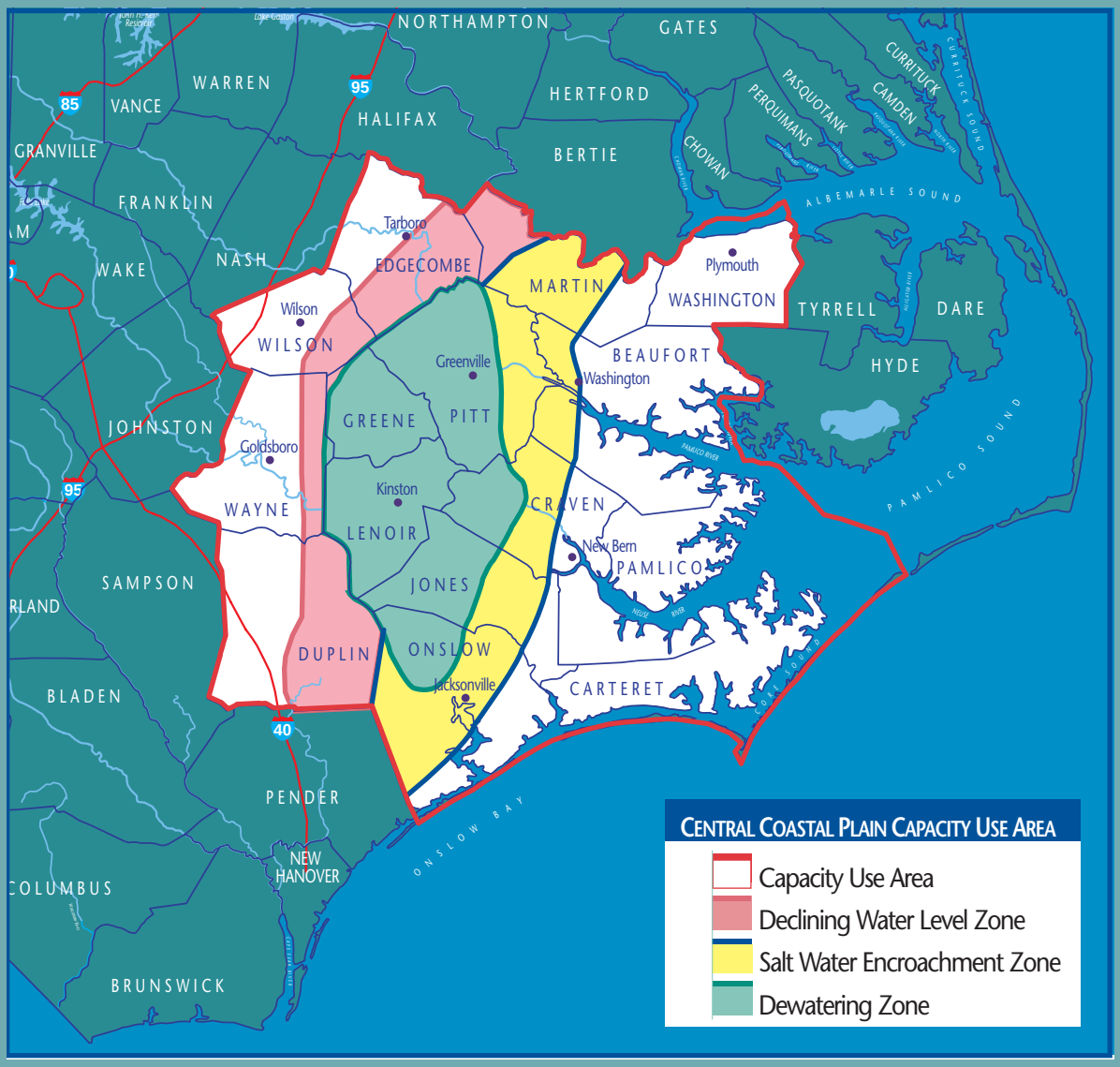
WATER WOES IN EASTERN NORTH CAROLINA

Facing the Facts, Reaching Solutions



A report on the depletion of ground water resources in 15 counties in North Carolina's Central Coastal Plain and recommended actions to help communities protect their economies, their water resources and their way of life.

North Carolina Rural Economic Development Center, Inc.

WATER WOES IN EASTERN NORTH CAROLINA

Facing the Facts, Reaching Solutions

Project Director

Jean Crews-Klein
Vice-President of Business & Natural Resource Development
N.C. Rural Economic Development Center

Project Oversight

Central Coastal Plain Capacity Use Area Steering Committee

Principal Investigators

Golder Associates Inc.
Regional Water Resource Study

Research Triangle Institute
Economic Impact Study

May 2002

N.C. Rural Economic Development Center, Inc.
4021 Carya Drive, Raleigh, NC 27610
(919) 250-4314
www.ncruralcenter.org

To an increasing extent, easily accessible water sources have already been tapped, supplies are approaching their physical limits, and new supplies for growing populations and rising consumption levels are available only at increasing costs. The syndrome of "water stress" is widespread.

