22,680	27,720	32,760	38,716	
SDC County Population	38,742	44,546	50,223	38,708	44,342	50,340	Extended using cubic polynomial equation
LWSP Service Pop % of SDC County Pop	0.325228434	0.395995151	0.451585927	0.716131032	0.738811272	0.769092681	

Service Area Population

Index Numbers	0	8	18	28	38	48	58	
	2002	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	
LWSP Serv Pop trend	9,906	12,600	17,640	22,680	27,720	32,760	38,716	Linear function based on LWSP Projections
CoPop Trend 1970-2030	9,906	13,552	18,030	22,867	28,065	33,626	39,551	Cubic polynomial equation based on SDC county population projections
CoPop Trend 1970-2000	9,906	14,780	17,402	22,238	35,790	64,559	115,048	
Linear Single 70-30 AGR	9,906	11,606	14,148	17,247	21,023	25,628	31,240	Linear function based on average growth rates
CoPop Trend 2000-2030	9,906	13,939	19,673	25,439	30,444	33,896	35,004	Cubic polynomial equation based on SDC county population projections



	2002	2010	2020	2030	2040	2050	2060
LWSP Serv Pop trend	9,906	12,600	17,640	22,680	27,720	32,760	38,716
CoPop Trend 1970-2030	9,906	13,552	18,030	22,867	28,065	33,626	39,551
CoPop Trend 1970-2000	9,906	14,780	17,402	22,238	35,790	64,559	115,048
Linear Single 70-30 AGR	9,906	11,606	14,148	17,247	21,023	25,628	31,240
CoPop Trend 2000-2030	9,906	13,939	19,673	25,439	30,444	33,896	35,004

DEMAND PROJECTIONS

Enter connection and demand for residential, commercial, industrial and institutional water use (2-D) from LWSP in beige cells

Average Growth Rates			2010	2020	2030	2040	2050	2060
	Res/Com AGR		0.02000	0.02000	0.02000	0.02000	0.02000	0.02000
	Inf Adjusted GSPndust/Instit AGR		**0.0166**	**0.0166**	**0.0166**	**0.0166**	**0.0166**	**0.0166**

AGR to get from 1970 to 2030 SDC #s from COUNTY POP worksheet
or NC from HDR's Catawba Water Supply Plan 2004

Estimates of Future Demands based on above AGRs applied to #of Customers * 02 gpd/cust

Use Type	02Con'cts/Dem'd	per connect	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Resid Cust #	3,706	2.673	4,342	5,293	6,452	7,865	9,588	11,687
Resid Demand	0.485	131	0.568	0.693	0.844	1.029	1.255	1.530
Comm Cust #	200		234	286	348	424	517	631
Comm Demand	0.03	150	0.035	0.043	0.052	0.064	0.078	0.095
Indust Cust #	20		23	27	32	37	44	52
Indust Demand	0.1	5000	0.114	0.134	0.159	0.187	0.220	0.260
Instit Cust #	5		6	7	8	9	11	13
Instit Demand	0.04	8000	0.046	0.054	0.063	0.075	0.088	0.104
(Service Area Demand) SAD	0.655		1.177	1.426	1.729	2.097	2.543	3.084
Sales to Others	0.697		0.817	0.995	1.213	1.479	1.803	2.198
Total Cust #	3931		4605	5612	6840	8336	10160	12383
Linear AGR based estimate	**1.352**		**1.993**	**2.422**	**2.943**	**3.576**	**4.346**	**5.282**
Adjusted LWSP SAD + Est Sales Line 39			**2.242**	**2.855**	**3.558**	**4.417**	**5.333**	**6.439**

Enter system name and average daily sale based on 365 (366) days (2-G) from LWSP in beige cells (adjust projections as needed)

Projections for purchasers that have an LWSP should be compared to data in their LWSP (add method of estimation note)

Sales to other systems

	mgd	expire	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
West Irdell Water Corp.	0.242		0.284	0.346	0.421	0.514	0.626	0.763
Town of Taylorsville	0.411		0.482	0.587	0.716	0.872	1.063	1.296
Iredell Water Corp.	0.044		0.052	0.063	0.077	0.093	0.114	0.139
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
Sales to Others	0.697		0.817	0.995	1.213	1.479	1.803	2.198

Notes:

Withdrawal Estimations

	% of AvAnn Use							
Source	% of AvAnn Use	**Yield Limit**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
South Yadkin River	109%		2.168	2.634	3.200	3.889	4.726	5.744
Alexander County	7%		0.144	0.174	0.212	0.258	0.313	0.381
0	0%		0.000	0.000	0.000	0.000	0.000	0.000
0	0.000		0	0	0	0	0	0
0	0.000		0	0	0	0	0	0

Assumptions:

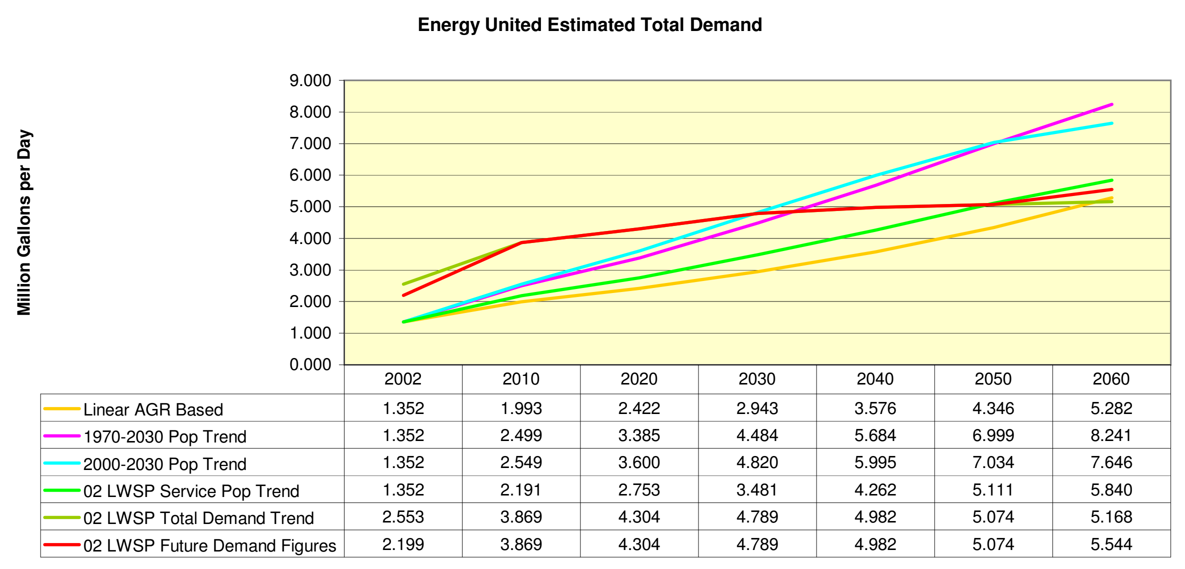
Future Demands 1970-2030 OSP County Pop Trend Equation for Resid Connections								
			8	18	28	38	48	58
Use Type	2002	per connect	2010	2020	2030	2040	2050	2060
Resid Cust #	3706	2.673	7352	11830	16667	21865	27426	33351
Resid Demand	0.485	131	0.962	1.548	2.181	2.861	3.589	4.365
Comm Cust #	200		234	286	348	424	517	631
Comm Demand	0.03	150	0	0	0	0	0	0
Indust Cust #	20		23	27	32	37	44	52
Indust Demand	0.1	5000	0	0	0	0	0	0
Instit Cust #	5		6	7	8	9	11	13
Instit Demand	0.04	8000	0	0	0	0	0	0
SAD	0.655		1.682	2.389	3.270	4.205	5.195	6.043
Sales to Others	0.697		0.817	0.995	1.213	1.479	1.803	2.198
Total Cust #	3931		7615	12150	17055	22336	27998	34047
Combined Unacc & Syst Proc	0.20750		0.525	0.61	0.815	1.018	1.22	1.22
1970-2030 Pop Trend	**1.352**		**2.499**	**3.385**	**4.484**	**5.684**	**6.999**	**8.241**

Future Demands 2000-2030 OSP County Pop Trend Equation for Resid Connections for Residential Demand								
			8	18	28	38	48	58
Use Type	2002	per connect	2010	2020	2030	2040	2050	2060
Resid Cust #	3706	2.673	7,739	13,473	19,239	24,244	27,696	28,804
Resid Demand	0.485	131	1.013	1.763	2.518	3.173	3.625	3.770
Comm Cust #	200		234	286	348	424	517	631
Comm Demand	0.03	150	0	0	0	0	0	0
Indust Cust #	20		23	27	32	37	44	52
Indust Demand	0.1	5000	0	0	0	0	0	0
Instit Cust #	5		6	7	8	9	11	13
Instit Demand	0.04	8000	0	0	0	0	0	0
SAD	0.655		1.733	2.604	3.607	4.516	5.231	5.448
Sales to Others	0.697		0.817	0.995	1.213	1.479	1.803	2.198
Total Cust #	3931		8002	13792	19627	24715	28269	29500
Combined Unacc & Syst Proc	0.20750		0.525	0.61	0.815	1.018	1.22	1.22
2000-2030 Pop Trend	**1.352**		**2.549**	**3.600**	**4.820**	**5.995**	**7.034**	**7.646**

Estimates of Future Demands based on 02 LWSP Service Pop. Trend Equation for Residential Demand								
			8	18	28	38	48	58
Use Type	2002	per connect	2010	2020	2030	2040	2050	2060
Resid Cust #	3706	2.673	5000	7000	9000	11000	13000	15000
Resid Demand	0.485	131	0.654	0.916	1.178	1.440	1.701	1.963
Comm Cust #	200		234	286	348	424	517	631
Comm Demand	0.03	150	0	0	0	0	0	0
Indust Cust #	20		23	27	32	37	44	52
Indust Demand	0.1	5000	0	0	0	0	0	0
Instit Cust #	5		6	7	8	9	11	13
Instit Demand	0.04	8000	0	0	0	0	0	0
SAD	0.655		1.374	1.757	2.267	2.783	3.307	3.641
Sales to Others	0.697		0.817	0.995	1.213	1.479	1.803	2.198
Total Cust #	3931		5263	7319	9388	11471	13573	15696
Combined Unacc & Syst Proc	0.20750		0.525	0.61	0.815	1.018	1.22	1.22
02 LWSP Serv. Pop Trend	**1.352**		**2.191**	**2.753**	**3.481**	**4.262**	**5.111**	**5.840**

Estimates of Future Demands based 2002 LWSP future demand information								
			8	18	28	38	48	58
Use Type	2002	per connect	2010	2020	2030	2040	2050	2060
Resid Cust #	3706	2.673	4,967	6,954	8,405	10,698	12,990	15,774
Resid Demand	0.485	131	0.650	0.910	1.100	1.400	1.700	2.064
Comm Cust #	200		267	400	533	667	800	960
Comm Demand	0.03	150	0.040	0.060	0.080	0.100	0.120	0.144
Indust Cust #	20		30	40	50	60	70	81.66666667
Indust Demand	0.1	5000	0	0	0	0	0	0
Instit Cust #	5		8	10	13	15	18	20
Instit Demand	0.04	8000	0.060	0.080	0.100	0.120	0.140	0.163
Backwash	0.05		0.075	0.010	0.015	0.018	0.020	0.020
Unaccounted-for	0.304		0.450	0.600	0.800	1.000	1.200	1.200
SAD	0.655		**1.425**	**1.860**	**2.345**	**2.938**	**3.530**	**4.000**
Sales contracts	1.544		2.444	2.444	2.444	2.044	1.544	1.544
Total Demand	**2.199**		**3.869**	**4.304**	**4.789**	**4.982**	**5.074**	**5.544**

Estimated Total Demand							
	2002	2010	2020	2030	2040	2050	2060
Linear AGR Based	1.352	1.993	2.422	2.943	3.576	4.346	5.282
1970-2030 Pop Trend	1.352	2.499	3.385	4.484	5.684	6.999	8.241
2000-2030 Pop Trend	1.352	2.549	3.600	4.820	5.995	7.034	7.646
02 LWSP Service Pop Trend	1.352	2.191	2.753	3.481	4.262	5.111	5.840
02 LWSP Total Demand Trend	2.553	3.869	4.304	4.789	4.982	5.074	5.168
02 LWSP Future Demand Figures	2.199	3.869	4.304	4.789	4.982	5.074	5.544



	2002	2010	2020	2030	2040	2050	2060
Linear AGR Based	1.352	1.993	2.422	2.943	3.576	4.346	5.282
1970-2030 Pop Trend	1.352	2.499	3.385	4.484	5.684	6.999	8.241
2000-2030 Pop Trend	1.352	2.549	3.600	4.820	5.995	7.034	7.646
02 LWSP Service Pop Trend	1.352	2.191	2.753	3.481	4.262	5.111	5.840
02 LWSP Total Demand Trend	2.553	3.869	4.304	4.789	4.982	5.074	5.168
02 LWSP Future Demand Figures	2.199	3.869	4.304	4.789	4.982	5.074	5.544

Owner	Taylorsville
System	Taylorsville
Facility	
Data Source	2002 LWSP
PWSID #	01-02-010
Data Reference Date	November 15, 2005
Data Source Notes	

2002 LWSP DATA

2002 Water Use Data		Calc from Mo#	
	mgd	mgd	% AvAnnUse
02 AvAnnUse	0.831	0.414	
02 AvAnnDis	0.29766667	**0.298**	
02 Unacct For	0.382		0.460
02 Sys Process	0		0.000
Combined Unacct and Sys Proc			0.460
# used in demand calc Table #1			**0.45969**

2002 LWSP Demand Projections								**% Increase Per Decade**					
	2002	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
Resid	0.206	0.21	0.22	0.23	0.24	0.25	0.260			0.048	0.045	0.043	0.042
Com	0.05	0.05	0.05	0.05	0.05	0.05	0.050			0.000	0.000	0.000	0.000
Indust	0.163	0.163	0.163	0.163	0.163	0.163	0.163			0.000	0.000	0.000	0.000
Instit	0.005	0.005	0.005	0.005	0.005	0.005	0.005			0.000	0.000	0.000	0.000
Backwash	0	0	0	0	0	0	0.000			0.000	0.000	0.000	0.000
Unacct	0.382	0.1	0.1	0.1	0.1	0.1	0.100			0.000	0.000	0.000	0.000
Sales Contracts	0.025	0.025	0.025	0.025	0.025	0.025	0.025			0.000	0.000	0.000	0.000
Fut Sales Contracts	0	0	0	0	0	0	0			0.000	0.000	0.000	0.000
Total Sales	0.025	0.025	0.025	0.025	0.025	0.025	0.025			0.000	0.000	0.000	0.000
Total Demand	0.831	0.553	0.563	0.573	0.583	0.593	0.603						

Service Pop relationship to previous period 1.048 1.045 1.043 1.042 1.042

2002 LWSP Demand and Wastewater Tables								
2002 Demand		**2002**	**2010**	**2020**	**2030**	**2040**	**2050**	
(6-A Y-R pop)	Service Pop	2,000	2,100	2,200	2,300	2,400	2,500	
(7-A 6)	Tot SAD	0.806	0.528	0.538	0.548	0.558	0.568	
(7-A 9)	Tot Demand	0.831	0.553	0.563	0.573	0.583	0.593	
Total # of connections	Connections	1,122	1,178	1,234	1,290	1,346	1,403	
2002 Wastewater		Enter info from 4-B in LWSP in beige cells - NOTE MODEL NODE						
NPDES/Name of Receiver	Permit Cap	Ann Ave Disc	Rec Strm	Sub-basin	% AvAnnDis	% AvAnnUse	Return Node	
NC 0026271	0.83	0.298	Lower Little Ri	Catawba Riv	99.87%	72.01%		
#2					0.00%	0.00%		
#3					0.00%	0.00%		
#4					0.00%	0.00%		
#5					0.00%	0.00%		
#6					0.00%	0.00%		
#7					0.00%	0.00%		
Total		**0.298**			0.999	0.720		

	2002 LWSP Demand Projections					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
	2,100	2,200	2,300	2,400	2,500	2,604
Estimated SAD	0.528	0.538	0.548	0.558	0.568	0.578
0.831	0.553	0.563	0.573	0.583	0.593	0.603
	2002 LWSP Wastewater Projections					
	(AvAnnDisch/AvAnnSAD (D46:D52/D41) x Est SAD above L41:Q41)					
NC 0026271	0.195	0.199	0.203	0.206	0.210	0.214
#2	0.000	0.000	0.000	0.000	0.000	0.000
#3	0.000	0.000	0.000	0.000	0.000	0.000
#4	0.000	0.000	0.000	0.000	0.000	0.000
#5	0.000	0.000	0.000	0.000	0.000	0.000
#6	0.000	0.000	0.000	0.000	0.000	0.000
#7	0.000	0.000	0.000	0.000	0.000	0.000

2002 Source Water Table							
Enter info from 3-A, 3-D, and/or 3-F from LWSP in beige cells				NOTE MODEL NODE			
Source	ADWithdrawa	#days	ADD	Avail Sup	% AvAnnUse		Withdrawal Node
Energy United	0.411	365	0.411	0.5	0.993		
Hickory	0.42	365	0.420	0.5	1.015		
			0.000		0.000		
			0.000		0.000		
			0.000		0.000		
Total			0.831	1	2.01		

2002 Monthly Pattern						
Enter monthly average daily use (2-E) and average daily discharge (4-A) from LWSP in beige cells						
Month	2002 Mon Ave Use mgd	2002 % of AAUse	2002 Mon Ave Disch mgd	2002 % of AADisch	Calculated Mon Disch mg	Calculated Mon Use
Jan	0.340	82.16%	0.166	55.63%	5.146	10.540
Feb	0.320	77.33%	0.165	55.30%	4.620	8.960
Mar	0.300	72.49%	0.239	80.10%	7.409	9.300
Apr	0.490	118.40%	0.246	82.44%	7.380	14.700
May	0.210	50.74%	0.262	87.81%	8.122	6.510
Jun	0.380	91.82%	0.247	82.78%	7.410	11.400
Jul	0.460	111.16%	0.233	78.09%	7.223	14.260
Aug	0.670	161.90%	0.406	136.07%	12.586	20.770
Sep	0.370	89.41%	0.415	139.08%	12.450	11.100
Oct	0.440	106.32%	0.381	127.69%	11.811	13.640
Nov	0.510	123.24%	0.419	140.42%	12.570	15.300
Dec	0.470	113.57%	0.393	131.71%	12.183	14.570

Population Projections

County Name: Alexander

County Population							
Index Numbers	0	10	20	0 30	10 40	20 50	30 60
Source	1970	1980	1990	2000	2010	2020	2030
State Data Center (SDC)	19,466	24,999	27,544	33,603	38,742	44,546	50,223
Annual Inc in decade		553.3	254.5	605.9	513.9	580.4	567.7
AGR from first yr of decade		0.0284	0.0102	0.0220	0.0153	0.0150	0.0127

From County Pop Worksheet

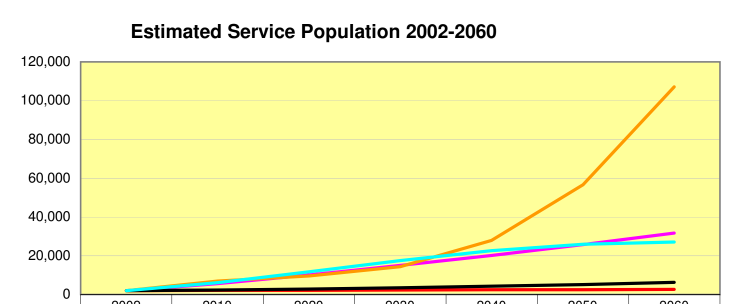
Population Comparisons							
Index Numbers	SDC 1970-2030	40	50	60	70	80	90
Index Numbers	SDC 2000-2030	10	20	30	40	50	60
		2010	2020	2030	2040	2050	2060
2002 Population by Residential Connectio		2,343	2,856	3,482	4,245	5,174	6,307
2002 LWSP Service Population		2,100	2,200	2,300	2,400	2,500	2,604
OSP County Population		38,742	44,546	50,223	38,708	44,342	50,340
LWSP Service Pop % of SDC County Pop		0.054204739	0.04938715	0.045795751	0.062002687	0.056380592	0.051731241

Assumed same rate of growth between 2040 and 2050 as between 2050 and 2060

Extended using cubic polynomial equation

Service Area Population

Index Numbers	0	8	18	28	38	48	58	
	2002	2010	2020	2030	2040	2050	2060	
LWSP Serv Pop trend	2,000	2,100	2,200	2,300	2,400	2,500	2,604	Linear function based on LWSP Projections
CoPop Trend 1970-2030	2,000	5,646	10,124	14,961	20,159	25,720	31,645	Cubic polynomial equation based on SDC county population projections
CoPop Trend 1970-2000	2,000	6,874	9,496	14,332	27,884	56,653	107,142	
Linear Single 70-30 AGR	2,000	2,343	2,856	3,482	4,245	5,174	6,307	Linear function based on average growth rates
CoPop Trend 2000-2030	2,000	6,033	11,767	17,533	22,538	25,990	27,098	Cubic polynomial equation based on SDC county population projections



	2002	2010	2020	2030	2040	2050	2060
LWSP Serv Pop trend	2,000	2,100	2,200	2,300	2,400	2,500	2,604
CoPop Trend 1970-2030	2,000	5,646	10,124	14,961	20,159	25,720	31,645
CoPop Trend 1970-2000	2,000	6,874	9,496	14,332	27,884	56,653	107,142
Linear Single 70-30 AGR	2,000	2,343	2,856	3,482	4,245	5,174	6,307
CoPop Trend 2000-2030	2,000	6,033	11,767	17,533	22,538	25,990	27,098