James Winpenny, Author
Managing Water as an Economic Resource

Executive Summary

Throughout its history, North Carolina has been a water-rich state. In addition to its vast system of rivers, lakes, and streams, North Carolina has been blessed with abundant reserves of water beneath the surface of the earth. Today we estimate that nearly half of North Carolina's population depends on groundwater to serve their daily needs.

The dependence on groundwater has been especially strong in portions of eastern North Carolina where groundwater resources are of good quality and easy to develop. As the population in this region has expanded, so have pressures on groundwater resources. This report focuses on 15 counties in the Central Coastal Plain of North Carolina that are facing serious challenges as a result of depletion of groundwater reserves. These counties include Beaufort, Carteret, Craven, Duplin, Edgecombe, Greene, Jones, Lenoir, Martin, Onslow, Pamlico, Pitt, Washington, Wayne and Wilson.

Why the concern? Consider the following*:

- Groundwater is the primary source of water in the 15-county area, accounting for 64 million gallons of water per day or 66 percent of total water use.
- By 2020, the average daily demand is expected to increase by 54 percent to 147 million gallons of water a day.
- More than 50 percent of this water use will occur in six of 122 water systems and in Onslow County. The six municipalities include Greenville, Wilson, Kinston, Goldsboro, New Bern, and Jacksonville.

Because this growing demand now exceeds the ability of the groundwater aquifer to replenish itself – as determined by data from monitoring wells – the Water Resources Division of the North Carolina Department of Environment and Natural Resources issued a rule in December 1998 to regulate groundwater withdrawals. That rule is known as the Central Coast Plain Capacity Use Area Rule and is scheduled to go into effect August 1, 2002.

Under the rule, 36 water systems in 11 of the 15 counties will be required to reduce withdrawals by 13 million gallons per day within six years. By 2018, total reductions must reach 38 million gallons of water per day.

To their credit, several local governments in the area have already taken steps to address the issue. Even so, the challenge to communities in the affected area remains substantial. To help the communities identify available options and prepare for the future, the North Carolina Rural Economic Development Center convened a steering committee, comprised of state and local officials, in the fall of 2000. The committee established three goals:

- Quantify the current and future water needs of the region;
- Identify the public water systems to be most affected by the rule and assess strategies for meeting water supply needs; and
- Estimate the costs for these systems to implement needed measures.

*Based on the assessment of 480 public wells in the 15 counties.

Under the guidance of the committee, the Rural Center commissioned two studies. One was a regional water resource study conducted by Golder Associates Inc. of Richmond, Virginia. The other was an economic impact study conducted by the Research Triangle Institute, Inc.

This report summarizes the findings of these studies. Included in the report is a chart detailing each water system in the affected area, alternative sources of supply for that system and anticipated costs. Total costs for meeting the requirements of the rule are expected to reach as high as $216 million.

The report also presents a set of recommendations for action on the state, regional and local levels. Following is a summary of the recommendations:

- Move forward with the Central Coastal Plain Capacity Use Area Rule to protect the area's water resources for the future and prevent stagnation of the economy.
- Create a Water Resources Study Commission as part of the State Infrastructure Council to address water resource issues statewide, drawing from the lessons of the 15-county Central Coastal Plain area.
- Support water supply planning statewide, among all water supply systems.
- Strengthen public education about water resources and conservation to ensure good local decisions and sound statewide policies.
- Evaluate and coordinate economic development policies that work effectively with water resources.
- Encourage strategies aimed at reducing overall demand, including regionalization and consolidation of systems, water conservation, water reuse and reclamation.
- Encourage local governments in the area to take advantage of the Rural Center's capacity building grants program as a means of evaluating system improvement needs.
- Encourage water supply providers in the 15-county area to make necessary corrections of leaks and other inefficiencies in water distribution systems.
- Support non-traditional means of obtaining, moving and storing water such as desalination, reverse osmosis, aquifer storage and recovery and water recycling.
- Encourage the Department of Environment and Natural Resources to routinely monitor water levels and water quality of the aquifer system to assess progress in withdrawal reductions.
- Support future investment in the state's monitoring well network.