DEMAND PROJECTIONS

Enter connection and demand for residential, commercial, industrial and institutional water use (2-D) from LWSP in beige cells

Average Growth Rates	Res/Com AGR	0.02000	0.02000	0.02000	0.02000	0.02000	0.02000	AGR to get from 1970 to 2030 SDC #s from COUNTY POP worksheet
	Inf Adjusted GSPndust/Instit AGR	**0.0166**	**0.0166**	**0.0166**	**0.0166**	**0.0166**	**0.0166**	or NC from HDR's Catawba Water Supply Plan 2004

Estimates of Future Demands based on above AGRs applied to #of Customers * 02 gpd/cust

Use Type	02Con'cts/Dem'd	per connect	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Resid Cust #	900	2.222	1,054	1,285	1,567	1,910	2,328	2,838
Resid Demand	0.205	228	0.240	0.293	0.357	0.435	0.530	0.646
Comm Cust #	190		223	271	331	403	492	599
Comm Demand	0.05	263	0.059	0.071	0.087	0.106	0.129	0.158
Indust Cust #	12		14	16	19	22	26	31
Indust Demand	0.163	13583	0.186	0.219	0.258	0.305	0.359	0.424
Instit Cust #	20		23	27	32	37	44	52
Instit Demand	0.005	250	0.006	0.007	0.008	0.009	0.011	0.013
(Service Area Demand) SAD	0.804		0.933	1.123	1.352	1.628	1.961	2.363
Sales to Others	0.025		0.029	0.036	0.044	0.053	0.065	0.079
Total Cust #	1122		1314	1600	1948	2373	2890	3521
Linear AGR based estimate	**0.829**		**0.962**	**1.158**	**1.395**	**1.681**	**2.026**	**2.442**
Adjusted LWSP SAD + Est Sales Line 39			**0.557**	**0.574**	**0.592**	**0.611**	**0.633**	**0.657**

Enter system name and average daily sale based on 365 (366) days (2-G) from LWSP in beige cells (adjust projections as needed)

Projections for purchasers that have an LWSP should be compared to data in their LWSP (add method of estimation note)

Sales to other systems

	mgd	expire	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Sugar Loaf (Alexander Co.)	0.025		0.029	0.036	0.044	0.053	0.065	0.079
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
			0.000	0.000	0.000	0.000	0.000	0.000
Sales to Others	0.025		0.029	0.036	0.044	0.053	0.065	0.079

Notes:

Withdrawal Estimations

	% of AvAnn Use							
Source	% of AvAnn Use	**Yield Limit**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Energy United	99%		0.955	1.150	1.386	1.670	2.012	2.425
Hickory	101%		0.976	1.176	1.416	1.706	2.056	2.479
0	0%		0.000	0.000	0.000	0.000	0.000	0.000
0	0.000		0	0	0	0	0	0
0	0.000		0	0	0	0	0	0

Assumptions:

Future Demands 1970-2030 OSP County Pop Trend Equation for Resid Connections

			8	18	28	38	48	58
Use Type	2002	per connect	2010	2020	2030	2040	2050	2060
Resid Cust #	900	2.222	4546	9024	13861	19059	24620	30545
Resid Demand	0.205	228	1.036	2.056	3.157	4.341	5.608	6.958
Comm Cust #	190		223	271	331	403	492	599
Comm Demand	0.05	263	0	0	0	0	0	0
Indust Cust #	12		14	16	19	22	26	31
Indust Demand	0.163	13583	0	0	0	0	0	0
Instit Cust #	20		23	27	32	37	44	52
Instit Demand	0.005	250	0	0	0	0	0	0
SAD	0.804		1.386	2.453	3.611	4.861	6.207	7.652
Sales to Others	0.025		0.029	0.036	0.044	0.053	0.065	0.079
Total Cust #	1122		4806	9339	14243	19522	25182	31228
Combined Unacc & Syst Proc	0.45969		0.1	0.1	0.1	0.1	0.1	0.1
1970-2030 Pop Trend	**0.829**		**1.415**	**2.489**	**3.654**	**4.914**	**6.272**	**7.731**

Future Demands 2000-2030 OSP County Pop Trend Equation for Resid Connections for Residential Demand

			8	18	28	38	48	58
Use Type	2002	per connect	2010	2020	2030	2040	2050	2060
Resid Cust #	900	2.222	4,933	10,667	16,433	21,438	24,890	25,998
Resid Demand	0.205	228	1.124	2.430	3.743	4.883	5.670	5.922
Comm Cust #	190		223	271	331	403	492	599
Comm Demand	0.05	263	0	0	0	0	0	0
Indust Cust #	12		14	16	19	22	26	31
Indust Demand	0.163	13583	0	0	0	0	0	0
Instit Cust #	20		23	27	32	37	44	52
Instit Demand	0.005	250	0	0	0	0	0	0
SAD	0.80414922		1.474	2.827	4.196	5.403	6.269	6.616
Sales to Others	0.025		0.029	0.036	0.044	0.053	0.065	0.079
Total Cust #	1122		5192	10981	16814	21901	25453	26681
Combined Unacc & Syst Proc	0.45969		0.1	0.1	0.1	0.1	0.1	0.1
2000-2030 Pop Trend	**0.829**		**1.503**	**2.863**	**4.240**	**5.456**	**6.334**	**6.695**

Estimates of Future Demands based on 02 LWSP Service Pop. Trend Equation for Residential Demand

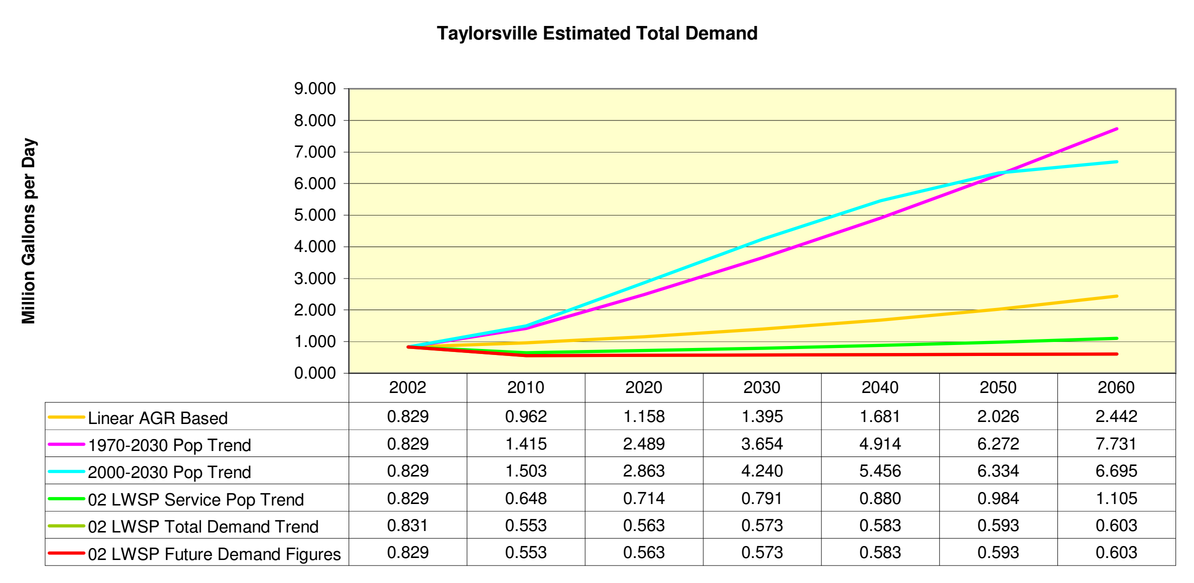
			8	18	28	38	48	58
Use Type	2002	per connect	2010	2020	2030	2040	2050	2060
Resid Cust #	900	2.222	1178	1234	1290	1346	1403	1459
Resid Demand	0.205	228	0.268	0.281	0.294	0.307	0.319	0.332
Comm Cust #	190		223	271	331	403	492	599
Comm Demand	0.05	263	0	0	0	0	0	0
Indust Cust #	12		14	16	19	22	26	31
Indust Demand	0.163	13583	0	0	0	0	0	0
Instit Cust #	20		23	27	32	37	44	52
Instit Demand	0.005	250	0	0	0	0	0	0
SAD	0.80414922		0.619	0.678	0.747	0.827	0.919	1.026
Sales to Others	0.025		0.029	0.036	0.044	0.053	0.065	0.079
Total Cust #	1122		1437	1549	1672	1809	1965	2141
Combined Unacc & Syst Proc	0.45969		0.1	0.1	0.1	0.1	0.1	0.1
02 LWSP Serv. Pop Trend	**0.829**		**0.648**	**0.714**	**0.791**	**0.880**	**0.984**	**1.105**

Estimates of Future Demands based 2002 LWSP future demand information

			8	18	28	38	48	58
Use Type	2002	per connect	2010	2020	2030	2040	2050	2060
Resid Cust #	900	2.222	922	966	1,010	1,054	1,098	1,143
Resid Demand	0.205	228	0.210	0.220	0.230	0.240	0.250	0.260
Comm Cust #	190		190	190	190	190	190	190
Comm Demand	0.05	263	0.050	0.050	0.050	0.050	0.050	0.050
Indust Cust #	12		12	12	12	12	12	12
Indust Demand	0.163	13583	0	0	0	0	0	0
Instit Cust #	20		20	20	20	20	20	20
Instit Demand	0.005	250	0.005	0.005	0.005	0.005	0.005	0.005
Backwash	0		0.000	0.000	0.000	0.000	0.000	0.000
Unaccounted-for	0.382		0.100	0.100	0.100	0.100	0.100	0.100
SAD	0.804		**0.528**	**0.538**	**0.548**	**0.558**	**0.568**	**0.578**
Sales contracts	0.025		0.025	0.025	0.025	0.025	0.025	0.025
Total Demand	**0.829**		**0.553**	**0.563**	**0.573**	**0.583**	**0.593**	**0.603**

Estimated Total Demand

	2002	2010	2020	2030	2040	2050	2060
Linear AGR Based	0.829	0.962	1.158	1.395	1.681	2.026	2.442
1970-2030 Pop Trend	0.829	1.415	2.489	3.654	4.914	6.272	7.731
2000-2030 Pop Trend	0.829	1.503	2.863	4.240	5.456	6.334	6.695
02 LWSP Service Pop Trend	0.829	0.648	0.714	0.791	0.880	0.984	1.105
02 LWSP Total Demand Trend	0.831	0.553	0.563	0.573	0.583	0.593	0.603
02 LWSP Future Demand Figures	0.829	0.553	0.563	0.573	0.583	0.593	0.603



Taylorsville Estimated Total Demand

	2002	2010	2020	2030	2040	2050	2060
Linear AGR Based	0.829	0.962	1.158	1.395	1.681	2.026	2.442
1970-2030 Pop Trend	0.829	1.415	2.489	3.654	4.914	6.272	7.731
2000-2030 Pop Trend	0.829	1.503	2.863	4.240	5.456	6.334	6.695
02 LWSP Service Pop Trend	0.829	0.648	0.714	0.791	0.880	0.984	1.105
02 LWSP Total Demand Trend	0.831	0.553	0.563	0.573	0.583	0.593	0.603
02 LWSP Future Demand Figures	0.829	0.553	0.563	0.573	0.583	0.593	0.603

Appendix D

Basin Model Inputs

Appendix D1

LIP Documents

Appendix C:
Low Inflow Protocol (LIP) for the Catawba-Wateree Project

PURPOSE

The purpose of this Low Inflow Protocol (LIP) is to establish procedures for reductions in water use during periods of low inflow to the Catawba-Wateree Project (the Project). The LIP was developed on the basis that all parties with interests in water quantity will share the responsibility to establish priorities and to conserve the limited water supply.

OVERVIEW

This Low Inflow Protocol provides trigger points and procedures for how the Catawba-Wateree Project will be operated by the Licensee, as well as water withdrawal reduction measures and goals for other water users during periods of low inflow (i.e., periods when there is not enough water flowing into the Project reservoirs to meet the normal water demands while maintaining Remaining Usable Storage in the reservoir system at or above a seasonal target level).

The Licensee will provide flow from hydro generation and other means to support electric customer needs and the instream flow needs of the Project. During periods of normal inflow, reservoir levels will be maintained within prescribed Normal Operating Ranges. During times that inflow is not adequate to meet all of the normal demands for water and maintain reservoir levels as normally targeted the Licensee will progressively reduce hydro generation. If hydrologic conditions worsen until trigger points outlined herein are reached, the Licensee will declare a Stage 0 - Low Inflow Watch and begin meeting with the applicable agencies and water users to discuss this LIP. If hydrologic conditions continue to worsen, the Licensee will declare various stages of a Low Inflow Condition (LIC) as defined in the Procedure section of this document. Each progressive stage of the LIC will call for greater reductions in hydro station releases and water withdrawals, and allow additional use of the available water storage inventory.

The goal of this staged LIP is to take the actions needed in the Catawba-Wateree River Basin to delay the point at which the Project's usable water storage inventory is fully depleted. While there are no human actions that can guarantee that the Catawba-Wateree River Basin will never experience operability limitations at water intake structures due to low reservoir levels or low streamflows, this LIP is intended to provide additional time to allow precipitation to restore streamflow, reservoir levels, and groundwater levels to normal ranges. The amount of additional time that is gained during the LIP depends primarily on the diagnostic accuracy of the trigger points, the amount of regulatory flexibility the Licensee has to operate the Project, and the effectiveness of the Licensee and other water users in working together to implement their required actions and achieve significant water use reductions in a timely manner.

To ensure continuous improvement regarding the LIP and its implementation throughout the term of the New License, the LIP will be re-evaluated and modified periodically. These re-evaluations and modifications will be as determined by the Catawba-Wateree Drought Management Advisory Group (CW-DMAG).

KEY FACTS AND DEFINITIONS

1. Human Health and Safety and the Integrity of the Public Water Supply and Electric Systems are of Utmost Importance – Nothing in this protocol will limit the Licensee's ability to take any and all lawful actions necessary at the Project to protect human health and safety, protect its equipment from major damage, protect the equipment of the Large Water Intake Owners from major damage, and ensure the stability of the regional electric grid and public water supply systems. It is recognized that the Licensee may take the steps that are necessary to protect these things without prior consultation or notification. Likewise, nothing in this LIP will limit the States of North Carolina and South Carolina from taking any and all lawful actions necessary within their jurisdictions to protect human health and safety. It is recognized that North Carolina and South Carolina may also take the steps necessary to protect these things without prior consultation or notification.
2. No Abrogation of Statutory Authority – It is understood that the South Carolina Department of Natural Resources (SCDNR) must operate under the statutory authority of its drought response statutes, and nothing in this LIP will require the SCDNR to take any action that contravenes its authority under their drought response statute.
3. Full Pond Elevation – Also referred to simply as "full pond", this is the level of a reservoir that corresponds to the point at which water would first begin to spill from the reservoir's dam(s) if the Licensee took no action. This level corresponds to the lowest point along the top of the spillway (including flashboards) for reservoirs without flood gates, and to the lowest point along the top of the flood gates for reservoirs that do have flood gates. To avoid confusion among the many reservoirs the Licensee operates, the Licensee has adopted the practice of referring to the Full Pond Elevation for all of its reservoirs as equal to 100.0-feet (ft.) relative. The Full Pond Elevations for the Catawba-Wateree Project reservoirs are as follows:

Reservoir	Full Pond Elevation (ft. above Mean Sea Level)
Lake James	1200.0
Lake Rhodhiss	995.1
Lake Hickory	935.0
Lookout Shoals Lake	838.1
Lake Norman	760.0
Mountain Island Lake	647.5
Lake Wylie	569.4
Fishing Creek Reservoir	417.2
Great Falls Reservoir	355.8
Cedar Creek Reservoir	284.4
Lake Wateree	225.5

4. Net Inflow – The cumulative inflow into a reservoir, expressed in acre-feet (ac-ft) per month. Net inflow is the sum of tributary stream flow, inflow from upstream hydro development releases (where applicable), groundwater inflow, precipitation falling on the reservoir surface, land surface runoff, and on-reservoir point-source return flows, less the sum of on-reservoir water withdrawals, groundwater recharge, hydro development flow releases, evaporation, and other factors.

5. Normal Minimum Elevation – The level of a reservoir (measured in feet above Mean Sea Level (msl) or feet relative to the full pond contour with 100.0 ft corresponding to full pond) that defines the bottom of the reservoir's Normal Operating Range for a given day of the year. If Net Inflows to the reservoir are within some reasonable tolerance of the average or expected amounts, hydro project equipment is operating properly, and no protocols for abnormal conditions have been implemented, reservoir level excursions below the Normal Minimum Elevation should not occur.

6. Normal Maximum Elevation – The level of a reservoir (measured in feet above Mean Sea Level (msl) or feet relative to the full pond contour with 100.0 feet corresponding to full pond) that defines the top of the reservoir's Normal Operating Range for a given day of the year. If net inflows to the reservoir are within some reasonable tolerance of the average or expected amounts, hydro project equipment is operating properly and no protocols for abnormal conditions have been implemented, reservoir level excursions above the Normal Maximum Elevation should not occur.

7. Normal Target Elevation - The level of a reservoir (measured in feet above Mean Sea Level (msl) or feet relative to the full pond contour with 100.0 ft corresponding to full pond) that the Licensee will endeavor in good faith to achieve, unless operating in this Low Inflow Protocol, the Maintenance and Emergency Protocol, the Spring Reservoir Level Stabilization Program (Lakes James, Norman, Wylie and Wateree only), a Spring Stable Flow Period (Lake Wateree only) or a Floodplain Inundation Period (Lake Wateree only). Since inflows vary significantly and outflow demands also vary, the Licensee will not always be able to maintain actual reservoir level at the Normal Target Elevation. The Normal Target Elevation falls within the Normal Operating Range, but it is not always the average of the Normal Minimum and Normal Maximum Elevations.

8. Normal Operating Range for Reservoir Levels – The band of reservoir levels within which the Licensee normally attempts to maintain a given reservoir that it operates on a given day. Each reservoir has its own specific Normal Operating Range, bounded by a Normal Maximum Elevation and a Normal Minimum Elevation. If net inflows to the reservoir are within some reasonable tolerance of the average or expected amounts, hydro project equipment is operating properly, and no protocols for abnormal conditions have been implemented, reservoir level excursions outside of the Normal Operating Range should not occur.

9. Large Water Intake – Any water intake (e.g., public water supply, industrial, agricultural, power plant, etc.) having a maximum instantaneous capacity greater than or equal to one million gallons per day (mgd) that withdraws water from the Catawba-Wateree River Basin.

10. Public Water Supply – Any water delivery system owned and/or operated by any governmental or private entity that uses waters from the Catawba-Wateree River Basin for public interest including drinking water; residential, commercial, industrial, and institutional uses; irrigation, and/or other public uses.

11. Critical Reservoir Elevation – Unless it is otherwise stated as applying only to a specific intake or type of intake, Critical Reservoir Elevation is the highest level of water in a reservoir (measured in feet above Mean Sea Level or feet relative to the full pond contour with 100.0 ft. corresponding to full pond) below which any Large Water Intake used for Public Water Supply or industrial uses, or any regional power plant intake located on the reservoir will not operate at its Licensee-approved capacity. The Critical Reservoir Elevations, as of June 1, 2006, are defined below:

Reservoir	**Critical Reservoir Elevation (ft. relative to local datum) (100 ft = Full Pond)**	**Type of Limit**
Lake James	61.0	Power Production
Lake Rhodhiss	89.4	Municipal Intake
Lake Hickory	94.0	Municipal Intake
Lookout Shoals Lake	74.9	Municipal Intake
Lake Norman	90.0	Power Production
Mountain Island Lake	94.3	Power Production
Lake Wylie	92.6	Industrial Intake
Fishing Creek Reservoir	95.0	Municipal Intake
Great Falls Reservoir	87.2	Power Production
Cedar Creek Reservoir	80.3	Power Production
Lake Wateree	92.5	Municipal Intake

12. Total Usable Storage (TUS) – The sum of the Project's volume of water expressed in acre-feet (ac-ft) contained between each reservoir's Critical Reservoir Elevation and the Full Pond Elevation.

13. Remaining Usable Storage (RUS) - The sum of the Project's volume of water expressed in acre-feet (ac-ft) contained between each reservoir's Critical Reservoir Elevation and the actual reservoir elevation at any given point in time.

14. Storage Index (SI) – The ratio, expressed in percent, of Remaining Usable Storage to Total Usable Storage at any given point in time.

15. Target Storage Index (TSI) – The ratio of Remaining Usable Storage to Total Usable Storage based on the Project reservoirs being at their Normal Target Elevations. The following table lists the Target Storage Index for the first day of each month:

Month	**Target Storage Index For 1st Day of Month (%)***
Jan	61
Feb	51
Mar	61
Apr	66
May	75
Jun	75

Month	Target Storage Index For 1st Day of Month (%)*
Jul	75
Aug	75
Sep	75
Oct	75
Nov	69
Dec	62

* Target Storage Indices for other days of the month are determined by linear interpolation.