Central Coastal Plain Capacity Use Area Steering Committee

Rural Economic Development Center, Inc.
Jean Crew-Klein, Vice President of Business and Natural Resource Development

North Carolina Department of Environment and Natural Resources
John Morris, Director, Division of Water Resources
Robin Smith, Assistant Secretary, Environmental Protection

United States Geological Survey
Melinda Chapman, Groundwater Specialist, Water Resources Division

North Carolina League of Municipalities
Paula Thomas, Manager of Environmental Policy

North Carolina Association of County Commissioners
Ed Regan, Deputy Director

City of Kinston
Ralph Clark, Manager

Duplin County
Judy Brown, Assistant County Manager

Town of Farmville
Richard Hicks, Manager

Other Participants:
Nat Wilson and Don Rayno
N.C. Department of Environment and Natural Resources, Division of Water Resources

We wish to express our appreciation to the following organizations for funding the research and development of this report: The North Carolina General Assembly through its annual funding of the Rural Center; the Z. Smith Reynolds Foundation through a grant for research and policy development; the Environmental Protection Agency through a grant for technical assistance; and the Global Transpark Commission through their environmental program.

Background

Where do we get groundwater and why is it important?

Groundwater comes from aquifers, or more accurately aquifer systems, which are bodies of sand, soil and rock that yield water in sufficient quantities to be economically useful. These systems are porous areas below the earth's surface that are made up of solid material (formed like grains of sand) and the pores or spaces that exist between these grains. The groundwater supply occupies those pores. The availability of groundwater is dependent upon the amount of natural recharge from precipitation that slowly infiltrates to the aquifers.

In the coastal plain of North Carolina – the area east of I-95 to the coast – the aquifer systems are typically composed of one to several layers of permeable sand and limestone that thicken from west to east. Above and below are continuous layers of clay that confine the aquifer and separate one aquifer from another. The groundwater that flows between these layers is under pressure. In areas where the pressure is greatest, water can rise in a well naturally. Freely flowing wells of this type are called artesian wells. Conversely, when groundwater pressure is low and water levels decline, the land over the aquifer can settle. These sinkholes are visible evidence of permanent damage to the aquifer and loss of storage capacity.

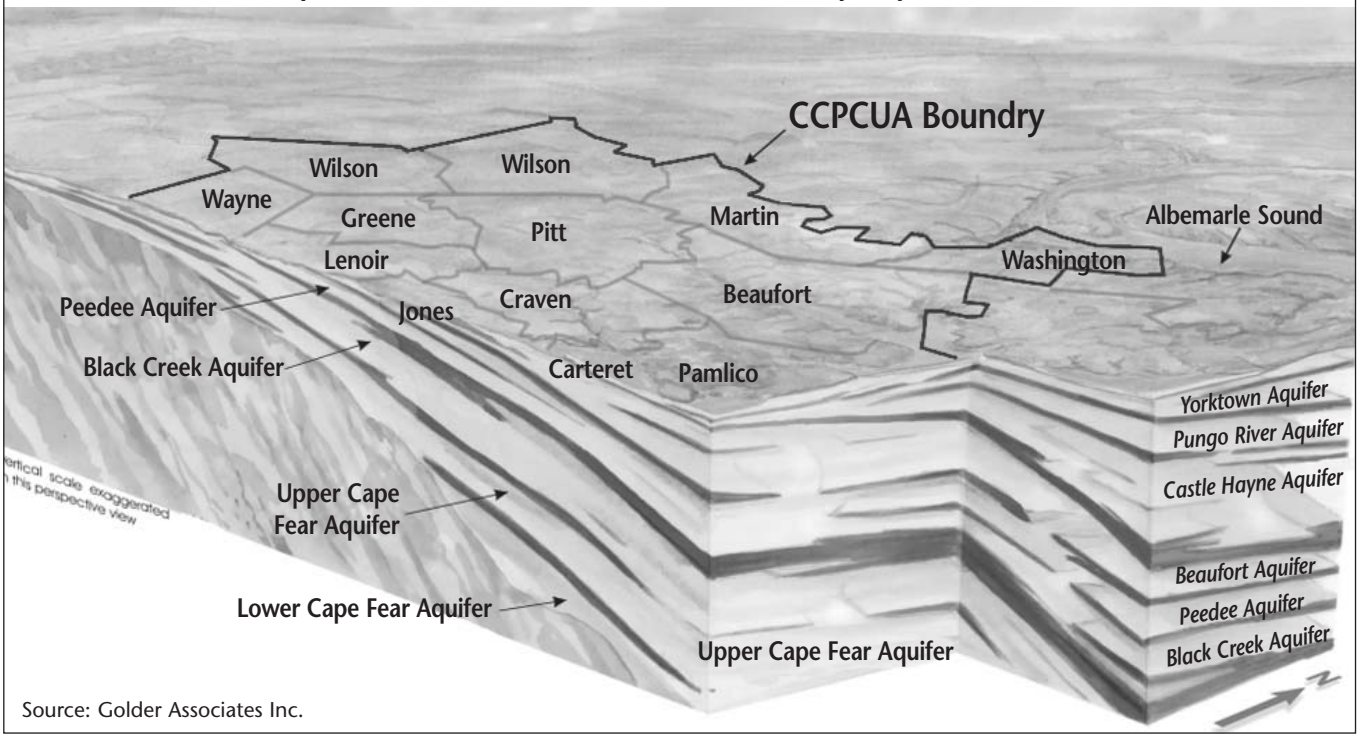
Only a very small percentage of rainfall infiltrates into a confined aquifer system. Most rainfall is lost to evaporation, runoff, or infiltrates into the shallow groundwater system and then discharges to local rivers and streams. In a confined aquifer system like the one in the coastal plain, it can take millions of years for water to move between the layers.

One of the most critical roles of groundwater is to fill our streams and rivers. During periods of drought, most stream flow is derived from groundwater. This is important because pumping of groundwater through wells decreases the amount of groundwater that flows to streams, or alternately, causes stream flow to replenish groundwater. Because groundwater and surface water are connected, users of water effectively compete for the same resource.

The principal aquifers of the 15-county area in this study are the Black Creek and Upper Cape Fear aquifers, which are part of the Cretaceous Aquifer System (Figure 1). In large portions of these aquifers, the sand and limestone materials are so well connected that withdrawals can cause pressure reductions many miles from the area where the actual pumping occurs. Large withdrawals of water, such as those from a series of deep wells that supply water for a town, can cause water levels to drop not only at the point of withdrawal, but can affect the water level in wells of neighboring towns.

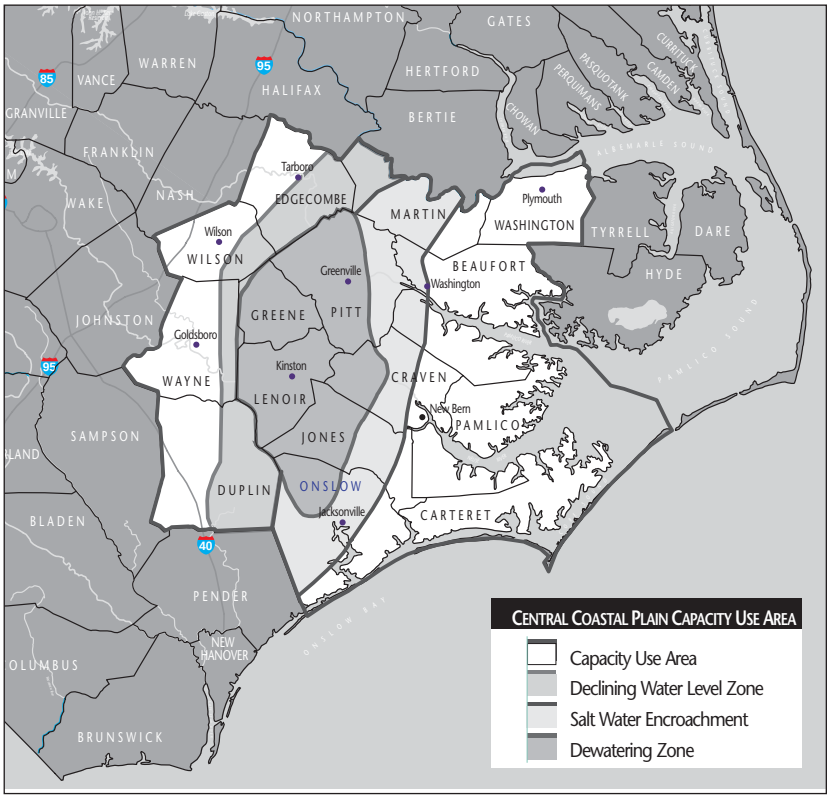
Figure 1

Aquifers Beneath the Central Coastal Plain Capacity Use Area



Source: Golder Associates Inc.

Figure 2



Source: Golder Associates Inc.

How is the water level determined?

Groundwater levels in North Carolina are determined through a series of monitoring wells distributed across the state. For the most part, these wells are not production wells (not used to produce water for consumption), but wells used only for the purpose of testing and measuring water levels. The Division of Water Resources, N.C. Department of Environment and Natural Resources, owns and operates monitoring wells for the State of North Carolina. The division also maintains a group of wells in cooperation with the United States Geological Survey (USGS) called the "USGS-DENR Cooperative Network." The Geological Survey has been evaluating the aquifers in North Carolina for more than 70 years and has extensive historical data available.

Problems in the Central Coastal Plain

Through this monitoring well network, the Division of Water Resources has documented that groundwater pressure levels in the Black Creek and Upper Cape Fear aquifers of the Central Coastal Plain have been declining as groundwater withdrawals have increased. In early 1998, new monitoring data indicated that the declines had increased faster than predicted. Water levels were dropping up to eight feet per year. In the most severely affected area, actual dewatering of the aquifer was occurring. The water level was 150 feet below the top of the aquifer. In addition, the Division of Water Resources noted that the boundary between fresh and saltwater had moved inland. Saltwater intrusion into the freshwater sections of the aquifer signaled problems for the environment and for water supply providers. Personnel from the Water Resources Division determined that there was increasing evidence of present and future groundwater supply shortages within the area encompassed by the following 15 North Carolina counties: Beaufort, Carteret, Craven, Duplin, Edgecombe, Greene, Jones, Lenoir, Martin, Onslow, Pamlico, Pitt, Washington, Wayne and Wilson (Figure 3).