16. U.S. Drought Monitor - A synthesis of multiple indices, outlooks, and news accounts that represents a consensus of federal and academic scientists concerning the drought status of all parts of the United States. Typically, the U.S. Drought Monitor indicates intensity of drought as D0-Abnormally Dry, D1-Moderate, D2-Severe, D3-Extreme, and D4-Exceptional. The website address is http://www.drought.unl.edu/dm/monitor.html. The following federal agencies are responsible for maintaining the U.S. Drought Monitor:
    - Joint Agricultural Weather Facility (U.S. Department of Agriculture and Department of Commerce/National Oceanic and Atmospheric Administration)
    - Climate Prediction Center (U.S. Department of Commerce/NOAA/National Weather Service)
    - National Climatic Data Center (DOC/NOAA)
17. U.S. Drought Monitor Three-Month Numeric Average – If the U.S. Drought Monitor has a reading of D0-D4 as of the last day of the previous month for any part of the Catawba-Wateree River Basin that drains to Lake Wateree, the Basin will be assigned a numeric value for the current month. The numeric value will equal the highest Drought Monitor designation (e.g., D0 = 0, D4 = 4) as of the last day of the previous month that existed for any part of the Catawba-Wateree River Basin that drains to Lake Wateree. A normal condition in the Basin, defined as the absence of a Drought Monitor designation, will be assigned a numeric value of negative one (-1). A running average numeric value of the current month and the previous two months will be monitored and designated as the U.S. Drought Monitor Three-Month Numeric Average.
18. Critical Flows – The minimum flow releases from the hydro developments that may be necessary to:
    a. prevent long-term or irreversible damage to aquatic communities consistent with the resource management goals and objectives for the affected stream reaches;
    b. provide some basic level of operability for Large Water Intakes located on regulated river reaches; and,
    c. provide some basic level of water quality maintenance in the affected stream reaches.

    For the purposes of this LIP, the Critical Flows are as follows:

a. Linville River, below the Bridgewater Development: 75 cubic feet per second (cfs).

b. Catawba River Bypassed Reach below the Bridgewater Development: 25 cfs.

c. Oxford Regulated River Reach below the Oxford Development: 100 cfs.

d. Lookout Shoals Regulated River Reach below the Lookout Shoals Development: 80 cfs.

e. Wylie Regulated River Reach below the Wylie Development: 700 cfs.

f. Great Falls Bypassed Reaches (Long and Short) at the Great Falls-Dearborn Development: 450 cfs and 80 cfs respectively.

g. Wateree Regulated River Reach below the Wateree Development: 800 cfs.

h. Leakage flows at the remaining Project structures. Leakage flows are defined as the flow of water through wicket gates when the hydro units are not operating and seepage through the Project structures at each development.

19. Recreation Flow Reductions - Since all recreation flow releases must be made by either releasing water through hydroelectric generation or through flow releases that bypass hydro generation equipment, reductions in Project Flow Requirements will impact recreation flow releases.

20. Organizational Abbreviations – Organizational abbreviations include the North Carolina Department of Environment and Natural Resources (NCDENR), North Carolina Wildlife Resources Commission (NCWRC), South Carolina Department of Natural Resources (SCDNR), South Carolina Department of Health and Environmental Control (SCDHEC), and the United States Geological Survey (USGS).

21. Catawba-Wateree Drought Management Advisory Group (CW-DMAG) – The CW-DMAG will be tasked with working with the Licensee when the LIP is initiated. This team will also meet as necessary to foster a basin-wide response to a Low Inflow Condition (see Procedure section of this LIP). Members of the CW-DMAG agree to comply with the conditions of this LIP. Membership on the CW-DMAG is open to the following organizations, of which each organization may have up to two members:

    a. NCDENR (including - Division of Water Resources and the Division of Water Quality)
    b. NCWRC
    c. SCDNR
    d. SCDHEC
    e. USGS
    f. Each Owner of a Large Water Intake located on one of the Catawba-Wateree Project reservoirs or the main stem of the Catawba-Wateree River
    g. Each Owner of a Large Water Intake located on any tributary stream within the Catawba-Wateree River Basin that ultimately drains to Lake Wateree
    h. Licensee (CW-DMAG Coordinator)

    The CW-DMAG will meet at least annually (typically during the month of May) beginning in 2007 and continuing throughout the term of the New License, regardless of the Low Inflow Condition status, to review prior year activities, discuss data input from Large Water Intake Owners, and discuss other issues relevant to the LIP. The Licensee will maintain an active roster of the CW-DMAG and update the roster as needed. The Licensee will prepare meeting summaries of all CW-DMAG meetings and will make these meeting summaries available to the public by posting on its website.

22. Revising the LIP - During the term of the New License, the CW-DMAG will review and update the LIP periodically to ensure continuous improvement of the LIP and its implementation. These evaluations and modifications will be considered at least once every five (5) years during the New License term. Modifications must be approved by a consensus of the participating CW-DMAG members. If the participating members cannot reach consensus, then the dispute resolution procedures set forth in Section 31.0 of the relicensing Final Agreement will apply. Approved modifications will be incorporated through revision of the LIP and the Licensee will file the revised LIP with the FERC. If any modifications of the LIP require amendment of the New License, the Licensee will: (i) provide notice to all Parties to the relicensing Final Agreement advising them of the proposed license article amendment and the Licensee's intent to file it with the FERC; (ii) submit the modification request to the North Carolina Division of Water Quality (NCDWQ) and/or the South Carolina Department of Health and Environmental Control (SCDHEC) for formal review and approval as may be required by any reopener conditions of the respective state's 401 Water Quality Certification for the Project; and (iii) file a license amendment request for FERC approval. During this process, the CW-DMAG may appoint an ad hoc committee to address issues and revisions relevant to the LIP. The filing of a revised LIP by the Licensee will not constitute or require modification to the relicensing Final Agreement and any Party to the relicensing Final Agreement may be involved in the FERC's public process for assessing the revised LIP. Issues such as sediment fill impact on reservoir storage volume calculations, revising the groundwater monitoring plan and substitution of a regional drought monitor for the U.S. Drought Monitor, if developed in the future, are examples of items that may be addressed.

23. Water Withdrawal Data Collection and Reporting – The Licensee will maintain information on cumulative water use from Project reservoirs during the term of the New License and make the information available to water intake owners and governmental agencies upon their request. The Licensee will require all owners of Large Water Intakes located within the FERC Project Boundaries to report to the Licensee, on an annual basis in MGD, their average monthly water withdrawals from and flow returns to the Project or its tributary streams that drain to Lake Wateree. The Licensee will maintain a database of this information including the Licensee's own non-hydro water use records (i.e., water uses due to thermal power generation). These annual withdrawal summaries will be in writing, certified for accuracy by a professional engineer or other appropriate official, and will be provided to the Licensee by January 31 of each year for the preceding calendar year beginning in 2007. This information may be used to determine if future increased water withdrawals would be within the projections of the Water Supply Study conducted during the relicensing process and filed with the FERC as part of the Licensee's Application for New License for the Project.

24. Reclaimed Water – Wastewater that has been treated to reclaimed water standards and is re-used for a designated purpose (e.g. industrial process, irrigation). Reclaimed Water will not be subject to the water use restrictions outlined in this LIP.

25. Drought Response Plan Updates – All Large Water Intake Owners will review and update their Drought Response Plans or Ordinances (or develop a plan or ordinance if they do not have one) by December 31, 2006 and within 90 days following the acceptance by the FERC of any future LIP revisions during the term of the New License to ensure compliance and coordination with the LIP, including the authority to enforce the provisions outlined herein, provided that the requirements of the LIP are consistent with state law.

26. Relationship Between the LIP and the Maintenance & Emergency Protocol (MEP) – The MEP outlines the response the Licensee will take under certain emergency and equipment failure and maintenance situations to continue practical and safe operation of the Project, to mitigate any related impacts to license conditions, and to communicate with resource agencies and the affected parties. Under the MEP, temporary modifications of minimum flow releases and the reservoir level Normal Operating Ranges are allowed. Lowering levels of Project reservoirs caused by situations addressed under the MEP will not invoke implementation of this Low Inflow Protocol (LIP). Also, if the LIP has already been implemented at the time that a situation covered by the MEP is initiated, the Licensee will typically suspend implementation of the LIP until the MEP situation has been eliminated. The Licensee may, however, choose to continue with the LIP if desirable.

27. Consensus – Consensus is reached when all CW-DMAG members can 'live with' the outcome or proposal being made. The concept of consensus is more fully described in the Catawba – Wateree Hydroelectric Project Relicensing – Stakeholder Teams Charter (dated October, 2005).

28. Monitored USGS Streamflow Gages - USGS streamflow gage #'s 02145000 (South Fork Catawba River at Lowell, NC), 02137727 (Catawba River near Pleasant Gardens, NC), 02140991 (Johns River at Arney's Store, NC), and 02147500 (Rocky Creek at Great Falls, SC)

ASSUMPTIONS

1. Instream Flows for Recreation – The New License for the Catawba-Wateree Project includes recreational flow releases as listed in the proposed Recreational Flows License Article.

2. Minimum Flows – The New License for the Catawba-Wateree Project includes the minimum flow requirements as listed in the proposed Minimum Flows License Article, including flow requirements in bypassed reaches.

3. Project Flow Requirements – These flow requirements include the Minimum Flows and the portion of the Recreational Flows that is greater than the Minimum Flows for normal conditions (i.e., conditions outside of this LIP or Maintenance and Emergency Protocol).

4. Public Information System – The New License for the Catawba-Wateree Project includes the public information as identified in the proposed Public Information License Article.

5. Normal Operating Ranges for Reservoir Levels – The New License for the Catawba-Wateree Project includes the Normal Operating Ranges for reservoir levels (i.e., Normal Minimum, Normal Maximum, and Normal Target Elevations) as listed in the proposed Reservoir Elevations License Article.

PROCEDURE

During periods of normal inflow, reservoir levels will be maintained within prescribed Normal Operating Ranges. During times that inflow is not adequate to meet all of the normal demands for water and maintain reservoir levels as normally targeted, the Licensee will progressively reduce hydro generation while meeting Project Flow Requirements. During a Low Inflow Watch or a Low Inflow Condition (LIC) (as defined below), the Licensee and other water users will follow the protocol set forth below for the Catawba-Wateree Project regarding communications and adjustments to hydro releases, bypassed flow releases, minimum reservoir elevations, and other water demands. The adjustments set forth below will be made on a monthly basis and are designed to equitably allocate the impacts of reduced water availability in accordance with the purpose statement of this LIP.

Trigger points that demonstrate worsening hydrologic conditions will define various stages of the Low Inflow Condition. A summary of trigger points for various stages is provided in the table below. The specific triggers required to enter successive stages are defined in the procedure for each stage.

Summary of LIP Trigger Points

Stage	Storage Index [1]		Drought Monitor [2] (3-month average)		Monitored USGS [3] Streamflow Gages
0[4]	90% < SI < 100% TSI		3mo Ave DM = 0		AVG = 85% LT 6mo Ave
1	75% TSI < SI = 90% TSI	**and**	3mo Ave DM = 1	**or**	AVG = 78% LT 6mo Ave
2	57% TSI < SI = 75% TSI	**and**	3mo Ave DM = 2	**or**	AVG = 65% LT 6mo Ave
3	42% TSI < SI = 57% TSI	**and**	3mo Ave DM = 3	**or**	AVG = 55% LT 6mo Ave
4	SI = 42% TSI	**and**	3mo Ave DM = 4	**or**	AVG = 40% LT 6mo Ave

[1] The ratio of Remaining Useable Storage to Total Usable Storage at a given point in time.

[2] The three-month numeric average of the published U.S. Drought Monitor.

[3] The sum of the rolling sixth-month average for the Monitored USGS Streamflow Gages as a percentage of the period of record rolling average for the same six-month period for the Monitored USGS Streamflow Gages.

[4] Stage 0 is triggered when any two of the three trigger points are reached.

Stage 0 - Low Inflow Watch:

The Licensee will monitor the Storage Index, the U.S. Drought Monitor, and the Monitored USGS Streamflow Gages on at least a monthly basis and will declare a Stage 0 - Low Inflow Watch if any two of the following conditions occur:

a. On the first day of the month, Storage Index is below the Target Storage Index, but greater than 90% of the Target Storage Index, while providing the Project Flow Requirements for the previous month.

b. The U.S. Drought Monitor Three-Month Numeric Average has a value greater than or equal to 0.

c. The sum of the actual rolling six-month average streamflows at the Monitored USGS Streamflow Gages is equal to or less than 85% of the sum of the period of record rolling average streamflows for the same six-month period.

When a Low Inflow Watch has been declared:

a. The Licensee will activate the CW-DMAG, including the initiation of monthly meetings or conference calls to occur on the second Tuesday of each month. These monthly discussions will focus on:

   - Proper communication channels between the CW-DMAG members.
   - Information reporting consistency for CW-DMAG members, including a storage index history and forecast (at least a 90-day look back and look ahead) from the Licensee, a water use history and forecast (at least a 90-day look back and look ahead) from each water user on the CW-DMAG, streamflow gage and groundwater monitoring status from the state agencies and USGS, and state-wide drought response status from the state agencies.
   - Refresher training on this LIP.
   - Overview discussions from each CW-DMAG member concerning their role and plans for responding if a Stage 1 or higher Low Inflow Condition is subsequently declared.

b. The Licensee will reduce the prescribed recreation flow releases at the Wylie Development from 6,000 cfs to 3,000 cfs.

<u>Stage 1 Actions:</u>

1. The Licensee will declare a Stage 1 Low Inflow Condition (LIC) and notify the CW-DMAG if:

   a. On the first day of the month, the Storage Index is at or below 90% of the Target Storage Index, but greater than 75% of the Target Storage Index, while providing the Project Flow Requirements for the previous month.

   and either of the following conditions exists:

   b. The U.S. Drought Monitor Three-Month Numeric Average has a value greater than or equal to 1.

   c. The sum of the actual rolling six-month average streamflows at the Monitored USGS Streamflow Gages is equal to or less than 78% of the sum of the period of record rolling average streamflows for the same six-month period.

2. The Licensee will complete the following activities within 5 days after the Stage 1 LIC declaration:

   a. Reduce the Project Flow Requirements by 60% of the difference between the Project Flow Requirements and the Critical Flows. These reduced Project Flow Requirements are referred to as Stage 1 Minimum Project Flows.

   b. Reduce the Normal Minimum Elevations by two feet at Lake James and Lake Norman and by one foot at each of the other Project reservoirs, but not to levels at any reservoir below the Critical Reservoir Elevations. These elevations are referred to as the Stage 1 Minimum Elevations.

c. Update its Web site and Interactive Voice Response (IVR) messages to account for the impacts of the LIP on reservoir levels, usability of the Licensee's public access areas, and recreation flow schedules.

d. Provide bi-weekly (once every two weeks) information updates to owners of Large Water Intakes about reservoir levels, meteorological forecasts, and inflow of water into the system.

e. In addition the Licensee may, at its sole discretion, modify or suspend its use of selected operating procedures that are designed for periods of normal inflow to optimize the water storage capabilities of the Project, including the Normal Maximum Elevations and Normal Target Elevations for reservoir levels; the Spring Reservoir Level Stabilization Program; and at Lake Wateree, the Spring Stable Flow Periods and Floodplain Inundation Periods. These modifications and suspensions may be used at the Licensee's sole discretion in any Low Inflow Condition (Stages 1 through 4).

3. Owners of Public Water Supply intakes and other intakes with a capacity greater than 100,000 gallons per day used for irrigation will complete the following activities within 14 days after the Stage 1 LIC declaration:

   a. Notify their water customers and employees of the Low Inflow Condition through public outreach and communication efforts.

   b. Request that their water customers and employees implement <u>voluntary</u> water use restrictions, in accordance with their drought response plans, which may include:

      - Reduction of lawn and landscape irrigation to no more than <u>two days</u> per week (i.e. residential, multi-family, parks, streetscapes, schools, etc).
      - Reduction of residential vehicle washing.

      At this stage, the goal is to reduce water usage by approximately 3-5% from the amount that would otherwise be expected. The baseline for this comparison will be generated by each entity and will be based on existing conditions (i.e. drought conditions). For the purposes of determining 'the amount that would otherwise be expected', each entity may give consideration to one or more of the following:

      - Historical maximum daily, weekly, and monthly flows during drought conditions.
      - Increased customer base (e.g. population growth, service area expansion) since the historical flow comparison.
      - Changes in major water users (e.g. industrial shifts) since the historical flow comparison.
      - Climatic conditions for the comparison period.
      - Changes in water use since the historical flow comparison.
      - Other system specific considerations.

   c. Provide a status update to the CW-DMAG on actual water withdrawal trends. Discuss plans for moving to mandatory restrictions, if required.

4. Owners of Large Water Intakes, other than those referenced in item 3 above, will complete the following activities within 14 days after the Stage 1 LIC declaration:
   a. Notify their customers and employees of the Low Inflow Condition through public outreach and communication efforts.
   b. Request that their customers and employees conserve water through reduction of water use, electric power consumption, and other means.
   c. Provide a status update to the CW-DMAG on actual water withdrawal trends.

<u>Stage 2 Actions:</u>

1. The Licensee will declare a Stage 2 Low Inflow Condition (LIC) and notify the CW-DMAG if:
   a. On the first day of the month, the Storage Index is at or below 75% of the Target Storage Index, but greater than 57% of the Target Storage Index, while providing the Stage 1 Minimum Project Flows during the previous month.

   and either of the following conditions exists:

   b. The U.S. Drought Monitor Three-Month Numeric Average has a value greater than or equal to 2.
   c. The sum of the actual rolling six-month average streamflows at the Monitored USGS Streamflow Gages is equal to or less than 65% of the sum of the period of record rolling average streamflows for the same six-month period.
2. The Licensee will complete the following activities within 5 days after the Stage 2 LIC declaration:
   a. Eliminate prescribed recreation flow releases at this stage and all subsequent stages. Reduce the Project Flow Requirements by 95% of the difference between the Project Flow Requirements and Critical Flows. These reduced flows are referred to as Stage 2 Minimum Project Flows.
   b. Reduce the Stage 1 Minimum Elevations by one additional foot at Lake James (three feet total below Normal Minimum Elevation) and two additional feet at Lake Norman (four feet below Normal Minimum Elevation) and by one additional foot (two feet below Normal Minimum Elevations) at each of the other Project reservoirs but not to levels at any reservoir below the Critical Reservoir Elevations. These elevations are referred to as the Stage 2 Minimum Elevations.
   c. Update its website and IVR messages to account for the impacts of the LIP on reservoir levels, usability of the Licensee's public access areas, and recreation flow schedules.
   d. Provide bi-weekly information updates to owners of Large Water Intakes about reservoir levels, meteorological forecasts, and inflow of water into the system.
   e. In addition the Licensee may, at its sole discretion, modify or suspend its use of selected operating procedures that are designed for periods of normal

inflow to optimize the water storage capabilities of the Project, including the Normal Maximum Elevations and Normal Target Elevations for reservoir levels; the Spring Reservoir Level Stabilization Program; and at Lake Wateree, the Spring Stable Flow Periods and Floodplain Inundation Periods. These modifications and suspensions may be used at the Licensee's sole discretion in any Low Inflow Condition (Stages 1 through 4).

3. Owners of Public Water Supply intakes and other intakes with a capacity greater than 100,000 gallons per day used for irrigation will complete the following activities within 14 days after the Stage 2 LIC declaration:
    a. Notify their water customers and employees of the continued Low Inflow Condition and movement to mandatory water use restrictions through public outreach and communication efforts.
    b. Require that their water customers and employees implement <u>mandatory</u> water use restrictions, in accordance with their drought response plans, which may include:
        - Limiting lawn and landscape irrigation to no more than <u>two days</u> per week (i.e. residential, multi-family, parks, streetscapes, schools, etc).
        - Eliminating residential vehicle washing.
        - Limiting public building, sidewalk, and street washing activities except as required for safety and/or to maintain regulatory compliance.

       At this stage, the goal is to reduce water usage by approximately 5-10% from the amount that would otherwise be expected (as discussed in Stage 1 above).
    c. Enforce mandatory water use restrictions through the assessment of penalties.
    d. Provide a status update to the CW-DMAG on actual water withdrawal trends.
4. Owners of Large Water Intakes, other than those referenced in item 3 above, will complete the following activities within 14 days after the Stage 2 LIC declaration:
    a. Continue informing their customers and employees of the Low Inflow Condition through public outreach and communication efforts.
    b. Request that their customers and employees conserve water through reduction of water use, electric power consumption, and other means.
    c. Provide a status update to the CW-DMAG on actual water withdrawal trends.

<u>Stage 3 Actions:</u>

1. The Licensee will declare a Stage 3 Low Inflow Condition (LIC) and notify the CW-DMAG if:
    a. On the first day of the month, the Storage Index is at or below 57% of the Target Storage Index, but greater than 42% of the Target Storage Index, while providing the Stage 2 Minimum Project Flows during the previous month.

    and either of the following conditions exists:

   b. The U.S. Drought Monitor Three-Month Numeric Average has a value greater than or equal to 3.
   c. The sum of the actual rolling six-month average streamflows at the Monitored USGS Streamflow Gages is equal to or less than 55% of the sum of the period of record rolling average streamflows for the same six-month period.