To address threatened groundwater supplies in the region, the Division of Water Resources set in motion the development of a rule to regulate groundwater withdrawals in the 15-county area. The rulemaking process began in December 1998 and will conclude within the first 30 days of the 2002 short session of the North Carolina General Assembly. Known as the Central Coastal Plain Capacity Use Area Rule (rule), it will regulate water use through permits to avoid depletion of groundwater resources and to maintain the availability of those sources of water indefinitely. The rule will go into effect on August 1, 2002.

What does the rule require?

The primary purpose of the Central Coastal Plain Capacity Use Area Rule will be to reduce water withdrawals from the Black Creek and Upper Cape Fear aquifers over the next 16 years. Three reduction zones have been established over the 15-county region: the dewatering zone, the saltwater intrusion zone and the declining water level zone (Figure 2). In the dewatering zone, which covers the most challenged portion of the aquifer, water use from the Black Creek and Upper Cape Fear must be reduced by 75 percent. In the saltwater intrusion zone, use from the aquifer must be reduced between 30 to 75 percent. In the declining water level zone, water use must be monitored and reduced up to 30 percent.

The rule also requires all groundwater users withdrawing more than 100,000 gallons per day to apply for and obtain a water use permit in order to continue withdrawing. Regulated withdrawals include those from a well, a group of wells operated as a system, or a sump. Groundwater users will have 180 days after the effective date of the rule to apply for a permit.

Rural Center leads study effort

In response to growing concerns in the 15-county region, the N.C. Rural Economic Development Center, Inc. was asked to lead an effort to identify viable alternatives for the most affected systems. In addition, the Rural Center undertook a separate study to assess the economic impact to the 15-county region.

In the fall of 2000, the Rural Center formed the Central Coastal Plain Capacity Use Area Steering Committee. The

committee included representation from local water supply providers that would be affected by the rule and staff members from the N.C. Department of Environment and Natural Resources, the U.S. Geological Survey, the N.C. League of Municipalities, and the N.C. Association of County Commissioners. Together, the committee initiated a regional water resource planning study to meet three main objectives:

1) Quantify the current and future water needs of the region;

2) Identify the public water systems to be most affected by the rule and assess strategies for meeting water supply needs; and

3) Estimate the costs for these systems to implement needed measures.

The Rural Center retained the services of Golder Associates, Inc., a water resources consulting firm, to conduct an evaluation of water resources in the 15-county area. The center also retained the Research Triangle Institute (RTI) to conduct an economic impact analysis on the rule.

Study Results

Quantifying the current and future water needs of the region

To determine current water needs in the 15-county region, Golder Associates used a number of data sources. These included data from Local Water Supply Plans submitted to the N.C. Department of Environment and Natural Resources in 1997 and data from the U.S. Geological Survey, including results of a regional aquifer system analysis. These secondary sources were verified through contact with individual system owners and operators.

Information from the 1997 Local Water Supply Plans was combined with a hydrogeologic database developed by the Division of Water Resources. The information was then entered into a geographic information system (GIS) to analyze the situation in the Central Coastal Plain Capacity Use Area. The GIS and associated database enabled Golder to examine 480 individual public water supply wells (location, well depth, and average and maximum daily withdrawal rates) to determine the amount of Cretaceous aquifer groundwater used.

The study reached the following conclusions about current water usage in the Central Coastal Plain Capacity Use Area:

• Groundwater is the primary source of water in the area, accounting for 64 million gallons of water per day (mgd) or 66 percent of total water use. Surface water accounts for 30 percent and purchased water for 4 percent.

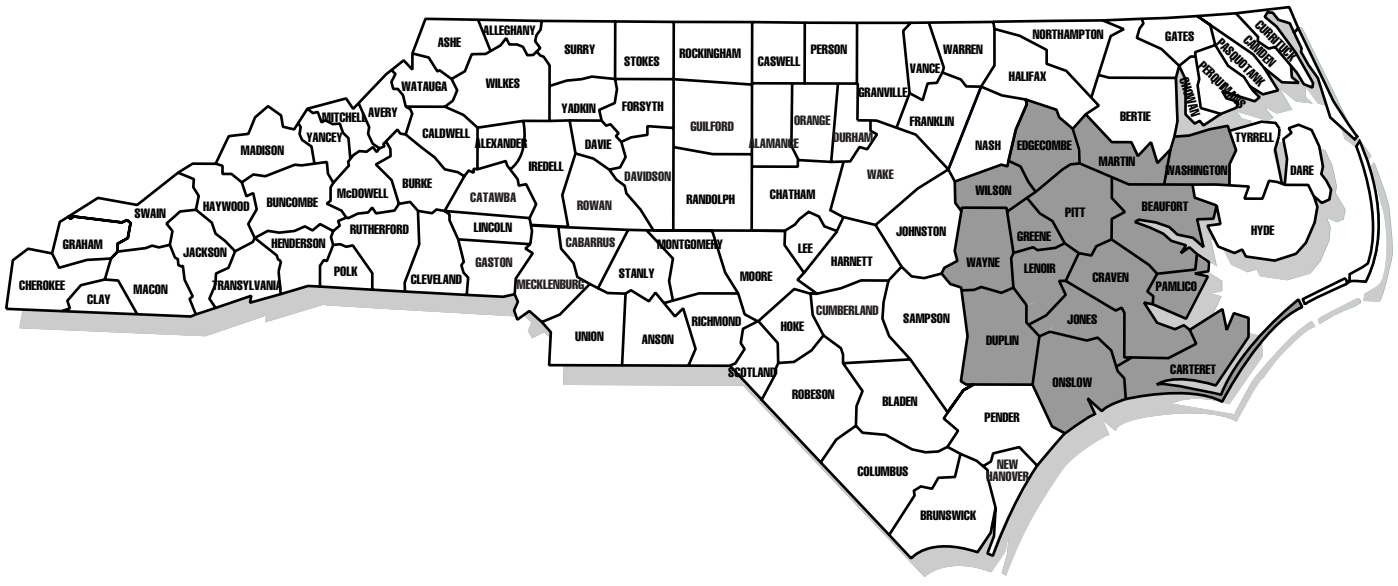
• Close to two-thirds or 40 million gallons a day of the groundwater used in the region comes from the Cretaceous aquifer system, most of which comes from the Upper Cape Fear and Black Creek aquifers.

• Public water systems provide water to 70 percent of the population in the area, or approximately 700,000 people.

• The average daily demand for the region is 95 million gallons of water per day.

Figure 3

Central Coastal Plain Capacity Use Area



• Some of the largest users of water are the major regional cities including Greenville (11.9 mgd), Wilson (8.0 mgd), and Goldsboro (6.2 mgd). The largest county water systems are Onslow (6.1 mgd), Wayne (3.1 mgd), and Craven (1.9 mgd).

• The maximum daily demand for the area, which reflects peak seasonal usage, is 142 million gallons of water per day.

• Forty-six percent of the total water used is for residential use, 39 percent is for industrial, commercial, and institutional use, 4 percent is sold, and 11 percent is unaccounted for and represents a water loss. Duplin, Edgecombe, Jones, and Wilson counties have water losses of more than 15 percent. Some individual water systems have water losses as high as 57 percent.

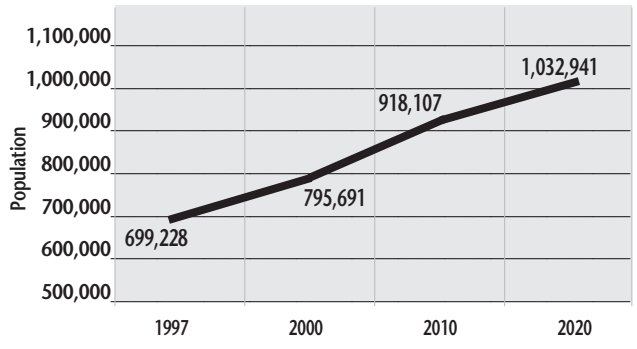
The study focused primarily on public water supply systems, which are required to document and submit information on their water usage. In addition to these public systems are many private systems – residences, farms, and fisheries – that withdraw groundwater through their own individual wells. This self-supplied water accounts for 68.5 million gallons of water per day. In addition, the dewatering operations of mining companies use 60-80 million gallons of water a day, bringing the total groundwater use in the area per day to 190-210 million gallons.

From the current water usage and population estimates supplied by the systems in the Local Water Supply Plans, Golder calculated future water use through the year 2020. Usage increased due to population growth, expansion of the system's service area, or by adding customers within the service area. Decreases were generally due to population loss, loss of industrial, institutional, or commercial establishments, or water conservation and reuse.