2. The Licensee will complete the following activities within 5 days after the Stage 3 LIC declaration:
   a. Reduce the Project Flow Requirements to Critical Flows. These reduced flows are referred to as Stage 3 Minimum Project Flows.
   b. Reduce the Stage 2 Minimum Elevations by seven additional feet at Lake James (ten feet below Normal Minimum Elevation) and one additional foot at Lake Norman (five feet below Normal Minimum Elevation) and by one additional foot (three feet total below Normal Minimum Elevations) at each of the other Project reservoirs but not to levels at any reservoir below the Critical Reservoir Elevations. These elevations are referred to as the Stage 3 Minimum Elevations.
   c. Update its website and IVR messages to account for the impacts of the LIP on reservoir levels, usability of the Licensee's public access areas, and recreation flow schedules.
   d. Provide bi-weekly information updates to owners of Large Water Intakes about reservoir levels, meteorological forecasts, and inflow of water into the system.
   e. In addition the Licensee may, at its sole discretion, modify or suspend its use of selected operating procedures that are designed for periods of normal inflow to optimize the water storage capabilities of the Project, including the Normal Maximum Elevations and Normal Target Elevations for reservoir levels; the Spring Reservoir Level Stabilization Program; and at Lake Wateree, the Spring Stable Flow Periods and Floodplain Inundation Periods. These modifications and suspensions may be used at the Licensee's sole discretion in any Low Inflow Condition (Stages 1 through 4).

3. Owners of Public Water Supply intakes and other intakes with a capacity greater than 100,000 gallons per day used for irrigation will complete the following activities within 14 days after the Stage 3 LIC declaration:
   a. Notify their water customers and employees of the continued Low Inflow Condition and movement to more stringent mandatory water use restrictions through public outreach and communication efforts.
   b. Require that their water customers and employees implement <u>increased mandatory</u> water use restrictions, in accordance with their drought response plans, which may include:
      - Limiting lawn and landscape irrigation to no more than <u>one day</u> per week (i.e. residential, multi-family, parks, streetscapes, schools, etc).
      - Eliminating residential vehicle washing.
      - Limiting public building, sidewalk, and street washing activities except as required for safety and/or to maintain regulatory compliance.

    - Limiting construction uses of water such as dust control.
    - Limiting flushing and hydrant testing programs, except to maintain water quality or other special circumstances.
    - Eliminating the filling of new swimming pools.

    At this stage, the goal is to reduce water usage by approximately 10-20% from the amount that would otherwise be expected (as discussed in Stage 1 above).

  c. Enforce mandatory water use restrictions through the assessment of penalties.
  d. Encourage industrial/manufacturing process changes that reduce water consumption.
  e. Provide a status update to the CW-DMAG on actual water withdrawal trends.

4. Owners of Large Water Intakes, other than those referenced in item 3 above, will complete the following activities within 14 days after the Stage 3 LIC declaration:
   a. Continue informing their customers and employees of the Low Inflow Condition through public outreach and communication efforts.
   b. Request that their customers and employees conserve water through reduction of water use, electric power consumption, and other means.
   c. Encourage industrial/manufacturing process changes that reduce water consumption.
   d. Provide a status update to the CW-DMAG on actual water withdrawal trends.

Stage 4 Actions:

1. The Licensee will declare a Stage 4 Low Inflow Condition (LIC) and notify the CW-DMAG if:
   a. On the first day of the month, the Storage Index is at or below 42% of the Target Storage Index, while providing the Stage 3 Minimum Project Flows during the previous month.

   and either of the following conditions exists:

   b. The U.S. Drought Monitor Three-Month Numeric Average has a value of 4.
   c. The sum of the actual rolling six-month average streamflows at the Monitored USGS Streamflow Gages is equal to or less than 40% of the sum of the period of record rolling six-month average streamflows for the same six-month period.
2. The Licensee will:
   a. Continue to provide Critical Flows as long as possible.
   b. Reduce the Stage 3 Minimum Elevations to the Critical Reservoir Elevations.
   c. Establish a meeting date and notify the CW-DMAG within 1 day following the Stage 4 LIC declaration.

   d. Continue to update its website and IVR messages to account for the impacts of the LIP on reservoir levels, usability of the Licensee's public access areas, and recreation flow schedules.

   e. Provide bi-weekly information updates to owners of Large Water Intakes about reservoir levels, meteorological forecasts, and inflow of water into the system.

   f. In addition the Licensee may, at its sole discretion, modify or suspend its use of selected operating procedures that are designed for periods of normal inflow to optimize the water storage capabilities of the Project, including the Normal Maximum Elevations and Normal Target Elevations for reservoir levels; the Spring Reservoir Level Stabilization Program; and at Lake Wateree, the Spring Stable Flow Periods and Floodplain Inundation Periods. These modifications and suspensions may be used at the Licensee's sole discretion in any Low Inflow Condition (Stages 1 through 4).

   Note: Once a Stage 4 LIC is declared, the Remaining Usable Storage in the reservoir system is small and can be fully depleted in a matter of weeks or months. Groundwater recharge may also contribute to declining reservoir levels. For these reasons in the Stage 4 LIC, the Licensee may not be able to ensure that releases from its hydro developments will meet or exceed Critical Flows or that reservoir elevations will be greater than or equal to the Critical Reservoir Elevations.

3. Owners of Public Water Supply intakes and other intakes with a capacity greater than 100,000 gallons per day used for irrigation will complete the following activities within 14 days after the Stage 4 LIC declaration:

   a. Notify their water customers and employees of the continued Low Inflow Condition and movement to <u>emergency</u> water use restrictions through public outreach and communication efforts.

   b. Restrict all outdoor water use.

   c. Implement emergency water use restrictions in accordance with their drought response plans, including enforcement of these restrictions and assessment of penalties.

   d. Prioritize and meet with their commercial and industrial large water customers to discuss strategies for water reduction measures including development of an activity schedule and contingency plans.

   e. Prepare to implement emergency plans to respond to water outages.

   At this level, the goal is to reduce water usage by approximately 20-30% from the amount that would otherwise be expected (as discussed in Stage 1 above).

4. Owners of Large Water Intakes on the CW-DMAG, other than those referenced in item 3 above, will complete the following activities within 14 days after the Stage 4 LIC declaration:

   a. Continue informing their customers and employees of the Low Inflow Condition through public outreach and communication efforts.

   b. Request that their customers and employees conserve water through reduction of water use, electric power consumption, and other means.

   c. Encourage industrial/manufacturing process changes that reduce water consumption.
   d. Provide a status update to the CW-DMAG on actual water withdrawal trends.
5. The CW-DMAG will:
   a. Meet within 5 days after the declaration of the Stage 4 LIC and determine if there are any additional measures that can be implemented to:
      (1) reduce water withdrawals;
      (2) reduce water releases from the Project; or
      (3) use additional reservoir storage without creating more severe regional problems.
   b. Work together to develop plans and implement any additional measures identified above.

Recovery from the Low Inflow Protocol

1. Recovery under the LIP as conditions improve will be accomplished by reversing the staged approach outlined above, except that:
   a. All three of the trigger points identified above for declaring the lower numbered stage must be met or exceeded before returning reservoir levels and flows to that LIC stage, Low Inflow Watch, or Normal Conditions.
   b. The following groundwater level trigger points must also be attained before returning reservoir levels and flows to that LIC stage, Low Inflow Watch, or Normal Conditions:

   USGS has reviewed available well records and has determined that there are existing wells with an adequate period that can be used for this process and has also determined that additional wells are advised in order to include groundwater data as part of the recovery. The CW-DMAG and the Catawba-Wateree Water Management Group (WMG) will work together to revise the plan for groundwater monitoring by December 31, 2007 and will update the table below.

Groundwater Trigger Points (depth below land surface (feet)) for Returning to:					
Groundwater Monitor [Reg.=regolith; BR=bedrock]	**Stage 3 (a)**	**Stage 2 (b)**	**Stage 1 (c)**	**LIW (d)**	**Normal (d)**
#1 Future Well Placeholder					
#2 Future Well Placeholder					
#3 Future Well Placeholder					
#4 Future Well Placeholder					
#5 Future Well Placeholder					
#6 USGS Langtree Peninsula RS Reg. well MW-2 & BR well MW-2D	24.91	23.61	22.21	18.21	18.21

Groundwater Trigger Points (depth below land surface (feet)) for Returning to:					
Groundwater Monitor [Reg.=regolith; BR=bedrock]	**Stage 3 (a)**	**Stage 2 (b)**	**Stage 1 (c)**	**LIW (d)**	**Normal (d)**
#7 USGS Linville RS NC-220 BR well	2.74	2.19	2.11	2.04	2.04
#8 NC DWR Glen Alpine BR well L 76G2	10.01	9.03	8.32	7.69	7.69
#9 Future Well Placeholder					
#10 Future Well Placeholder					

Note: USGS groundwater levels calculated from daily mean data. NCDWR water levels calculated from hourly data. All trigger levels calculated from water levels collected through the 2005 water year. Trigger groundwater levels may be updated on a yearly or water-year basis.

Footnotes:

(a) Stage 3: Period of record low water level
(b) Stage 2: 10th percentile
(c) Stage 1: 25th percentile
(d) LIW and Normal: 50th percentile

2. The NCDENR, SCDNR, SCDHEC, USGS and the Licensee will determine when attainment of the groundwater trigger points for recovery is reached.
3. The Licensee will directly notify the CW-DMAG members within 5 days following attainment of all the trigger points necessary to recover to a lower stage of the LIC, Low Inflow Watch, or Normal Conditions.
4. The Licensee will update its website and IVR messages to account for the impacts of the LIP on reservoir levels, usability of the Licensee's public access areas, and recreation flow schedules.

Appendix D2

LIP Input Table

Input sheet for LIP criterion to be modeled in the Catawba Wateree CHEOPS Model

Data updated: 08/15/2005 09/15/2005 09/27/2005
nded Scenario: Base Condition, by-plant changes to Minimum Elevations
Modified By: Brian Krolak Ey Miles

Days of Month to Recalculate LIP Conditions: 1 - -

NS: Changed critical flows and critical elevation by NS on 11-21-05

Reservoir Critial Elevations (should be at or below the Minimum Elevation entered in the scenario being run.)

Reservoir Nam	1	2	3	4	5	6	7	8	9	10	11
Critical Reservoir Elevation (ft, relative datum)	61.0	89.4	94.0	74.9	90.0	94.3	92.6	95.0	87.2	80.3	92.5

Critical Flows (flows from dams per LIP documentation)

Reservoir Nam	1	2	3	4	5	6	7	8	9	10	11
Critical Flow (cfs) Jan	100.0	-	100.0	80.0	-	-	700.0	-	530.0	-	800.0
Critical Flow (cfs) Feb	100.0	-	100.0	80.0	-	-	700.0	-	530.0	-	800.0
Critical Flow (cfs) Mar	100.0	-	100.0	80.0	-	-	700.0	-	530.0	-	800.0
Critical Flow	100.0	-	100.0	80.0	-	-	700.0	-	530.0	-	800.0
Critical Flow	100.0	-	100.0	80.0	-	-	700.0	-	530.0	-	800.0
Critical Flow (cfs) Jun	100.0	-	100.0	80.0	-	-	700.0	-	530.0	-	800.0
Critical Flow (cfs) Jul	100.0	-	100.0	80.0	-	-	700.0	-	530.0	-	800.0
Critical Flow (cfs) Aug	100.0	-	100.0	80.0	-	-	700.0	-	530.0	-	800.0
Critical Flow (cfs) Sep	100.0	-	100.0	80.0	-	-	700.0	-	530.0	-	800.0
Critical Flow (cfs) Oct	100.0	-	100.0	80.0	-	-	700.0	-	530.0	-	800.0
Critical Flow (cfs) Nov	100.0	-	100.0	80.0	-	-	700.0	-	530.0	-	800.0
Critical Flow (cfs) Dec	100.0	-	100.0	80.0	-	-	700.0	-	530.0	-	800.0

Changed Wateree and Wylie Critical flows to a low of 800 cfs based on request from Duke on 9/13/05.

BOM Storage/Target Storage ratio

	Ratio less than or equal to	Ratio greater than	6 Month USGS Gage hydrology sum less than or equal to
Stage 0		90%	85%
Stage 1	90%	75%	78%
Stage 2	75%	57%	65%
Stage 3	57%	42%	55%
Stage 4	42%	0%	40%

Modified BOM storage target ratios for stages 3 to 4 - 11/21/09

Actions to be performed

Licensee Actions	Licensee Delay in implementing Actions (days)	NLPF Reduction (%) Reduction to difference between NLPF and Critical Flow	Bypass Reduction (%) Reduction to difference between Bypass and Critical Flow	Recreation Flows Reduction (%)	Plant 1 Normal Minimum Pond Elevation Reduction (ft, absolute)	Plant 2 Normal Minimum Pond Elevation Reduction (ft, absolute)	Plant 3 Normal Minimum Pond Elevation Reduction (ft, absolute)	Plant 4 Normal Minimum Pond Elevation Reduction (ft, absolute)	Plant 5 Normal Minimum Pond Elevation Reduction (ft, absolute)	Plant 6 Normal Minimum Pond Elevation Reduction (ft, absolute)	Plant 7 Normal Minimum Pond Elevation Reduction (ft, absolute)	Plant 8 Normal Minimum Pond Elevation Reduction (ft, absolute)	Plant 9 Normal Minimum Pond Elevation Reduction (ft, absolute)	Plant 10 Normal Minimum Pond Elevation Reduction (ft, absolute)	Plant 11 Normal Minimum Pond Elevation Reduction (ft, absolute)
Stage 0	4	0%	0%	0%	0	0	0	0	0	0	0	0	0	0	0
Stage 1	4	60%	60%	60%	2	1	1	1	2	1	1	1	1	1	1
Stage 2	4	95%	95%	100%	3	2	2	2	4	2	2	2	2	2	2
Stage 3	4	100%	100%	100%	10	3	3	3	5	3	3	3	3	3	3
Stage 4	4	100%	100%	100%	critical	critical	critical	critical	critical	critical	critical	critical	critical	critical	critical

Consumptive Withdrawal Reduction (%)

Owners of public and large water supply intakes	Owner Delay in implementing Actions (days)	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6	Plant 7	Plant 8	Plant 9	Plant 10	Plant 11
Stage 0	4	0%										
Stage 1	4	0.6%	3.0%	3.0%	3.0%	1.9%	3.0%	0.6%	3.0%	3.0%	3.0%	0.9%
Stage 2	4	1.3%	7.0%	7.0%	7.0%	4.5%	6.9%	1.4%	7.0%	7.0%	7.0%	2.0%
Stage 3	4	2.8%	15.0%	15.0%	15.0%	9.6%	14.8%	3.0%	15.0%	15.0%	15.0%	4.3%
Stage 4	4	4.6%	25.0%	25.0%	25.0%	16.1%	24.7%	4.9%	25.0%	25.0%	25.0%	7.2%

LIP Recovery

Days delayed after storage and hydrology condition recovery for groundwater wells to indicate groundwater levels have recovered

	From Stage 4 to Stage 3	From Stage 3 to Stage 2	From Stage 2 to Stage 1	From Stage 1 to Stage 0	Stage 0 to Normal
Groundwater Monitor	0	0	0	0	0

Appendix D3

Mutual Gain CHEOPS Scenario Input Sheet

Revised 11/09/05

FOR DTA USE ONLY	
Run #	

CATAWBA-WATEREE CHEOPS SCENARIO INPUT SHEET
Request For Operations Model Run

Originator: Duke Nov 09 - Mutual Gain Date Requested:11/09/05

Stakeholder Group: Duke Trial Balloon AIP Needed By: 11/15/05

Period of Run: ☐ Typical Normal Conditions ☐ Typical Dry Conditions
☐ Typical Wet Conditions ☐ Full Record
☒ Other: 1953 thru 2003 with PW, Sed and LIP

Output Format: ☐ Tables ☒ Figures ☐ Report
☒ Performance Measures Sheet
☒ Other: Powerpoint Summary

Directions: Complete this entire form, including the specific questions you think this model run will answer. The Baseline (current day operation) parameters are fixed unless an alternative is requested in the "Scenario" column.

Facility	***Constraint***	***Baseline***	***Run of River***	***Mutual Gain***	
BRIDGEWATER DEVELOPMENT					
Lake James	Normal Operating Ranges for Lake Levels	See Attached	NA	See Attached Reference Lake Stabilization Program	
Catawba Dam	Bypass Flow (cfs)	0	NA	See Schedule	
Paddy Creek Dam	Bypass Flow (cfs)	0	NA	0	
Linville Dam & PH	Minimum Flow (cfs)	25	Inflow	See Schedule	
	Prescribed Recreation Flow Releases (cfs)	0	Inflow	See Schedule	
	MADF (cfs)	66	Inflow	0	
RHODHISS DEVELOPMENT					
Lake Rhodhiss & PH	Normal Operating Ranges for Lake Levels	See Attached	NA	See Attached	
	Minimum Flow (cfs)	40	Inflow	0	
	MADF (cfs)	225	Inflow	225	
OXFORD DEVELOPMENT					
Lake Hickory & PH	Normal Operating Ranges for Lake Levels	See Attached	NA	See Attached	
	Minimum Flow (cfs)	40	Inflow	See Schedule	
	Prescribed Recreation Flow Releases (cfs)	0	Inflow	See Schedule	
	MADF (cfs)	261	Inflow	0	

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Facility	*Constraint*	*Baseline*	*Run of River*	*Mutual Gain*	
LOOKOUT SHOALS DEVELOPMENT					
Lookout Shoals Lake & PH	Normal Operating Ranges for Lake Levels	See Attached	NA	See Attached	
	Minimum Flow (cfs)	60	Inflow	May 1 thru Dec 31 - 80 Jan 1 thru April 30 – 160 use min flow units	
	MADF (cfs)	278	Inflow	278	
COWANS FORD DEVELOPMENT					
Lake Norman & PH	Normal Operating Ranges for Lake Levels	See Attached	NA	See Attached Reference Lake Stabilization Program	
	Minimum Flow (cfs)	80	Inflow	0	
	MADF (cfs)	311	Inflow	311	
MT. ISLAND DEVELOPMENT					
Mt Island Lake & PH	Normal Operating Ranges for Lake Levels	See Attached	NA	See Attached	
	Minimum Flow (cfs)	80	Inflow	0	
	Bypass Flow (cfs)	0	NA	0	
	MADF (cfs)	314	Inflow	314	
WYLIE DEVELOPMENT					
Lake Wylie & PH	Normal Operating Ranges for Lake Levels	See Attached	NA	See Attached Reference Lake Stabilization Program	
	Minimum Flow (cfs)	1 unit at best efficiency every third hour	Inflow	See Schedule	
	Prescribed Recreation Flow Releases (cfs)	0	Inflow	See Schedule	
	MADF (cfs)	619 (CMUD)	Inflow	0	
FISHING CREEK DEVELOPMENT					
F. Creek Reservoir & PH	Normal Operating Ranges for Lake Levels	See Attached	NA	See Attached	
	Minimum Flow (cfs)	0	Inflow	0	
	MADF (cfs)	440	Inflow	440	
GREAT FALLS / DEARBORN DEVELOPMENT					
Great Falls-Dearborn Reservoir	Normal Operating Ranges for Lake Levels	See Attached	NA	See Attached	
	Prescribed Recreation Flow Releases (cfs)	0	Inflow	See Schedule	
	Habitat – Short & Long Bypassed Reaches combined (cfs)	0	NA	See Schedule	
		0			
Great Falls PH	Minimum Flow (cfs)	0	Inflow	0	
Dearborn PH	Minimum Flow (cfs)	0	Inflow	0	
	MADF (cfs)	444	Inflow	0	
ROCKY CREEK / CEDAR CREEK DEVELOPMENT					
Cedar Creek Reservoir	Normal Operating Ranges for Lake Levels	See Attached	NA	See Attached	
Rocky Creek PH	Minimum Flow (cfs)	0	Inflow	0	
Cedar Creek PH	Minimum Flow (cfs)	0	Inflow	0	
	MADF (cfs)	445	Inflow	445	
WATEREE DEVELOPMENT					

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Facility	***Constraint***	***Baseline***	***Run of River***	***Mutual Gain***	
Lake Wateree & PH	Normal Operating Ranges for Lake Levels	See Attached	NA	See Attached Reference Lake Stabilization Program	
	Minimum Flow (cfs)	0	Inflow	See Schedule	
	Prescribed Recreation Flow Releases (cfs)	0	Inflow	See Schedule	
	Bypass Flow (cfs)	0	NA	0	
	MADF (cfs)	800	Inflow	0	

MADF = Minimum Average Daily Flow

PH = Powerhouse

Revised 11/09/05

Target Elevations (100ft = Full Pond) as of Day 1 of Each Month

	Lake James				Lake Rhodhiss			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	96	100	96	96	97	100	97	97
February	94	100	94	94	97	100	97	97
March	92	100	95	95	97	100	97	97
April	94	100	96	96	97	100	97	97
May	96	100	97	98	97	100	97	97
June	98	100	98	98	97	100	97	97
July	98	100	98	98	97	100	97	97
August	98	100	98	98	97	100	97	97
September	98	100	98	98	97	100	97	97
October	96	100	96	98	97	100	97	97
November	96	100	96	96	97	100	97	97
December	96	100	96	96	97	100	97	97

	Lake Hickory				Lookout Shoals Lake			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	97	100	96	96	97	100	97	97
February	97	100	96	96	97	100	97	97
March	97	100	97	97	97	100	97	97
April	97	100	97	97	97	100	97	97
May	97	100	97	97	97	100	97	97
June	97	100	97	97	97	100	97	97
July	97	100	97	97	97	100	97	97
August	97	100	97	97	97	100	97	97
September	97	100	97	97	97	100	97	97
October	97	100	97	97	97	100	97	97
November	97	100	97	97	97	100	97	97
December	97	100	97	97	97	100	97	97

	Lake Norman				Mountain Island Lake			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	96	100	96	96	96	100	96	96
February	94	100	94	94	96	100	96	96
March	92	100	95	95.26	96	100	96	96
April	94	100	96	96.65	96	100	96	96
May	96	100	97	98	96	100	96	96
June	98	100	98	98	96	100	96	96
July	98	100	98	98	96	100	96	96
August	98	100	98	98	96	100	96	96
September	98	100	98	98	96	100	96	96
October	97.67	100	97	98	96	100	96	96
November	97.33	100	97	97	96	100	96	96
December	97	100	97	96	96	100	96	96

Note: Modelers have the flexibility to adjust the Run of River Scenario elevations below 100 if required for model stability at start-up.
(Example: 99.8 vs. 100)

Revised 11/09/05

Target Elevations (100ft = Full Pond) as of Day 1 of Each Month

	Lake Wylie				Fishing Creek Reservoir			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	97	100	97	97	97	100	97	98
February	97	100	97	97	97	100	97	98
March	97	100	97	97	97	100	97	98
April	97	100	97	97	97	100	97	98
May	97	100	97	97	97	100	97	98
June	97	100	97	97	97	100	97	98
July	97	100	97	97	97	100	97	98
August	97	100	97	97	97	100	97	98
September	97	100	97	97	97	100	97	98
October	97	100	97	97	97	100	97	98
November	97	100	97	97	97	100	97	98
December	97	100	97	97	97	100	97	98

	Great Falls – Dearborn Reservoir				Cedar Creek Reservoir			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	98	100	97.5	97.5	98	100	97.5	97.5
February	98	100	97.5	97.5	98	100	97.5	97.5
March	98	100	97.5	97.5	98	100	97.5	97.5
April	98	100	97.5	97.5	98	100	97.5	97.5
May	98	100	97.5	97.5	98	100	97.5	97.5
June	98	100	97.5	97.5	98	100	97.5	97.5
July	98	100	97.5	97.5	98	100	97.5	97.5
August	98	100	97.5	97.5	98	100	97.5	97.5
September	98	100	97.5	97.5	98	100	97.5	97.5
October	98	100	97.5	97.5	98	100	97.5	97.5
November	98	100	97.5	97.5	98	100	97.5	97.5
December	98	100	97.5	97.5	98	100	97.5	97.5

	Lake Wateree			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	94.5	100	94.5	94.5
February	95.5	100	95	95
March	97	100	97	97
April	97	100	97	97
May	97	100	97	97
June	97	100	97	97
July	97	100	97	97
August	97	100	97	97
September	97	100	97	97
October	97	100	97	97
November	97	100	97	97
December	95.5	100	95	95

222.5 FP = 225.5

Note: Modelers have the flexibility to adjust the Run of River Scenario elevations below 100 if required for model stability at start-up.

Revised 11/09/05

Normal Maximum Elevations (100ft = Full Pond) as of Day 1 of Each Month

	Lake James				**Lake Rhodhiss**			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	100	100	99.5	100	100	100	99.5	100
February	100	100	99.5	100	100	100	99.5	100
March	100	100	99.5	100	100	100	99.5	100
April	100	100	99.5	100	100	100	99.5	100
May	100	100	99.5	100	100	100	99.5	100
June	100	100	99.5	100	100	100	99.5	100
July	100	100	99.5	100	100	100	99.5	100
August	100	100	99.5	100	100	100	99.5	100
September	100	100	99.5	100	100	100	99.5	100
October	100	100	99.5	100	100	100	99.5	100
November	100	100	99.5	100	100	100	99.5	100
December	100	100	99.5	100	100	100	99.5	100

	Lake Hickory				**Lookout Shoals Lake**			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	100	100	99.5	100	100	100	99.5	100
February	100	100	99.5	100	100	100	99.5	100
March	100	100	99.5	100	100	100	99.5	100
April	100	100	99.5	100	100	100	99.5	100
May	100	100	99.5	100	100	100	99.5	100
June	100	100	99.5	100	100	100	99.5	100
July	100	100	99.5	100	100	100	99.5	100
August	100	100	99.5	100	100	100	99.5	100
September	100	100	99.5	100	100	100	99.5	100
October	100	100	99.5	100	100	100	99.5	100
November	100	100	99.5	100	100	100	99.5	100
December	100	100	99.5	100	100	100	99.5	100

	Lake Norman				**Mountain Island Lake**			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	100	100	99.5	100	100	100	99.5	100
February	100	100	99.5	100	100	100	99.5	100
March	100	100	99.5	100	100	100	99.5	100
April	100	100	99.5	100	100	100	99.5	100
May	100	100	99.5	100	100	100	99.5	100
June	100	100	99.5	100	100	100	99.5	100
July	100	100	99.5	100	100	100	99.5	100
August	100	100	99.5	100	100	100	99.5	100
September	100	100	99.5	100	100	100	99.5	100
October	100	100	99.5	100	100	100	99.5	100
November	100	100	99.5	100	100	100	99.5	100
December	100	100	99.5	100	100	100	99.5	100

Revised 11/09/05

Normal Maximum Elevations (100ft = Full Pond) as of Day 1 of Each Month

	Lake Wylie				Fishing Creek Reservoir			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	100	100	99.5	100	100	100	99.5	100
February	100	100	99.5	100	100	100	99.5	100
March	100	100	99.5	100	100	100	99.5	100
April	100	100	99.5	100	100	100	99.5	100
May	100	100	99.5	100	100	100	99.5	100
June	100	100	99.5	100	100	100	99.5	100
July	100	100	99.5	100	100	100	99.5	100
August	100	100	99.5	100	100	100	99.5	100
September	100	100	99.5	100	100	100	99.5	100
October	100	100	99.5	100	100	100	99.5	100
November	100	100	99.5	100	100	100	99.5	100
December	100	100	99.5	100	100	100	99.5	100

	Great Falls – Dearborn Reservoir				Cedar Creek Reservoir			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	100	100	99.5	100	100	100	99.5	100
February	100	100	99.5	100	100	100	99.5	100
March	100	100	99.5	100	100	100	99.5	100
April	100	100	99.5	100	100	100	99.5	100
May	100	100	99.5	100	100	100	99.5	100
June	100	100	99.5	100	100	100	99.5	100
July	100	100	99.5	100	100	100	99.5	100
August	100	100	99.5	100	100	100	99.5	100
September	100	100	99.5	100	100	100	99.5	100
October	100	100	99.5	100	100	100	99.5	100
November	100	100	99.5	100	100	100	99.5	100
December	100	100	99.5	100	100	100	99.5	100

	Lake Wateree			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	100	100	99.5	100
February	100	100	99.5	100
March	100	100	99.5	100
April	100	100	99.5	100
May	100	100	99.5	100
June	100	100	99.5	100
July	100	100	99.5	100
August	100	100	99.5	100
September	100	100	99.5	100
October	100	100	99.5	100
November	100	100	99.5	100
December	100	100	99.5	100

Revised 11/09/05

Normal Minimum Elevations (100ft = Full Pond) as of Day 1 of Each Month

	Lake James				Lake Rhodhiss			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	61	NA	94	93	89.4	NA	95	94
February	61	NA	92	92	89.4	NA	95	94
March	61	NA	92	92	89.4	NA	95	94
April	61	NA	92	92	89.4	NA	95	94
May	61	NA	94	95	89.4	NA	95	94
June	61	NA	96	95	89.4	NA	95	94
July	61	NA	96	95	89.4	NA	95	94
August	61	NA	96	95	89.4	NA	95	94
September	61	NA	96	95	89.4	NA	95	94
October	61	NA	94	95	89.4	NA	95	94
November	61	NA	94	93	89.4	NA	95	94
December	61	NA	94	93	89.4	NA	95	94

	Lake Hickory				Lookout Shoals Lake			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	94	NA	95	94	74.9	NA	95	94
February	94	NA	95	94	74.9	NA	95	94
March	94	NA	95	94	74.9	NA	95	94
April	94	NA	95	94	74.9	NA	95	94
May	94	NA	95	94	74.9	NA	95	94
June	94	NA	95	94	74.9	NA	95	94
July	94	NA	95	94	74.9	NA	95	94
August	94	NA	95	94	74.9	NA	95	94
September	94	NA	95	94	74.9	NA	95	94
October	94	NA	95	94	74.9	NA	95	94
November	94	NA	95	94	74.9	NA	95	94
December	94	NA	95	94	74.9	NA	95	94

	Lake Norman				Mountain Island Lake			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	90	NA	94	93	94.3	NA	94.5	94.3
February	90	NA	92	91	94.3	NA	94.5	94.3
March	90	NA	92	92.26	94.3	NA	94.5	94.3
April	90	NA	92	93.65	94.3	NA	94.5	94.3
May	90	NA	94	95	94.3	NA	94.5	94.3
June	90	NA	96	95	94.3	NA	94.5	94.3
July	90	NA	96	95	94.3	NA	94.5	94.3
August	90	NA	96	95	94.3	NA	94.5	94.3
September	90	NA	96	95	94.3	NA	94.5	94.3
October	90	NA	95	95	94.3	NA	94.5	94.3
November	90	NA	94	93.98	94.3	NA	94.5	94.3
December	90	NA	94	93	94.3	NA	94.5	94.3

FP= 760

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Normal Minimum Elevations (100ft = Full Pond) as of Day 1 of Each Month

	Lake Wylie				Fishing Creek Reservoir			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	92.6	NA	95	94	95	NA	95	95
February	92.6	NA	95	94	95	NA	95	95
March	92.6	NA	95	94	95	NA	95	95
April	92.6	NA	95	94	95	NA	95	95
May	92.6	NA	95	94	95	NA	95	95
June	92.6	NA	95	94	95	NA	95	95
July	92.6	NA	95	94	95	NA	95	95
August	92.6	NA	95	94	95	NA	95	95
September	92.6	NA	95	94	95	NA	95	95
October	92.6	NA	95	94	95	NA	95	95
November	92.6	NA	95	94	95	NA	95	95
December	92.6	NA	95	94	95	NA	95	95

	Great Falls – Dearborn Reservoir				Cedar Creek Reservoir			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	87.2	NA	95	95	80.3	NA	96	96**
February	87.2	NA	95	95	80.3	NA	96	96**
March	87.2	NA	95	95	80.3	NA	96	96**
April	87.2	NA	95	95	80.3	NA	96	96**
May	87.2	NA	95	95	80.3	NA	96	96**
June	87.2	NA	95	95	80.3	NA	96	96**
July	87.2	NA	95	95	80.3	NA	96	96**
August	87.2	NA	95	95	80.3	NA	96	96**
September	87.2	NA	95	95	80.3	NA	96	96**
October	87.2	NA	95	95	80.3	NA	96	96**
November	87.2	NA	95	95	80.3	NA	96	96**
December	87.2	NA	95	95	80.3	NA	96	96**

	Lake Wateree			
Month	***Baseline***	***Run of River***	***Recreation***	***Mutual Gain***
January	88.5	NA	94	93
February	88.5	NA	94	93
March	88.5	NA	94	94
April	88.5	NA	94	94
May	88.5	NA	94	94
June	88.5	NA	94	94
July	88.5	NA	94	94
August	88.5	NA	94	94
September	88.5	NA	94	94
October	88.5	NA	94	94
November	88.5	NA	94	93
December	88.5	NA	94	93

FC = 2259

Revised 11/09/05

Prescribed Recreation Flow Releases

Scenario	Development	Use Date Schedule	Date	Flow (cfs) released from Hydro Development	Start Hour	End Hour
Mutual Gain	**Bridgewater**	Yes	April 1 thru 30 - Last Full Weekend for two days	900	1100	1600
			May 1 thru September 30 Each Fri, Sat & Sun Plus Memorial, July 4 and Labor day	900	1100	1600
			June 1 thru July 31 Each Wed & Thur	900	1600	1800
			Oct 1 thru 31 – First full weekend two days	900	1100	1600
			Two Floating Days during the Year	One Unit at 900	1100	1600
Mutual Gain	**Oxford**	Yes	April 1 thru 30– Last Full Weekend for two days	2600	1100	1600
			May 1 thru September 30 Each Sat & Sun Plus Memorial, July 4 and Labor day	2600	1100	1600
			Oct 1 thru 31– First full weekend two days	2600	1100	1600
			Two Floating Days during the Year	One Unit at 2600	1100	1600
Mutual Gain	**Wylie**	Yes	April 1 thru 30– Last Full Weekend for two days	See Min. Flow Page 2		
			April 1 thru 30– Last Full Weekend for two days	3000	1000	1600

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Scenario	Development	Use Date Schedule	Date	Flow (cfs) released from Hydro Development	Start Hour	End Hour
			May 1 thru June 15 Each Fri, Sat & Sun plus Memorial Day	See Min. Flow Page 2		
			May 1 thru June 15 Each Fri, Sat & Sun plus Memorial Day	3000	1000	1600
Mutual Gain	**Wylie**	Yes	June 16 thru Sept 30 Each Fri, Sat & Sun plus July 4 and Labor Day	See Min. Flow Page 2		
			June 16 thru Sept 30 Each Fri, Sat & Sun plus July 4 and Labor Day	6000	1000	1600
			Oct 1 thru 31- First full weekend two days	See Min. Flow Page 2		
			Oct 1 thru 31- First full weekend two days	6000	1000	1600
			Two Floating Days during the Year	One Unit at 3000	1100	1600
Mutual Gain	**Great Falls Long Bypass**	Yes	March 1 thru Oct 31 Two Sat per Month	2940	*1000	1500
			March 1 thru Oct 31 A total of 4 Sundays to give 4 two-day weekends in the period	2940	*1000	1500
	Short Bypass		May 1 thru Oct 31 Two weekends (two days) per month	2860	*1000	1500

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Scenario	**Development**	**Use Date Schedule**	**Date**	**Flow (cfs) released from Hydro Development**	**Start Hour**	**End Hour**
			March 1 thru 31 & April 1 thru 30 One Sat per month to correspond to Long Channel release	2860	*1000	1500
	Great Falls Bypass		Two Floating Days during the Year	5800*	1000*	1500
				* Note: In CHEOPS these flows are modeled as total Bypass flows of equal volume over 24 hours		
Mutual Gain	**Wateree**	Yes	April 1 thru 30– Last Full Weekend for two days	2760	1100	1600
			May 1 thru September 30 Each Sat & Sun Plus Memorial, July 4 and Labor day	2760	1100	1600
			Oct 1 thru 31– First full weekend two days	2760	1100	1600
			Two Floating Days during the Year	One Unit at 2760	1100	1600

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Aquatic Habitat Mutual Gains Flow Scenarios

Bridgewater Development (10/28/05)

Month	Minimum Flows from Linville Dam & PH(cfs)	Catawba Dam Bypass Flows (cfs)	Combined Flows below OCC Confluence (cfs)	Critical Low Flows below OCC Confluence (cfs)
Jan	145	75	220	100
Feb	145	75	220	100
Mar	145	75	220	100
Apr	95	75	170	100
May	95	75	170	100
Jun	95	75	170	100
Jul	95	50	145	100
Aug	75	50	125	100
Sep	75	50	125	100
Oct	75	50	125	100
Nov	75	50	125	100
Dec	145	75	220	100

Oxford Development (11/09/05)

Month	Minimum Flows from Lake Hickory & PH (cfs)	LIP Critical Low Flows below Lake Hickory (cfs)
Jan	150	100
Feb	200	100
Mar	200	100
Apr	200	100
May	200	100
Jun	150	100
Jul	150	100
Aug	150	100
Sep	150	100
Oct	150	100
Nov	150	100
Dec	150	100

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Wylie Development (11/09/05)

Month	Minimum Flows from Wylie Hydro (cfs)	LIP Critical Low Flows (cfs)
Jan	1100	700
Feb 15*	1100	700
Mar *	1100	700
Apr*	1100	700
May 15*	1100	700
Jun	1100	700
Jul	1100	700
Aug	1100	700
Sep	1100	700
Oct	1100	700
Nov	1100	700
Dec	1100	700

Note * Provided Duke Power is not operating in the LIP or the Maintenance and Emergency Protocol, then the HIP would be implemented at Wylie.

Great Falls Bypassed Channels (11/09/05)

Month	Bypass Flows for Combined (Long and Short) Reaches (cfs)	LIP Critical Low Flows (cfs)
Jan	550	530
Feb 15	950	530
Mar	950	530
Apr	950	530
May 15	950	530
Jun	550	530
Jul	550	530
Aug	550	530
Sep	550	530
Oct	550	530
Nov	550	530
Dec	550	530

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Wateree Development (10/28/05)

Month	Minimum Flows from Wateree Hydro (cfs)	LIP Critical Low Flows (cfs)
Jan	930	800
Feb 1-14	930	800
Feb 15-29	2400	800
Mar 1-31	2700	800
Apr	2700	800
May 1-15	2400	800
May 16-31	1250	800
Jun	930	800
Jul	930	800
Aug	930	800
Sep	930	800
Oct	930	800
Nov	930	800
Dec	930	800

Lake Level Stabilization Program (Ref July 6, 2005 Draft AIP)

Reservoir	***CHEOPS Fluctuation Limit***	***Start Date***	***End Date***
Lake Wateree	1 ft	April 10	April 30
Lake Wylie	1 ft	April 12	May 02
Lake Norman	1 ft	April 18	May 08
Lake James	1 ft	April 24	May 14

Notes:

1. Stabilization Period – Three weeks on each applicable reservoir.
2. Lake Level Variability – reservoir level when the program is initiated on a given reservoir plus two feet, minus one foot.

Loss of Reservoir Volume due to Sedimentation

	Volume Decrease (ac-ft / year)	
Reservoir	***Baseline, Run-of-River****	***Mutual Gains***
Lake James	N/A	Use Standard Table
Lake Rhodhiss	N/A	Use Standard Table
Lake Hickory	N/A	Use Standard Table
Lookout Shoals Lake	N/A	Use Standard Table
Lake Norman	N/A	Use Standard Table
Mountain Island Lake	N/A	Use Standard Table
Lake Wylie	N/A	Use Standard Table
Fishing Creek Reservoir	N/A	Use Standard Table
Great Falls – Dearborn Reservoir	N/A	Use Standard Table
Cedar Creek Reservoir	N/A	Use Standard Table
Lake Wateree	N/A	Use Standard Table

*Notes: No reduction for sedimentation used in typical Wet, Normal & Dry hydrology scenarios.

Revised 11/09/05

Additional Information

1. Current and future withdrawals and returns found in the Operations 04 Water Supply Study Report will be the basis of the inputs to the CHEOPS™ model.
2. Water withdrawals and returns are at projected future rates for year starting in 1953 (2008 projection) and extending thru 2003 (2058 projection) for this Mutual Gain scenario.
3. Hours in the Recreation schedule have been adjusted as coded into CHEOPS. Total flow time has been preserved but the start and stop times modified to match the hard code schedule in CHEOPS.
4. Use Lake Level Stabilization Program as proposed in the July 6, 2005 Draft AIP.
5. LIP code has been used in this CHEOPS model scenario based on the July 15, 2005 revision to Exhibit G of the Draft AIP with adjustments based on the 10/28/05 scenario.
6. HIP code has been used in this CHEOPS model scenario for Feb 15 thru May 15 as stipulated.

Specific Questions this Model Run Should Answer

Impacts of using the Modified Mutual Gain Scenario 11.09.05.

Impacts of using the July 15, 2005 LIP with the modification of requiring both the storage and hydrologic indices and changes to the stage triggers to keep all intakes covered (critical elevations) and meet critical minimum flows downstream of specified hydros. Specifically the number of times each stage of the LIP is entered and for how long.