The study reached the following conclusions about projected water usage in the Central Coastal Plain Capacity Use Area:

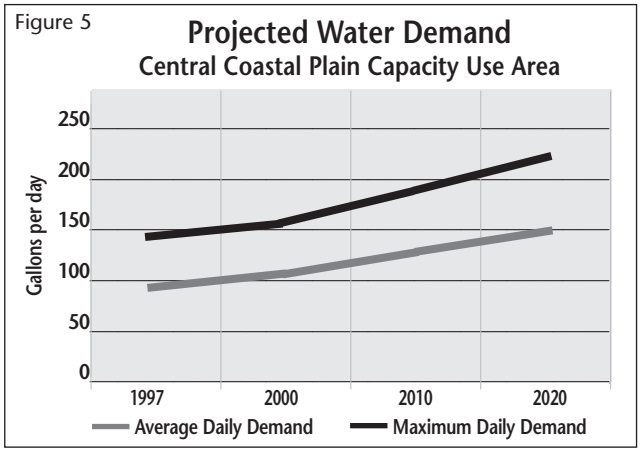
• The population served in the area is projected to grow by 48 percent from 1997 to 2020 to more than one million people (Figure 4).

Figure 4



• With population growth, water use is expected to increase as well. The average daily demand is projected to increase by 54 percent to 147 million gallons per day in 2020; maximum daily demand projection for 2020 is expected to reach 221 million gallons of water per day (Figure 5).

Figure 5



• According to the 2020 projections, more than 55 percent of the total daily water use in the region will occur in seven of the 122 systems: Greenville (18.6 mgd), Wilson (17.3 mgd), Kinston (16.0 mgd), Onslow County (13.2 mgd), Goldsboro (9.3 mgd), New Bern (5.8 mgd), and Jacksonville (5.2 mgd).

Identifying the most affected systems

Golder Associates identified a total of 122 public water systems in the 15-county region covered by the rule. All 122 systems will be required to register their water use, apply for and receive a permit, and institute water conservation measures; however, not all will be required to actually reduce consumption from the affected aquifers. From the list of 122, Golder determined that 36 systems would be "most affected" by the rule as follows:

• Of the total 122 systems, there are currently 44 public water systems that use groundwater from the Cretaceous aquifer wells and are located within the declining water level, dewatering, or saltwater encroachment zones. These are the areas that the Division of Water Resources has identified as in danger of sustaining damage if water withdrawal reductions are not made.

• Of the 44 water systems, 36 will be required to reduce withdrawals from the Cretaceous aquifer. The total reductions for the wells in the affected area must be 38 million gallons of water per day by 2018 (Figure 6). Most of the wells that will face reductions are in the dewatering or saltwater encroachment zones.

Figure 6

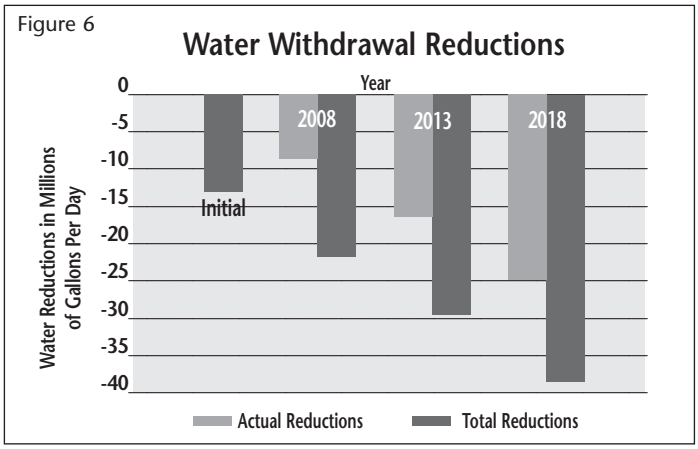
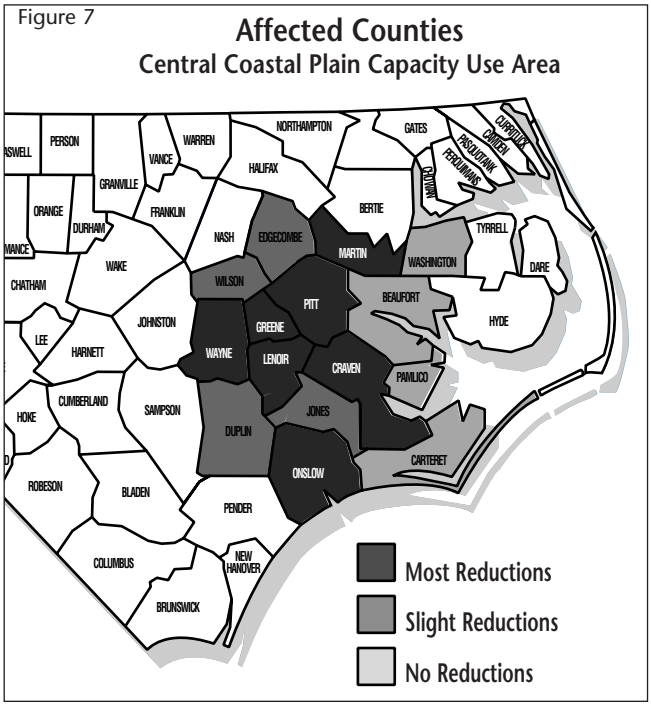


Figure 7



• The remaining eight water systems that use groundwater from the Cretaceous aquifer project withdrawals less than 100,000 gallons per day and therefore will not be required to reduce under the rule.