Appendix D4

Plan Withdrawal Table _ HIGH

Catawba-Wateree Withdrawals Summary Sheet (in mgd)

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
LAKE JAMES								
Industrial								
Coats American	Sevier Finishing Plant	North Fork Catawba River	1.080	1.200	1.400	1.700	2.000	2.300
Municipal								
City of Marion	Marion WTP	Buck Creek, Clear Creek, Mackey Creek	1.500	1.971	2.754	3.559	4.253	4.968
Power								
Duke Energy Corporation	Future - New	Lake James	0.000	0.000	0.000	0.000	0.000	15.300
Agricultural/Irrigation								
Buck Creek Trout Farm	Buck Creek Trout Farm	Buck Creek	1.320	1.400	1.400	1.500	1.600	1.700
Harris Creek Trout Farm	Harris Creek Trout Farm	Harris Creek	0.877	0.900	0.900	1.000	1.000	1.100
NC Wildlife Resources Commission	Armstrong State Fish Hatchery - Upper	Armstrong Creek	0.761	0.800	0.800	0.900	0.900	1.000
NC Wildlife Resources Commission	Armstrong State Fish Hatchery - Lower	Armstrong Creek	3.309	3.400	3.600	3.800	4.000	4.200
NC Wildlife Resources Commission	Armstrong State Fish Hatchery	Bee Rock Creek	0.508	0.500	0.500	0.600	0.600	0.600
NC Wildlife Resources Commission	Marion State Fish Hatchery	Catawba River	0.284	0.300	0.300	0.300	0.300	0.400
Basin Agricultural/Irrigation Demand	Varies	Varies	1.700	1.800	2.200	2.600	3.100	3.900
		LAKE JAMES SUB-BASIN TOTAL FLOW	**11.339**	**12.271**	**13.400**	**14.800**	**17.753**	**35.468**

LAKE RHODHISS

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Municipal								
Town of Granite Falls	Granite Falls WTP	Lake Rhodhiss	0.906	2.169	3.339	4.293	5.145	6.013
City of Lenoir	Lenoir WTP	Lake Rhodhiss	4.041	5.282	6.540	7.644	8.700	9.812
City of Morganton	Catawba River WTP	Catawba River	7.055	8.897	11.308	14.235	16.830	19.152
Town of Valdese	Valdese WTP	Lake Rhodhiss	4.851	6.638	9.063	11.993	14.625	16.824
Caldwell County S		Lenoir	0.511	4.602	8.337	11.252	13.741	16.197
Icard Township		Valdese	0.778	1.190	2.198	3.447	4.385	5.023
Burke County		Morganton, Valdese	0.218	1.061	2.254	3.730	4.820	5.544
Rhodhiss		Granite Falls, Morganton, Valdese	0.057	0.953	2.153	3.638	4.730	5.451
Caldwell County N		Lenoir	0.300	1.514	2.610	3.481	4.241	5.002
Caldwell County SE		Lenoir	0.410	0.882	1.401	1.807	2.155	2.499
Caldwell County W		Lenoir	0.599	1.954	3.240	4.246	5.109	5.961
Sawmills		Lenoir	0.282	1.349	2.304	3.051	3.689	4.320
Baton WC		Lenoir	0.529	1.849	3.034	3.961	4.755	5.538
Joyceton*								
Triple Comm WC		Valdese	0.568	1.718	3.338	5.340	6.817	7.798
Rutherford College*								

Drexel		Morganton	0.240	1.743	3.725	6.177	7.983	9.179
Brentwood WA		Morganton	0.760	2.432	4.640	7.373	9.386	10.717
Brentwood WC		Morganton	0.342	1.610	3.286	5.359	6.886	7.894
Burke Caldwell**			0.220	0.243	0.275	0.312	0.353	0.399
Agricultural/Irrigation								
NC Wildlife Resources Commission	Table Rock State Fish Hatchery	Irish Creek	0.930	1.000	1.000	1.100	1.100	1.200
Basin Agricultural/Irrigation Demand	Varies	Varies	3.600	3.800	4.200	4.700	5.300	6.100
		LAKE RHODHISS SUB-BASIN TOTAL FLOW	**27.197**	**50.884**	**78.244**	**107.138**	**130.752**	**150.625**

LAKE HICKORY

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Municipal								
City of Hickory	Hickory WTP	Lake Hickory	8.944	12.478	18.014	24.186	25.623	32.123
Town of Long View	Long View WTP	Lake Hickory	1.036	1.282	1.587	1.926	2.292	2.678
Bethlehem		Hickory	0.447	1.254	2.401	3.556	4.563	5.270
Alexander County		Hickory	0.730	1.476	2.537	3.608	4.548	5.215
Conover		Hickory	1.553	4.019	7.932	12.087	16.132	19.713
Claremont		Hickory	0.233	2.251	5.161	8.239	11.213	13.814
Icard Twp		Hickory	0.350	0.973	1.799	2.820	3.588	4.110
Burke County		Long View	0.055	0.354	0.751	1.243	1.607	1.848
Rhodhiss		Hickory, Long View	0.013	0.269	0.607	1.026	1.334	1.538
SE Catawba County		Hickory	0.096	3.833	9.214	14.884	20.321	25.002
Taylorsville		Hickory	0.402	0.737	1.414	2.098	2.702	3.135
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	1.200	1.300	1.500	1.800	2.100	2.500
		LAKE HICKORY SUB-BASIN TOTAL FLOW	**15.058**	**30.226**	**52.915**	**77.474**	**96.024**	**116.946**

LOOKOUT SHOALS LAKE

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Municipal								
City of Statesville (Under Construction)	Statesville WTP	Lookout Shoals Lake	0	4.5	5.5	6.6	8	9
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	1.2	1.3	1.6	1.9	2.2	2.7
		LOOKOUT SHOALS LAKE SUB-BASIN TOTAL FLOW	**1.2**	**5.8**	**7.1**	**8.5**	**10.2**	**11.7**

LAKE NORMAN

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Industrial								

Burlington Industries	Mooresville Plant		0.000	0.000	0.000	0.000	0.000	0.000
Municipal								
Charlotte-Mecklenburg	North Mecklenburg WTP	Lake Norman	17.319	27.626	40.420	53.666	66.604	79.744
Lincoln County	Lincoln County WTP	Lake Norman	2.102	4.008	6.786	9.539	12.269	14.873
Town of Mooresville	Mooresville WTP	Lake Norman	3.579	12.269	22.993	32.989	42.800	53.637
Corcord/Kannapolis/Cabarrus Co.	Future - New - IBT	Lake Norman	0.000	0.000	5.000	10.000	15.000	23.000
Power								
Duke Energy Corporation	Marshall Steam Station	Lake Norman	0.000	13.100	13.100	13.100	13.100	13.100
Duke Energy Corporation	McGuire Nuclear Station	Lake Norman	0.000	23.300	23.300	23.300	23.300	23.300
Duke Energy Corporation	Future - New	Lake Norman	0.000	0.000	9.600	9.600	9.600	26.100
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	2.800	2.900	3.200	3.500	3.800	4.200
		LAKE NORMAN SUB-BASIN TOTAL FLOW	**25.800**	**83.203**	**124.400**	**155.694**	**186.473**	**237.954**

MOUNTAIN ISLAND LAKE

Entity	**Facility**	**Source Water**	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal								
Charlotte-Mecklenburg	Franklin and Vest WTP	Mountain Island Lake	90.925	145.037	212.205	281.745	349.670	418.656
City of Gastonia	Gastonia WTP	Mountain Island Lake	10.689	14.660	20.333	21.686	25.237	28.758
City of Mount Holly	Mount Holly WTP	Mountain Island Lake	1.453	3.801	6.678	9.506	12.307	15.097
Lowell		Gastonia	0.430	3.684	7.673	11.508	15.183	18.646
McAdenville		Gastonia	0.372	3.098	6.444	9.679	12.791	15.744
Cramerton		Gastonia	0.355	2.147	4.334	6.418	8.432	10.335
Stanley		Mount Holly	0.812	2.825	5.555	8.206	10.737	13.141
Power								
Duke Energy Corporation	Riverbend Steam Station	Mountain Island Lake	2.500	2.500	2.500	2.500	2.500	2.500
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	0.800	0.800	0.900	0.900	1.000	1.000
		MOUNTAIN ISLAND LAKE SUB-BASIN TOTAL FLOW	**108.336**	**178.553**	**266.621**	**352.149**	**437.857**	**523.876**

LAKE WYLIE

Entity	**Facility**	**Source Water**	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
Industrial								
American & Efird, Inc.	Dyeing & Finishing Plant 15	Catawba River	1.820	1.820	1.820	1.820	1.820	1.820
Clariant Corporation	Mt. Holly Plant	Catawba River	0.260	0.300	0.500	0.800	1.200	1.800
Cramer Mountain Finishing LLC	Cramer Mountain Finishing	South Fork Catawba River	1.360	1.400	1.700	2.000	2.300	2.700
Hedrich Industries	Lake Norman Quarry	Forney Creek	0.680	0.700	0.800	1.000	1.100	1.400
Siemens Westinghouse	Siemens Westinghouse	Catawba River	10.700	10.800	10.800	10.800	10.800	10.800

Municipal								
City of Belmont	Belmont WTP	Lake Wylie	2.483	4.623	6.970	9.283	11.640	13.843
Bessemer City	J.V. Tarpley WTP	Long Creek, Arrowood	0.861	3.000	5.443	7.825	10.129	12.334
City of Cherryville	Cherryville WTP	Indian Creek	0.821	2.661	4.992	7.118	9.223	11.220
Town of Dallas	Dallas WTP	South Fork Catawba River	0.572	2.338	4.495	6.436	8.421	10.293
Town of High Shoals	High Shoals WTP	South Fork Catawba River	0.064	2.488	5.448	8.306	11.034	13.604
City of Lincolnton	Lincolnton WTP	South Fork Catawba River	4.310	7.372	11.456	15.668	19.840	23.808
City of Newton	Newton WTP	Jacobs Fork, City Lake	2.334	6.155	11.665	17.546	23.261	28.306
Energy United		Newton	0.000	1.733	2.389	3.607	4.516	5.231
Taylorsville		Energy United	0.000	1.474	2.827	4.196	5.403	6.269
West Iredell		Energy United	0.000	5.683	12.436	19.541	27.055	35.559
Town of Stanley	Stanley WTP	Hoyle Creek	0.406	1.413	2.777	4.103	5.368	6.570
Catawba		Newton	0.073	2.480	5.941	9.591	13.091	16.104
Maiden		Lake Wylie	1.459	4.337	8.405	12.722	16.919	20.629
Rock Hill		Lake Wylie	13.600	14.300	17.400	21.200	25.800	31.500
Tega Cay			0.000	0.000	0.000	0.000	0.000	0.000
Power								
Duke Energy Corporation	Allen Steam Plant	Lake Wylie	0.000	6.100	6.100	6.100	6.100	6.100
Duke Energy Corporation	Lincoln Combustion Turbine Facility	Killian Creek	NA	NA	NA	NA	NA	NA
Duke Energy Corporation	Catawba Nuclear Station	Lake Wylie	0.000	35.800	35.800	35.800	35.800	35.800
Duke Energy Corporation	Future - New	Lake Wylie	0.000	0.000	0.000	11.100	11.100	11.100
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	8.500	8.800	9.600	10.400	11.400	12.600
		LAKE WYLIE SUB-BASIN TOTAL FLOW	**50.303**	**125.777**	**169.765**	**226.963**	**273.322**	**319.389**

FISHING CREEK RESERVOIR

Entity	**Facility**	**Source Water**	**2002**	**2010**	**2020**	**2030**	**2040**	**2050**
Industrial								
Celanese Acetate	Celriver Plant	Catawba River	36.100	60.000	60.000	60.000	60.000	60.000
Bowater	Pulp and Paper Mill	Catawba River	25.300	30.000	31.500	33.100	34.800	36.600
Springs Industrial	Grace Complex	Catawba River	10.600	10.900	11.500	12.000	12.700	13.300
Nation Ford Chemical		Catawba River	1.100	1.200	1.600	2.200	2.900	4.000
Municipal								
Rock Hill (Emergency/Backup)		Catawba River	0.000	0.000	0.000	0.000	0.000	0.000
Union County	Catawba River Plant	Catawba River	5.925	15.144	25.335	36.097	49.168	66.160
Wingate		Union County	0.258	8.031	17.001	26.585	38.341	53.816
Lancaster County	Catawba River Plant	Catawba River	6.300	7.500	9.100	10.600	12.300	13.500
Chester Metro		Catawba River	3.500	4.000	4.900	6.200	7.200	8.300

Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	8.200	8.400	8.800	9.300	9.800	10.300
		FISHING CREEK RESERVOIR SUB-BASIN TOTAL FLOW	**97.283**	**145.175**	**169.736**	**196.082**	**227.209**	**265.976**

GREAT FALLS - DEARBORN RESERVOIR

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	1.4	1.5	1.6	1.7	1.9	2.1
		GREAT FALLS - DEARBORN RESERVOIR SUB-BASIN TOTAL FLOW	**1.4**	**1.5**	**1.6**	**1.7**	**1.9**	**2.1**

CEDAR CREEK RESERVOIR

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	0.6	0.6	0.7	0.7	0.8	0.8
		CEDAR CREEK RESERVOIR SUB-BASIN TOTAL FLOW	**0.6**	**0.6**	**0.7**	**0.7**	**0.8**	**0.8**

LAKE WATEREE

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Municipal								
Camden		Lake Wateree	2.8	2.7	3.2	3.7	4.2	4.9
Lugoff Elgin Water Authority		Lake Wateree	2.3	3.6	4.8	6.0	6.8	7.8
Power								
Duke Energy Corporation	Future - New	Lake Wateree	NA	0.0	0.0	0.0	13.1	13.1
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	1.2	1.2	1.3	1.4	1.5	1.6
		LAKE WATEREE SUB-BASIN TOTAL FLOW	**6.3**	**7.5**	**9.3**	**11.0**	**25.7**	**27.4**

NOTE: Duke Power Withdrawals are actually net consumptive use or "outflows" from the system. No return projections are given for these facilites since the values reported here are for net outflow

Appendix D5

Plan Withdrawal Table _ LOW

Catawba-Wateree Withdrawals Summary Sheet (in mgd)

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
LAKE JAMES								
Industrial								
Coats American	Sevier Finishing Plant	North Fork Catawba River	1.080	1.200	1.400	1.700	2.000	2.300
Municipal								
City of Marion	Marion WTP	Buck Creek, Clear Creek, Mackey Creek	1.500	1.611	1.860	2.148	2.482	2.868
Power								
Duke Energy Corporation	Future - New	Lake James	0.000	0.000	0.000	0.000	0.000	15.300
Agricultural/Irrigation								
Buck Creek Trout Farm	Buck Creek Trout Farm	Buck Creek	1.320	1.400	1.400	1.500	1.600	1.700
Harris Creek Trout Farm	Harris Creek Trout Farm	Harris Creek	0.877	0.900	0.900	1.000	1.000	1.100
NC Wildlife Resources Commission	Armstrong State Fish Hatchery - Upper	Armstrong Creek	0.761	0.800	0.800	0.900	0.900	1.000
NC Wildlife Resources Commission	Armstrong State Fish Hatchery - Lower	Armstrong Creek	3.309	3.400	3.600	3.800	4.000	4.200
NC Wildlife Resources Commission	Armstrong State Fish Hatchery	Bee Rock Creek	0.508	0.500	0.500	0.600	0.600	0.600
NC Wildlife Resources Commission	Marion State Fish Hatchery	Catawba River	0.284	0.300	0.300	0.300	0.300	0.400
Basin Agricultural/Irrigation Demand	Varies	Varies	1.700	1.800	2.200	2.600	3.100	3.900
		LAKE JAMES SUB-BASIN TOTAL FLOW	**11.339**	**11.911**	**12.960**	**14.548**	**15.982**	**33.368**

LAKE RHODHISS

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Municipal								
Town of Granite Falls	Granite Falls WTP	Lake Rhodhiss	0.906	1.022	1.178	1.321	1.483	1.670
City of Lenoir	Lenoir WTP	Lake Rhodhiss	4.041	4.420	4.954	5.563	6.138	6.719
City of Morganton	Catawba River WTP	Catawba River	7.055	7.903	8.914	10.112	11.535	13.236
Town of Valdese	Valdese WTP	Lake Rhodhiss	4.851	5.519	6.485	7.621	8.956	10.333
Caldwell County S		Lenoir	0.511	0.443	0.452	0.461	0.470	0.480
Icard Township		Valdese	0.778	0.473	0.512	0.559	0.614	0.672
Burke County		Morganton, Valdese	0.218	0.182	0.208	0.239	0.273	0.313
Rhodhiss		Granite Falls, Morganton, Valdese	0.057	0.047	0.049	0.051	0.056	0.062
Caldwell County N		Lenoir	0.300	0.336	0.377	0.425	0.482	0.549
Caldwell County SE		Lenoir	0.410	0.313	0.323	0.333	0.345	0.356
Caldwell County W		Lenoir	0.599	0.539	0.557	0.576	0.596	0.619
Sawmills		Lenoir	0.282	0.300	0.324	0.350	0.371	0.385
Baton WC		Lenoir	0.529	0.563	0.606	0.634	0.669	0.700
Joyceton*								
Triple Comm WC		Valdese	0.568	0.538	0.610	0.692	0.785	0.890

Rutherford College*								
Drexel		Morganton	0.240	0.265	0.302	0.344	0.391	0.446
Brentwood WA		Morganton	0.760	0.801	0.844	0.892	0.944	0.997
Brentwood WC		Morganton	0.342	0.354	0.371	0.393	0.417	0.447
Burke Caldwell**			0.220	0.243	0.275	0.312	0.353	0.399
Agricultural/Irrigation								
NC Wildlife Resources Commission	Table Rock State Fish Hatchery	Irish Creek	0.930	1.000	1.000	1.100	1.100	1.200
Basin Agricultural/Irrigation Demand	Varies	Varies	3.600	3.800	4.200	4.700	5.300	6.100
		LAKE RHODHISS SUB-BASIN TOTAL FLOW	**27.197**	**29.060**	**32.539**	**36.676**	**41.279**	**46.572**

LAKE HICKORY

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Municipal								
City of Hickory	Hickory WTP	Lake Hickory	8.944	10.448	12.226	14.362	16.673	19.609
Town of Long View	Long View WTP	Lake Hickory	1.036	1.170	1.363	1.581	1.821	2.098
Bethlehem		Hickory	0.447	0.524	0.622	0.716	0.813	0.925
Alexander County		Hickory	0.730	0.855	1.011	1.151	1.298	1.465
Conover		Hickory	1.553	1.684	2.139	2.659	3.223	3.908
Claremont		Hickory	0.233	0.269	0.323	0.387	0.463	0.555
Icard Twp		Hickory	0.350	0.387	0.419	0.457	0.503	0.550
Burke County		Long View	0.055	0.061	0.069	0.080	0.091	0.104
Rhodhiss		Hickory, Long View	0.013	0.013	0.014	0.014	0.016	0.018
SE Catawba County		Hickory	0.096	0.112	0.137	0.167	0.204	0.248
Taylorsville		Hickory	0.402	0.309	0.339	0.374	0.413	0.460
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	1.200	1.300	1.500	1.800	2.100	2.500
		LAKE HICKORY SUB-BASIN TOTAL FLOW	**15.058**	**17.134**	**20.161**	**23.749**	**27.617**	**32.439**

LOOKOUT SHOALS LAKE

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Municipal								
City of Statesville (Under Construction)	Statesville WTP	Lookout Shoals Lake	0	4.5	5.5	6.6	8	9
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	1.2	1.3	1.6	1.9	2.2	2.7
		LOOKOUT SHOALS LAKE SUB-BASIN TOTAL FLOW	**1.2**	**5.8**	**7.1**	**8.5**	**10.2**	**11.7**

LAKE NORMAN

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Industrial								
Burlington Industries	Mooresville Plant		0.000	0.000	0.000	0.000	0.000	0.000
Municipal								
Charlotte-Mecklenburg	North Mecklenburg WTP	Lake Norman	17.319	20.849	24.662	26.338	25.643	25.479
Lincoln County	Lincoln County WTP	Lake Norman	2.102	2.539	3.218	4.080	5.178	6.542
Town of Mooresville	Mooresville WTP	Lake Norman	3.579	5.904	8.091	9.085	9.148	7.314
Corcord/Kannapolis/Cabarrus Co.	Future - New - IBT	Lake Norman	0.000	0.000	5.000	10.000	15.000	23.000
Power								
Duke Energy Corporation	Marshall Steam Station	Lake Norman	0.000	13.100	13.100	13.100	13.100	13.100
Duke Energy Corporation	McGuire Nuclear Station	Lake Norman	0.000	23.300	23.300	23.300	23.300	23.300
Duke Energy Corporation	Future - New	Lake Norman	0.000	0.000	9.600	9.600	9.600	26.100
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	2.800	2.900	3.200	3.500	3.800	4.200
		LAKE NORMAN SUB-BASIN TOTAL FLOW	**25.800**	**68.592**	**90.170**	**99.004**	**104.768**	**129.036**

MOUNTAIN ISLAND LAKE

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Municipal								
Charlotte-Mecklenburg	Franklin and Vest WTP	Mountain Island Lake	90.925	109.459	129.473	138.274	134.626	133.766
City of Gastonia	Gastonia WTP	Mountain Island Lake	10.689	14.044	19.109	16.299	18.950	22.034
City of Mount Holly	Mount Holly WTP	Mountain Island Lake	1.453	1.688	2.036	2.456	2.964	3.578
Lowell		Gastonia	0.430	0.486	0.521	0.543	0.581	0.621
McAdenville		Gastonia	0.372	0.434	0.528	0.587	0.690	0.812
Cramerton		Gastonia	0.355	0.459	0.530	0.544	0.634	0.710
Stanley		Mount Holly	0.812	0.844	0.910	0.979	1.060	1.155
Power								
Duke Energy Corporation	Riverbend Steam Station	Mountain Island Lake	2.500	2.500	2.500	2.500	2.500	2.500
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	0.800	0.800	0.900	0.900	1.000	1.000
		MOUNTAIN ISLAND LAKE SUB-BASIN TOTAL FLOW	**108.336**	**130.714**	**156.507**	**163.081**	**163.004**	**166.177**

LAKE WYLIE

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Industrial								
American & Efird, Inc.	Dyeing & Finishing Plant 15	Catawba River	1.820	1.800	1.800	1.800	1.800	1.800
Clariant Corporation	Mt. Holly Plant	Catawba River	0.260	0.300	0.500	0.800	1.200	1.800

Cramer Mountain Finishing LLC	Cramer Mountain Finishing	South Fork Catawba River	1.360	1.400	1.700	2.000	2.300	2.700
Hedrich Industries	Lake Norman Quarry	Forney Creek	0.680	0.700	0.800	1.000	1.100	1.400
Siemens Westinghouse	Siemens Westinghouse	Catawba River	10.700	10.800	10.800	10.800	10.800	10.800
Municipal								
City of Belmont	Belmont WTP	Lake Wylie	2.483	2.761	3.157	3.612	4.139	4.746
Bessemer City	J.V. Tarpley WTP	Long Creek, Arrowood	0.861	1.026	1.176	1.350	1.550	1.754
City of Cherryville	Cherryville WTP	Indian Creek	0.821	0.909	1.013	1.139	1.282	1.445
Town of Dallas	Dallas WTP	South Fork Catawba River	0.572	0.578	0.587	0.158	0.609	0.624
Town of High Shoals	High Shoals WTP	South Fork Catawba River	0.064	0.068	0.073	0.079	0.086	0.093
City of Lincolnton	Lincolnton WTP	South Fork Catawba River	4.310	4.894	5.636	6.405	7.300	8.344
City of Newton	Newton WTP	Jacobs Fork, City Lake	2.334	2.622	3.032	3.507	4.057	4.694
Energy United		Newton	0.000	1.374	1.757	2.267	2.783	3.307
Taylorsville		Energy United	0.000	0.619	0.678	0.747	0.827	0.919
West Iredell		Energy United	0.000	0.530	0.679	0.884	0.984	1.369
Town of Stanley	Stanley WTP	Hoyle Creek	0.406	0.422	0.455	0.489	0.530	0.577
Catawba		Newton	0.073	0.082	0.090	0.097	0.103	0.109
Maiden		Lake Wylie	1.459	1.674	1.922	2.190	2.504	2.874
Rock Hill		Lake Wylie	13.600	14.300	17.400	21.200	25.800	31.500
Tega Cay			0.000	0.000	0.000	0.000	0.000	0.000
Power								
Duke Energy Corporation	Allen Steam Plant	Lake wylie	0.000	6.100	6.100	6.100	6.100	6.100
Duke Energy Corporation	Lincoln Combustion Turbine Facility	Killian Creek	NA	NA	NA	NA	NA	NA
Duke Energy Corporation	Catawba Nuclear Station	Lake Wylie	0.000	35.800	35.800	35.800	35.800	35.800
Duke Energy Corporation	Future - New	Lake Wylie	0.000	0.000	0.000	11.100	11.100	11.100
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	8.500	8.800	9.600	10.400	11.400	12.600
		LAKE WYLIE SUB-BASIN TOTAL FLOW	**50.303**	**97.560**	**104.756**	**123.924**	**134.154**	**146.454**

FISHING CREEK RESERVOIR

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Industrial								
Celanese Acetate	Celriver Plant	Catawba River	36.100	60.000	60.000	60.000	60.000	60.000
Bowater	Pulp and Paper Mill	Catawba River	25.300	30.000	31.500	33.100	34.800	36.600
Springs Industrial	Grace Complex	Catawba River	10.600	10.900	11.500	12.000	12.700	13.300
Nation Ford Chemical		Catawba River	1.100	1.200	1.600	2.200	2.900	4.000
Municipal								
Rock Hill (Emergency/Backup)		Catawba River	0.000	0.000	0.000	0.000	0.000	0.000

Union County	Catawba River Plant	Catawba River	5.925	8.253	13.109	19.442	23.077	26.712
Wingate		Union County	0.258	0.489	0.751	1.125	1.705	2.618
Lancaster County	Catawba River Plant	Catawba River	6.300	7.500	9.100	10.600	12.300	13.500
Chester Metro		Catawba River	3.500	4.000	4.900	6.200	7.200	8.300
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	8.200	8.400	8.800	9.300	9.800	10.300
		FISHING CREEK RESERVOIR SUB-BASIN TOTAL FLOW	**97.283**	**130.741**	**141.259**	**153.967**	**164.482**	**175.330**

GREAT FALLS - DEARBORN RESERVOIR

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	1.4	1.5	1.6	1.7	1.9	2.1
		GREAT FALLS - DEARBORN RESERVOIR SUB-BASIN TOTAL FLOW	**1.4**	**1.5**	**1.6**	**1.7**	**1.9**	**2.1**

CEDAR CREEK RESERVOIR

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	0.6	0.6	0.7	0.7	0.8	0.8
		CEDAR CREEK RESERVOIR SUB-BASIN TOTAL FLOW	**0.6**	**0.6**	**0.7**	**0.7**	**0.8**	**0.8**

LAKE WATEREE

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Municipal								
Camden		Lake Wateree	2.8	2.7	3.2	3.7	4.2	4.9
Lugoff Elgin Water Authority		Lake Wateree	2.3	3.6	4.8	6.0	6.8	7.8
Power								
Duke Energy Corporation	Future - New	Lake Wateree	NA	0.0	0.0	0.0	13.1	13.1
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	1.2	1.2	1.3	1.4	1.5	1.6
		LAKE WATEREE SUB-BASIN TOTAL FLOW	**6.3**	**7.5**	**9.3**	**11.0**	**25.7**	**27.4**

NOTE: Duke Power Withdrawals are actually net consumptive use or "outflows" from the system. No return projections are given for these facilites since the values reported here are for net outflow

Appendix D6

Plan Withdrawal Table _ LWSP

Catawba-Wateree Withdrawals Summary Sheet (in mgd)

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
LAKE JAMES								
Industrial								
Coats American	Sevier Finishing Plant	North Fork Catawba River	1.080	1.200	1.400	1.700	2.000	2.300
Municipal								
City of Marion	Marion WTP	Buck Creek, Clear Creek, Mackey Creek	1.500	1.717	1.983	2.243	2.542	2.889
Power								
Duke Energy Corporation	Future - New	Lake James	0.000	0.000	0.000	0.000	0.000	15.300
Agricultural/Irrigation								
Buck Creek Trout Farm	Buck Creek Trout Farm	Buck Creek	1.320	1.400	1.400	1.500	1.600	1.700
Harris Creek Trout Farm	Harris Creek Trout Farm	Harris Creek	0.877	0.900	0.900	1.000	1.000	1.100
NC Wildlife Resources Commission	Armstrong State Fish Hatchery - Upper	Armstrong Creek	0.761	0.800	0.800	0.900	0.900	1.000
NC Wildlife Resources Commission	Armstrong State Fish Hatchery - Lower	Armstrong Creek	3.309	3.400	3.600	3.800	4.000	4.200
NC Wildlife Resources Commission	Armstrong State Fish Hatchery	Bee Rock Creek	0.508	0.500	0.500	0.600	0.600	0.600
NC Wildlife Resources Commission	Marion State Fish Hatchery	Catawba River	0.284	0.300	0.300	0.300	0.300	0.400
Basin Agricultural/Irrigation Demand	Varies	Varies	1.700	1.800	2.200	2.600	3.100	3.900
		LAKE JAMES SUB-BASIN TOTAL FLOW	**11.339**	**12.017**	**13.400**	**14.800**	**16.042**	**33.389**

LAKE RHODHISS

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Municipal								
Town of Granite Falls	Granite Falls WTP	Lake Rhodhiss	0.906	0.996	1.113	1.241	1.385	1.549
City of Lenoir	Lenoir WTP	Lake Rhodhiss	4.041	4.152	4.357	4.554	4.747	4.938
City of Morganton	Catawba River WTP	Catawba River	7.055	7.266	7.506	7.796	8.146	8.566
Town of Valdese	Valdese WTP	Lake Rhodhiss	4.851	5.112	5.514	5.842	6.600	7.187
Caldwell County S		Lenoir	0.511	0.441	0.450	0.459	0.468	0.477
Icard Township		Valdese	0.497	0.477	0.507	0.600	0.696	0.715
Burke County		Morganton, Valdese	0.218	0.177	0.202	0.227	0.256	0.289
Rhodhiss		Granite Falls, Morganton, Valdese	0.057	0.045	0.045	0.048	0.048	0.048
Caldwell County N		Lenoir	0.300	0.311	0.315	0.319	0.323	0.328
Caldwell County SE		Lenoir	0.410	0.353	0.360	0.366	0.374	0.384
Caldwell County W		Lenoir	0.599	0.532	0.542	0.552	0.563	0.574
Sawmills		Lenoir	0.282	0.288	0.301	0.309	0.320	0.330
Baton WC		Lenoir	0.529	0.673	0.591	0.615	0.641	0.667
Joyceton*								
Triple Comm WC		Valdese	0.568	0.568	0.645	0.721	0.801	0.881
Rutherford College*								
Drexel		Morganton	0.240	0.336	0.400	0.464	0.523	0.582
Brentwood WA		Morganton	0.760	0.795	0.831	0.871	0.912	0.955
Brentwood WC		Morganton	0.342	0.354	0.371	0.388	0.407	0.426
Burke Caldwell**			0.220					
Agricultural/Irrigation								
NC Wildlife Resources Commission	Table Rock State Fish Hatchery	Irish Creek	0.930	1.000	1.000	1.100	1.100	1.200

Basin Agricultural/Irrigation Demand	Varies	Varies	3.600	3.800	4.200	4.700	5.300	6.100
		LAKE RHODHISS SUB-BASIN TOTAL FLOW	**26.916**	**27.677**	**29.250**	**31.171**	**33.609**	**36.196**

LAKE HICKORY

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Municipal								
City of Hickory	Hickory WTP	Lake Hickory	8.944	9.531	10.540	11.760	12.980	14.510
Town of Long View	Long View WTP	Lake Hickory	1.036	1.140	1.184	1.211	1.484	1.551
Bethlehem		Hickory	0.447	0.520	0.608	0.693	0.778	0.876
Alexander County		Hickory	0.730	0.742	0.962	1.086	1.215	1.360
Conover		Hickory	1.553	1.617	2.101	2.731	3.550	4.616
Claremont		Hickory	0.233	0.300	0.427	0.625	0.930	1.421
Icard Twp		Hickory	0.403	0.391	0.415	0.491	0.569	0.585
Burke County		Long View	0.055	0.059	0.067	0.076	0.085	0.096
Rhodhiss		Hickory, Long View	0.013	0.013	0.013	0.013	0.013	0.014
SE Catawba County		Hickory	0.096	0.137	0.206	0.268	0.321	0.071
Taylorsville		Hickory	0.402	0.264	0.269	0.274	0.279	0.284
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	1.200	1.300	1.500	1.800	2.100	2.500
		LAKE HICKORY SUB-BASIN TOTAL FLOW	**15.111**	**16.013**	**18.292**	**21.028**	**24.305**	**27.884**

LOOKOUT SHOALS LAKE

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Municipal								
City of Statesville (Under Construction	Statesville WTP	Lookout Shoals Lake	0	4.5	5.5	6.6	8	9
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	1.2	1.3	1.6	1.9	2.2	2.7
		LOOKOUT SHOALS LAKE SUB-BASIN TOTAL FLOW	**1.2**	**5.8**	**7.1**	**8.5**	**10.2**	**11.7**

LAKE NORMAN

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Industrial								
Burlington Industries	Mooresville Plant		0.000	0.000	0.000	0.000	0.000	0.000
Municipal								
Charlotte-Mecklenburg	North Mecklenburg WTP	Lake Norman	17.319	20.048	23.888	27.168	30.451	33.536
Lincoln County	Lincoln County WTP	Lake Norman	2.102	2.493	3.259	4.073	5.090	6.365
Town of Mooresville	Mooresville WTP	Lake Norman	3.579	6.000	8.750	11.750	14.750	17.500
Corcord/Kannapolis/Cabarrus Co.	Future - New - IBT	Lake Norman	0.000	0.000	5.000	10.000	15.000	23.000
Power								
Duke Energy Corporation	Marshall Steam Station	Lake Norman	0.000	13.100	13.100	13.100	13.100	13.100
Duke Energy Corporation	McGuire Nuclear Station	Lake Norman	0.000	23.300	23.300	23.300	23.300	23.300
Duke Energy Corporation	Future - New	Lake Norman	0.000	0.000	9.600	9.600	9.600	26.100
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	2.800	2.900	3.200	3.500	3.800	4.200

		LAKE NORMAN SUB-BASIN TOTAL FLOW	**25.800**	**67.841**	**90.097**	**102.491**	**115.091**	**147.101**

MOUNTAIN ISLAND LAKE

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Municipal								
Charlotte-Mecklenburg	Franklin and Vest WTP	Mountain Island Lake	90.925	105.252	125.412	142.632	159.869	176.064
City of Gastonia	Gastonia WTP	Mountain Island Lake	10.689	14.233	19.007	21.868	25.164	28.931
City of Mount Holly	Mount Holly WTP	Mountain Island Lake	1.453	3.272	5.308	7.871	11.954	18.392
Lowell		Gastonia	0.430	0.449	0.471	0.496	0.521	0.546
McAdenville		Gastonia	0.372	0.544	0.565	0.588	0.615	0.643
Cramerton		Gastonia	0.355	0.424	0.461	0.497	0.538	0.575
Stanley		Mount Holly	0.812	0.859	1.038	1.219	1.342	1.593
Power								
Duke Energy Corporation	Riverbend Steam Station	Mountain Island Lake	2.500	2.500	2.500	2.500	2.500	2.500
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	0.800	0.800	0.900	0.900	1.000	1.000
		MOUNTAIN ISLAND LAKE SUB-BASIN TOTAL FLOW	**108.336**	**128.333**	**155.662**	**178.571**	**203.503**	**230.244**

LAKE WYLIE

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Industrial								
American & Efird, Inc.	Dyeing & Finishing Plant 15	Catawba River	1.820	1.800	1.800	1.800	1.800	1.800
Clariant Corporation	Mt. Holly Plant	Catawba River	0.260	0.300	0.500	0.800	1.200	1.800
Cramer Mountain Finishing LLC	Cramer Mountain Finishing	South Fork Catawba River	1.360	1.400	1.700	2.000	2.300	2.700
Hedrich Industries	Lake Norman Quarry	Forney Creek	0.680	0.700	0.800	1.000	1.100	1.400
Siemens Westinghouse	Siemens Westinghouse	Catawba River	10.700	10.800	10.800	10.800	10.800	10.800
Municipal								
City of Belmont	Belmont WTP	Lake Wylie	2.483	3.783	4.564	5.431	6.379	7.013
Bessemer City	J.V. Tarpley WTP	Long Creek, Arrowood	0.861	1.082	1.092	1.107	1.122	1.137
City of Cherryville	Cherryville WTP	Indian Creek	0.821	1.129	1.446	1.763	2.079	2.396
Town of Dallas	Dallas WTP	South Fork Catawba River	0.572	0.567	0.617			
Town of High Shoals	High Shoals WTP	South Fork Catawba River	0.064	0.110	0.138	0.153	0.170	0.204
City of Lincolnton	Lincolnton WTP	South Fork Catawba River	4.310	4.825	5.546	6.375	7.329	8.425
City of Newton	Newton WTP	Jacobs Fork, City Lake	2.334	2.581	2.994	3.651	4.449	5.423
Town of Stanley	Stanley WTP	Hoyle Creek	0.406	0.430	0.519	0.610	0.671	0.797
Catawba		Newton	0.073	0.084	0.088	0.092	0.096	0.099
Energy United		Newton	0.000	1.425	1.860	2.345	2.938	3.530
Taylorsville		Energy United	0.000	0.264	0.269	0.274	0.279	0.284
West Iredell		Energy United	0.000	0.302	0.388	0.506	0.561	0.785
Maiden		Lake Wylie	1.459	1.548	1.592	1.648	1.696	1.755
Rock Hill		Lake Wylie	13.600	14.300	17.400	21.200	25.800	31.500
Tega Cay			0.000	0.000	0.000	0.000	0.000	0.000
Power								
Duke Energy Corporation	Allen Steam Plant	Lake wylie	0.000	6.100	6.100	6.100	6.100	6.100

Duke Energy Corporation	Lincoln Combustion Turbine Facility	Killian Creek	NA	NA	NA	NA	NA	NA
Duke Energy Corporation	Catawba Nuclear Station	Lake Wylie	0.000	35.800	35.800	35.800	35.800	35.800
Duke Energy Corporation	Future - New	Lake Wylie	0.000	0.000	0.000	11.100	11.100	11.100
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	8.500	8.800	9.600	10.400	11.400	12.600
		LAKE WYLIE SUB-BASIN TOTAL FLOW	**50.303**	**98.130**	**105.613**	**124.955**	**135.169**	**147.447**

FISHING CREEK RESERVOIR

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Industrial								
Celanese Acetate	Celriver Plant	Catawba River	36.100	60.000	60.000	60.000	60.000	60.000
Bowater	Pulp and Paper Mill	Catawba River	25.300	30.000	31.500	33.100	34.800	36.600
Springs Industrial	Grace Complex	Catawba River	10.600	10.900	11.500	12.000	12.700	13.300
Nation Ford Chemical		Catawba River	1.100	1.200	1.600	2.200	2.900	4.000
Municipal								
Rock Hill (Emergency/Backup)		Catawba River	0.000	0.000	0.000	0.000	0.000	0.000
Union County	Catawba River Plant	Catawba River	5.925	13.804	17.672	21.735	25.866	30.014
Wingate		Union County	0.258	0.508	0.826	1.347	2.193	3.573
Lancaster County	Catawba River Plant	Catawba River	6.300	7.500	9.100	10.600	12.300	13.500
Chester Metro		Catawba River	3.500	4.000	4.900	6.200	7.200	8.300
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	8.200	8.400	8.800	9.300	9.800	10.300
		FISHING CREEK RESERVOIR SUB-BASIN TOTAL FLOW	**97.283**	**136.312**	**145.898**	**156.482**	**167.759**	**179.587**

GREAT FALLS - DEARBORN RESERVOIR

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	1.4	1.5	1.6	1.7	1.9	2.1
		GREAT FALLS - DEARBORN RESERVOIR SUB-BASIN TOTAL FLOW	**1.4**	**1.5**	**1.6**	**1.7**	**1.9**	**2.1**

CEDAR CREEK RESERVOIR

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Agricultural/Irrigation								
Basin Agricultural/Irrigation Demand	Varies	Varies	0.6	0.6	0.7	0.7	0.8	0.8
		CEDAR CREEK RESERVOIR SUB-BASIN TOTAL FLOW	**0.6**	**0.6**	**0.7**	**0.7**	**0.8**	**0.8**

LAKE WATEREE

Entity	Facility	Source Water	2002	2010	2020	2030	2040	2050
Municipal								
Camden		Lake Wateree	2.8	2.7	3.2	3.7	4.2	4.9
Lugoff Elgin Water Authority		Lake Wateree	2.3	3.6	4.8	6.0	6.8	7.8
Power								
Duke Energy Corporation	Future - New	Lake Wateree	NA	0.0	0.0	0.0	13.1	13.1
Agricultural/Irrigation								

Basin Agricultural/Irrigation Demand	Varies	Varies	1.2	1.2	1.3	1.4	1.5	1.6
		LAKE WATEREE SUB-BASIN TOTAL FLOW	**6.3**	**7.5**	**9.3**	**11.0**	**25.7**	**27.4**

NOTE: Duke Power Withdrawals are actually net consumptive use or "outflows" from the system. No return projections are given for these facilites since the values reported here are for net outflow

Appendix D7

Plan Withdrawal from 11 Reservoirs in Model

Lake James at Bridgewater

Withdrawals **Returns**

HIGH OPTION, cfs

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2002	19.2	19.2	17.9	18.2	18.2	17.6	16.6	16.4	16.1	16.1	16.7	17.7	2002	16.2	16.3	15.0	15.4	15.2	14.3	13.8	13.5	13.5	13.9	14.6	15.3
2010	20.7	20.8	19.4	19.7	19.6	19.1	18.0	17.8	17.4	17.5	18.1	19.2	2010	18.9	19.0	17.4	17.9	17.7	16.6	16.0	15.7	15.7	16.1	16.9	17.8
2020	22.5	22.6	21.1	21.5	21.4	20.9	19.7	19.5	19.1	19.1	19.7	20.9	2020	21.5	21.6	19.9	20.4	20.2	19.1	18.5	18.2	18.1	18.6	19.5	20.4
2050	54.5	54.6	52.8	52.8	49.3	52.9	51.7	51.4	50.6	50.6	50.6	52.2	2050	29.5	29.7	27.5	28.4	28.2	26.7	26.1	25.8	25.6	26.2	27.2	28.2

LOW OPTION, cfs

2002	19.2	19.2	17.9	18.2	18.2	17.6	16.6	16.4	16.1	16.1	16.7	17.7	2002	16.2	16.3	15.0	15.4	15.2	14.3	13.8	13.5	13.5	13.9	14.6	15.3
2010	20.1	20.2	18.8	19.1	19.1	18.5	17.5	17.2	16.9	16.9	17.6	18.6	2010	18.1	18.2	16.8	17.2	17.0	16.0	15.4	15.1	15.1	15.5	16.3	17.1
2020	22.5	22.6	21.1	21.5	21.4	20.9	19.7	19.5	19.1	19.1	19.7	20.9	2020	19.6	19.7	18.2	18.6	18.5	17.4	16.9	16.6	16.5	17.0	17.8	18.6
2050	54.5	54.6	52.8	52.8	49.3	52.9	51.7	51.4	50.6	50.6	50.6	52.2	2050	25.1	25.3	23.5	24.2	24.0	22.8	22.2	22.0	21.8	22.3	23.2	24.1

LWSP OPTION, cfs

2002	19.2	19.2	17.9	18.2	18.2	17.6	16.6	16.4	16.1	16.1	16.7	17.7	2002	16.2	16.3	15.0	15.4	15.2	14.3	13.8	13.5	13.5	13.9	14.6	15.3
2010	20.3	20.3	19.0	19.3	19.2	18.7	17.6	17.4	17.1	17.1	17.7	18.8	2010	18.2	18.3	16.8	17.2	17.0	16.0	15.5	15.1	15.2	15.6	16.4	17.2
2020	22.5	22.6	21.1	21.5	21.4	20.9	19.7	19.5	19.1	19.1	19.7	20.9	2020	19.8	19.8	18.3	18.7	18.6	17.5	17.0	16.7	16.7	17.1	17.9	18.8
2050	54.5	54.6	52.8	52.8	49.3	52.9	51.7	51.4	50.6	50.6	50.6	52.2	2050	25.0	25.2	23.3	24.1	23.9	22.7	22.1	21.9	21.7	22.2	23.1	23.9

Lake Rhodhiss

Withdrawals **Returns**

HIGH OPTION, cfs

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2002	40.6	40.1	40.5	43.0	45.4	47.4	47.2	45.6	41.4	38.7	36.8	36.9	2002	23.6	22.6	23.8	22.4	22.1	21.2	18.8	20.4	21.7	22.2	22.7	23.3
2010	75.9	75.0	75.8	80.4	85.0	88.7	88.3	85.3	77.4	72.4	68.9	69.0	2010	33.3	31.9	33.6	31.7	31.1	29.9	26.5	28.7	30.7	31.4	32.1	32.9
2020	116.6	115.2	116.5	123.5	130.7	136.4	135.8	131.3	119.1	111.3	106.0	106.1	2020	47.6	45.7	48.2	45.2	44.5	42.7	38.0	41.2	43.9	45.0	46.0	47.2
2050	224.0	221.3	224.0	237.6	251.1	262.8	261.7	253.1	229.4	214.1	204.6	204.8	2050	91.6	87.6	92.6	86.6	85.1	81.7	73.4	79.2	84.4	86.7	88.5	91.2

LOW OPTION, cfs

2002	40.6	40.1	40.5	43.0	45.4	47.4	47.2	45.6	41.4	38.7	36.8	36.9	2002	23.6	22.6	23.8	22.4	22.1	21.2	18.8	20.4	21.7	22.2	22.7	23.3
2010	43.3	42.8	43.3	45.9	48.6	50.6	50.4	48.7	44.2	41.3	39.3	39.4	2010	24.4	23.4	24.7	23.3	22.9	21.9	19.5	21.1	22.5	23.0	23.6	24.2
2020	48.5	47.9	48.4	51.4	54.3	56.7	56.5	54.6	49.5	46.3	44.1	44.1	2020	27.8	26.7	28.1	26.4	26.0	24.9	22.2	24.1	25.7	26.3	26.9	27.6
2050	69.3	68.4	69.2	73.4	77.6	81.3	80.9	78.3	70.9	66.2	63.3	63.3	2050	41.3	39.5	41.8	39.0	38.4	36.9	33.1	35.7	38.1	39.1	39.9	41.1

LWSP OPTION, cfs

2002	40.6	40.1	40.5	43.0	45.4	47.4	47.2	45.6	41.4	38.7	36.8	36.9	2002	23.6	22.6	23.8	22.4	22.1	21.2	18.8	20.4	21.7	22.2	22.7	23.3
2010	41.3	40.8	41.2	43.7	46.2	48.2	48.0	46.4	42.1	39.4	37.5	37.5	2010	23.1	22.2	23.4	22.0	21.7	20.8	18.4	20.0	21.3	21.8	22.3	22.9
2020	43.6	43.1	43.5	46.2	48.8	51.0	50.8	49.1	44.5	41.6	39.6	39.7	2020	24.8	23.7	25.0	23.5	23.1	22.2	19.8	21.4	22.8	23.4	23.9	24.6
2050	53.8	53.2	53.8	57.1	60.3	63.2	62.9	60.8	55.1	51.5	49.2	49.2	2050	31.0	29.6	31.3	29.3	28.8	27.6	24.8	26.8	28.5	29.3	29.9	30.8

Lake Hickory at Oxford

Withdrawals **Returns**

HIGH OPTION, cfs

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2002	22.1	20.2	19.7	22.3	24.5	27.6	27.0	27.1	23.9	22.1	21.5	20.7		2002	8.7	7.9	8.3	7.6	7.5	7.5	7.5	7.6	8.0	8.4	9.3	9.4
2010	44.3	40.6	39.6	44.7	49.2	55.5	54.1	54.4	48.0	44.3	43.2	41.5		2010	13.8	12.6	13.2	12.1	11.9	12.0	11.9	12.2	12.8	13.5	14.8	15.1
2020	77.5	71.0	69.3	78.3	86.1	97.2	94.9	95.3	84.0	77.5	75.6	72.7		2020	20.8	19.0	19.8	18.2	18.0	18.1	18.1	18.5	19.3	20.3	22.2	22.6
2050	171.2	156.6	152.8	172.8	190.3	215.2	210.1	211.0	185.9	171.2	167.1	160.8		2050	38.6	35.6	36.9	34.1	33.8	33.9	34.0	34.6	35.9	37.5	40.8	41.8

LOW OPTION, cfs

2002	22.1	20.2	19.7	22.3	24.5	27.6	27.0	27.1	23.9	22.1	21.5	20.7		2002	8.7	7.9	8.2	7.6	7.5	7.5	7.5	7.6	8.0	8.4	9.3	9.4
2010	25.1	23.0	22.5	25.4	27.9	31.5	30.7	30.8	27.2	25.1	24.5	23.6		2010	9.8	9.0	9.4	8.6	8.5	8.5	8.5	8.7	9.1	9.6	10.5	10.7
2020	29.5	27.1	26.4	29.8	32.8	37.0	36.2	36.3	32.0	29.5	28.8	27.7		2020	11.4	10.4	10.8	9.9	9.8	9.9	9.9	10.1	10.5	11.1	12.1	12.3
2050	47.5	43.4	42.4	47.9	52.8	59.7	58.3	58.5	51.6	47.5	46.3	44.6		2050	17.5	16.2	16.8	15.5	15.4	15.4	15.5	15.7	16.3	17.1	18.6	19.0

LWSP OPTION, cfs

2002	22.1	20.2	19.7	22.3	24.5	27.6	27.0	27.1	23.9	22.1	21.5	20.7		2002	8.7	7.9	8.3	7.6	7.5	7.5	7.5	7.6	8.0	8.4	9.3	9.4
2010	23.5	21.5	21.0	23.7	26.1	29.4	28.7	28.8	25.4	23.5	22.9	22.0		2010	9.2	8.4	8.8	8.0	7.9	8.0	7.9	8.1	8.5	9.0	9.9	10.0
2020	26.8	24.5	24.0	27.1	29.8	33.6	32.8	33.0	29.1	26.8	26.1	25.1		2020	10.3	9.5	9.9	9.1	9.0	9.0	9.0	9.2	9.6	10.1	11.0	11.2
2050	40.8	37.3	36.4	41.2	45.4	51.3	50.1	50.3	44.3	40.8	39.8	38.3		2050	12.2	11.3	11.7	10.8	10.7	10.8	10.8	11.0	11.4	11.9	12.9	13.3

Lake Lookout Shoals

Withdrawals **Returns**

HIGH OPTION, cfs

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2002	2.0	2.0	2.0	2.2	2.3	2.4	2.0	1.6	1.4	1.5	1.5	1.5		2002	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.5	0.5	0.5	0.5
2010	9.5	9.5	9.6	10.6	10.9	11.8	9.9	7.5	6.6	7.2	7.1	7.1		2010	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.5	0.5	0.5	0.5
2020	11.7	11.6	11.7	12.9	13.4	14.5	12.1	9.2	8.1	8.8	8.7	8.7		2020	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5
2050	19.2	19.1	19.3	21.2	22.0	23.8	19.9	15.2	13.4	14.5	14.5	14.4		2050	0.4	0.5	0.5	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.5	0.5

LOW OPTION, cfs

2002	2.0	2.0	2.0	2.2	2.3	2.4	2.0	1.6	1.4	1.5	1.5	1.5		2002	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.5	0.5	0.5	0.5
2010	9.5	9.5	9.6	10.6	10.9	11.8	9.9	7.5	6.6	7.2	7.1	7.1		2010	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.5	0.5	0.5	0.5
2020	11.7	11.6	11.7	12.9	13.4	14.5	12.1	9.2	8.1	8.8	8.7	8.7		2020	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.5	0.5	0.5	0.5
2050	19.2	19.1	19.3	21.2	22.0	23.8	19.9	15.2	13.4	14.5	14.5	14.4		2050	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.5	0.5	0.5

LWSP OPTION, cfs

2002	2.0	2.0	2.0	2.2	2.3	2.4	2.0	1.6	1.4	1.5	1.5	1.5		2002	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.5	0.5	0.5	0.5
2010	9.5	9.5	9.6	10.6	10.9	11.8	9.9	7.5	6.6	7.2	7.1	7.1		2010	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.5	0.5	0.5	0.5
2020	11.7	11.6	11.7	12.9	13.4	14.5	12.1	9.2	8.1	8.8	8.7	8.7		2020	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.5	0.5	0.5	0.5
2050	19.2	19.1	19.3	21.2	22.0	23.8	19.9	15.2	13.4	14.5	14.5	14.4		2050	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.5	0.5	0.5	0.5

Lake Norman at Cowans Ford

Withdrawals **Returns**

HIGH OPTION, cfs

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2002	39	38	32	42	42	46	46	44	39	39	33	38	2002	3.0	2.4	2.6	2.3	2.3	2.1	2.0	2.1	2.1	2.2	2.7	2.9
2010	126	121	103	137	137	148	147	141	127	125	107	122	2010	10.1	8.1	8.6	7.8	7.6	7.0	6.8	7.2	7.1	7.5	9.0	9.8
2020	185	179	160	202	205	222	220	210	189	186	164	180	2020	20.7	16.5	17.5	15.8	15.3	14.0	13.6	14.5	14.3	15.3	18.4	20.0
2050	351	343	322	382	391	424	416	397	360	354	325	341	2050	51.0	41.1	43.2	38.9	38.2	34.9	34.1	36.2	35.8	38.1	45.9	49.9

LOW OPTION, cfs

2002	39	38	32	42	42	46	46	44	39	39	33	38	2002	3.0	2.4	2.6	2.3	2.3	2.1	2.0	2.1	2.1	2.3	2.7	2.9
2010	104	100	85	113	113	122	121	116	104	103	88	101	2010	3.4	2.7	2.9	2.6	2.5	2.3	2.3	2.4	2.4	2.5	3.0	3.3
2020	134	130	116	146	149	161	159	152	137	135	119	130	2020	4.0	3.2	3.4	3.1	3.0	2.7	2.6	2.8	2.8	3.0	3.6	3.9
2050	190	186	174	207	212	230	226	215	195	192	176	185	2050	6.4	5.2	5.5	4.9	4.8	4.4	4.3	4.6	4.5	4.8	5.8	6.3

LWSP OPTION, cfs

2002	39	38	32	42	42	46	46	44	39	39	33	38	2002	3.0	2.4	2.6	2.3	2.3	2.1	2.0	2.1	2.1	2.2	2.7	2.9
2010	103	99	84	111	111	121	120	115	103	102	87	100	2010	3.2	2.6	2.8	2.5	2.4	2.2	2.2	2.3	2.3	2.4	2.9	3.1
2020	134	130	116	146	149	161	159	152	137	134	119	130	2020	3.8	3.1	3.2	2.9	2.8	2.6	2.5	2.7	2.6	2.8	3.4	3.7
2050	217	212	199	236	242	262	257	245	223	219	201	211	2050	6.9	5.6	5.9	5.3	5.2	4.7	4.6	4.9	4.9	5.2	6.2	6.8

Lake Mountain Island

Withdrawals **Returns**

HIGH OPTION, cfs

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2002	142	138	138	166	194	214	208	196	170	159	143	137	2002	7	7	8	8	7	7	7	7	7	8	8	8
2010	235	228	228	274	320	353	343	323	280	263	235	225	2010	9	9	9	9	9	8	9	9	9	9	10	10
2020	351	341	341	409	476	526	511	482	418	392	352	337	2020	13	13	13	13	13	12	13	13	13	14	14	15
2050	691	671	671	805	933	1032	1003	947	820	770	692	664	2050	25	25	26	26	25	25	25	25	26	27	28	29

LOW OPTION, cfs

2002	142	138	138	166	194	214	208	196	170	159	143	137	2002	7	7	8	8	7	7	7	7	7	8	8	8
2010	172	167	167	201	234	258	251	236	205	192	172	165	2010	7	7	7	7	6	6	7	7	7	7	7	8
2020	206	200	200	240	279	309	300	283	245	230	206	198	2020	8	8	8	8	8	8	8	8	8	8	9	9
2050	219	213	213	255	296	327	318	300	260	244	220	211	2050	9	9	10	9	9	9	9	9	9	10	10	10

LWSP OPTION, cfs

2002	142	138	138	166	194	214	208	196	170	159	143	137	2002	7	7	8	8	7	7	7	7	7	8	8	8
2010	169	164	164	197	230	254	246	232	201	189	169	162	2010	6	6	7	6	6	6	6	6	6	7	7	7
2020	205	199	199	239	278	307	298	281	244	229	205	197	2020	8	7	8	8	7	7	7	7	8	8	8	9
2050	304	295	295	354	410	453	441	416	360	339	304	292	2050	11	10	11	11	10	10	11	10	11	11	12	12

Lake Wylie

Withdrawals **Returns**

HIGH OPTION, cfs

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2002	76	75	75	77	72	80	82	82	81	81	77	75	2002	68	64	66	66	67	66	66	67	65	65	65	66
2010	189	187	188	191	180	199	205	204	204	201	193	186	2010	110	103	107	107	109	107	107	109	105	106	105	108
2020	256	252	253	258	244	269	277	276	275	272	260	251	2020	173	163	169	169	172	169	170	172	166	168	166	170
2050	481	473	474	484	461	508	520	521	519	512	490	469	2050	353	329	342	344	351	344	350	351	338	345	337	343

LOW OPTION, cfs

2002	76	75	75	77	72	80	82	82	81	81	77	75	2002	68	64	66	66	67	66	66	67	65	65	65	66
2010	147	145	146	148	140	154	159	158	158	156	150	144	2010	70	66	68	68	69	68	68	69	67	67	67	68
2020	158	156	156	159	150	166	171	170	170	168	161	155	2020	82	77	80	80	81	80	80	81	79	79	79	80
2050	220	217	218	222	212	233	239	239	238	235	224	215	2050	116	108	113	113	116	113	115	116	112	114	111	113

LWSP OPTION, cfs

2002	76	75	75	77	72	80	82	82	81	81	77	75	2002	68	64	66	66	67	66	66	67	65	65	65	66
2010	148	146	147	149	141	155	160	159	159	157	150	145	2010	73	69	71	71	72	71	72	72	70	71	70	72
2020	159	157	158	161	152	167	172	172	171	169	162	156	2020	87	82	85	85	86	85	86	86	84	84	84	85
2050	222	218	219	223	213	234	240	240	240	236	226	217	2050	94	87	91	91	93	91	93	93	90	92	89	91

Fishing Creek Reservoir

Withdrawals **Returns**

HIGH OPTION, cfs

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2002	130	127	129	136	135	146	148	141	136	134	127	127	2002	215	205	217	205	202	209	216	208	209	214	231	264
2010	217	210	215	225	225	242	246	235	226	222	211	211	2010	296	281	298	282	278	287	297	285	287	295	317	363
2020	252	244	250	264	265	287	289	276	264	259	246	245	2020	368	350	371	352	347	357	369	355	358	368	397	452
2050	391	379	388	415	419	458	456	436	413	405	383	381	2050	595	566	602	572	563	576	594	574	581	601	649	733

LOW OPTION, cfs

2002	145	141	144	151	151	162	165	157	152	149	142	142	2002	215	205	217	205	202	209	216	208	209	214	231	264
2010	195	190	194	203	203	218	221	212	204	200	190	190	2010	259	246	260	247	243	251	260	249	251	258	277	318
2020	209	203	208	220	221	239	241	230	220	216	205	204	2020	283	269	286	271	267	274	284	273	276	283	305	348
2050	257	250	256	274	276	302	301	287	272	267	252	251	2050	321	305	325	308	304	311	321	310	313	324	350	395

LWSP OPTION, cfs

2002	145	141	144	151	151	162	165	157	152	149	142	142	2002	215	205	217	205	202	209	216	208	209	214	231	264
2010	203	198	202	212	211	228	231	221	213	209	198	198	2010	256	244	258	244	241	248	257	247	249	255	274	315
2020	216	210	215	227	228	247	249	237	227	223	211	211	2020	280	267	283	268	264	272	281	271	273	281	302	345
2050	264	256	262	280	283	309	308	294	279	273	259	257	2050	347	330	351	333	328	336	347	335	339	350	378	427

Great Falls Reservoir

Withdrawals — Returns

HIGH OPTION, cfs

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2002	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2002	1.8	1.6	1.9	1.6	1.8	2.9	1.6	1.6	1.8	2.0	2.2	2.6
2010	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2010	1.8	1.6	1.9	1.6	1.8	2.9	1.6	1.6	1.8	2.0	2.2	2.6
2020	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2020	2.5	2.2	2.6	2.2	2.5	3.5	2.2	2.2	2.5	2.7	3.0	3.5
2050	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	2050	5.9	5.2	6.2	5.2	5.9	6.7	5.2	5.2	5.9	6.5	7.2	8.4

LOW OPTION, cfs

2002	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2002	1.8	1.6	1.9	1.6	1.8	2.9	1.6	1.6	1.8	2.0	2.2	2.6
2010	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2010	1.8	1.6	1.9	1.6	1.8	2.9	1.6	1.6	1.8	2.0	2.2	2.6
2020	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2020	1.9	1.7	2.0	1.7	1.9	2.6	1.7	1.7	1.9	2.1	2.3	2.7
2050	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	2050	1.9	1.7	2.0	1.7	1.9	2.2	1.7	1.7	1.9	2.1	2.3	2.7

LWSP OPTION, cfs

2002	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2002	1.8	1.6	1.9	1.6	1.8	2.9	1.6	1.6	1.8	2.0	2.2	2.6
2010	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2010	1.8	1.6	1.9	1.6	1.8	2.9	1.6	1.6	1.8	2.0	2.2	2.6
2020	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2020	1.9	1.7	2.0	1.7	1.9	2.6	1.7	1.7	1.9	2.1	2.3	2.7
2050	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	2050	1.9	1.7	2.0	1.7	1.9	2.2	1.7	1.7	1.9	2.1	2.3	2.7

Rocky Creek Reservoir

Withdrawals — Returns

HIGH OPTION, cfs

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2002	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	2002	1.5	1.5	1.4	1.8	1.6	1.5	1.5	1.3	1.5	1.7	1.7	1.5
2010	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	2010	1.5	1.5	1.4	1.8	1.6	1.5	1.5	1.3	1.5	1.7	1.7	1.5
2020	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	2020	1.5	1.5	1.4	1.8	1.6	1.5	1.5	1.3	1.5	1.7	1.7	1.5
2050	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	2050	1.5	1.5	1.4	1.8	1.6	1.5	1.5	1.3	1.5	1.7	1.7	1.5

LOW OPTION, cfs

2002	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	2002	1.5	1.5	1.4	1.8	1.6	1.5	1.5	1.3	1.5	1.7	1.7	1.5
2010	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	2010	1.5	1.5	1.4	1.8	1.6	1.5	1.5	1.3	1.5	1.7	1.7	1.5
2020	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	2020	1.5	1.5	1.4	1.8	1.6	1.5	1.5	1.3	1.5	1.7	1.7	1.5
2050	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	2050	1.8	1.8	1.7	2.2	1.9	1.8	1.8	1.6	1.8	2.0	2.0	1.8

LWSP OPTION, cfs

2002	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	2002	1.5	1.5	1.4	1.8	1.6	1.5	1.5	1.3	1.5	1.7	1.7	1.5
2010	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	2010	1.5	1.5	1.4	1.8	1.6	1.5	1.5	1.3	1.5	1.7	1.7	1.5
2020	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	2020	1.5	1.5	1.4	1.8	1.6	1.5	1.5	1.3	1.5	1.7	1.7	1.5
2050	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	2050	1.8	1.8	1.7	2.2	1.9	1.8	1.8	1.6	1.8	2.0	2.0	1.8

Lake Wateree

Withdrawals **Returns**

HIGH OPTION, cfs

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2002	9.6	9.1	8.9	9.4	9.9	10.6	10.4	10.4	10.1	9.5	9.5	9.1	2002	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	11.5	10.9	10.6	11.2	11.8	12.7	12.4	12.4	12.0	11.3	11.3	10.8	2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	14.3	13.5	13.2	13.9	14.7	15.8	15.4	15.3	14.9	14.0	14.0	13.4	2020	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	42.6	41.5	41.1	41.4	38.9	44.4	44.3	44.0	43.4	42.6	41.8	41.2	2050	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

LOW OPTION, cfs

2002	9.6	9.1	8.9	9.4	9.9	10.6	10.4	10.4	10.1	9.5	9.5	9.1	2002	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	11.5	10.9	10.6	11.2	11.8	12.7	12.4	12.4	12.0	11.3	11.3	10.8	2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	14.3	13.5	13.2	13.9	14.7	15.8	15.4	15.3	14.9	14.0	14.0	13.4	2020	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	42.6	41.5	41.1	41.4	38.9	44.4	44.3	44.0	43.4	42.6	41.8	41.2	2050	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

LWSP OPTION, cfs

2002	9.6	9.1	8.9	9.4	9.9	10.6	10.4	10.4	10.1	9.5	9.5	9.1	2002	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	11.5	10.9	10.6	11.2	11.8	12.7	12.4	12.4	12.0	11.3	11.3	10.8	2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	14.3	13.5	13.2	13.9	14.7	15.8	15.4	15.3	14.9	14.0	14.0	13.4	2020	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	42.6	41.5	41.1	41.4	38.9	44.4	44.3	44.0	43.4	42.6	41.8	41.2	2050	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0