What does this mean for the 15 counties in the Central Coastal Plain Capacity Use Area? Water systems in 11 counties will face reductions (Figure 7). The most affected counties are Lenoir (9.4 mgd), Onslow (7.2 mgd), Craven (5.7 mgd), Pitt (4.7 mgd), Wayne (3.7 mgd), Martin (3.4 mgd), and Greene (1.4 mgd). Jones, Duplin, Edgecombe, and Wilson will face slight reductions. Beaufort, Carteret, Pamlico, and Washington counties do not face any withdrawal reductions.

Several of the water systems that will be most affected by the rule have already begun work on large water projects. Recognizing that their futures depend upon developing a sustainable water source, the cities of Greenville, Kinston, Goldsboro, Wilson, Jacksonville and New Bern have planned major regional water treatment and distribution projects. Together these projects will bring an estimated 31 million gallons per day online. Without these planned projects, the 36 systems most affected by the rule would face a projected deficit of 48 million gallons a day. With the projects, the deficit is reduced to 16.8 million gallons a day. Continued support for these important improvements is vital for the region.

Water supply alternatives for the region

Having identified the most affected systems and the amounts of new water supply that must be developed to replace withdrawals from the impacted aquifers, Golder Associates conducted a scan of all available water supply sources in the 15-county region. The list of supply options identified is summarized below and in the table on page 11.

Groundwater resources from other aquifers within the 15-county region were the first options identified. Possible alternatives include the Peedee, Castle Hayne, Lower Cape Fear and Surficial aquifers. Limited amounts can be withdrawn from the Beaufort and Yorktown aquifers. The Upper Cape Fear, Black Creek, and Pungo River aquifers are either faced with restrictions or are not options for this region.

Surface water represents a second option considered in the study. Surface water resources are currently used in Goldsboro, Greenville, Tarboro, and Wilson. These systems withdrew 28.5 million gallons of surface water a day in 1997. Greenville, drawing from the Tar-Pamlico River Basin, is the only water system using surface water that faces reductions under the rule.

Brackish water development is increasing throughout coastal areas of the United States, and **reverse osmosis** and desalination plants are in operation in Dare County. Brackish groundwater underlies a large portion of the 15-county area within the deeper portions of the aquifers. The Atlantic Ocean and coastal estuaries are a surface source of brackish water. Desalination of brackish water is more expensive than conventional treatment of fresh groundwater or surface water and disposal of the extremely saline brine residue is an environmental concern. Most likely, brackish water will not be developed as a supply in the area until after all fresh water sources are exhausted.

Aquifer storage and recovery (ASR), another alternative that may help to compensate for the reduction in Cretaceous aquifer withdrawals, includes a variety of water extraction and water management tools. ASR involves the storage of water in a suitable aquifer in a well during times when water is available and recovery of the water from the same well during times when it is needed. ASR is primarily used to meet seasonal or peak water demands. In this application, surface water or water pumped from a supply aquifer is injected into a storage aquifer during periods of low demand and excess supply. Water is then recovered during periods of high demand or low supply.

Table 1

Water Supply Alternatives for Affected Public Water Systems

Central Coastal Plain Capacity Use Area

County	System	2020 Water System Reserve/(Deficit) (MGD)	Conservation	Reuse	Purchased Water	Instream Intake	Impoundment	Bedrock	Cretaceous	Peedee	Beaufort	Castle Hayne	Yorktown	Surficial	Mine Dewatering	Brackish Aquifer	ASR
CRAVEN	CRAVEN CO	(2.214)	x	x		1				2		1			2			
CRAVEN	NEW BERN	(0.663)	x	x		1				2		1			2			
DUPLIN	BEULAVILLE	(0.061)	x		1	3				1		3				3		
DUPLIN	CHINQUAPIN WA	(0.050)	x		1	3				1		3				3		
DUPLIN	DUPLIN CO WD A	(0.045)	x		1	3				1								
DUPLIN	DUPLIN CO WD B	(0.138)	x		1	3												
DUPLIN	DUPLIN CO WD F	(0.301)	x		1	3			1									
DUPLIN	GREENEVERS	0.002	x		1				1	1								
EDGECOMBE	CONETOE	0.000	x		1			3					3	3				
EDGECOMBE	PINETOPS	(0.106)	x		1			3					3	3				
GREENE	GREENE CO	(0.818)	x		1	1				2								
GREENE	SNOW HILL	(0.282)	x		1	1				2								
JONES	JONES CO	(0.047)	x		3					1	2	1				3		
LENOIR	DEEP RUN WC	(0.132)	x			1												
LENOIR	KINSTON	(2.638)	x	x		1											2	
LENOIR	LA GRANGE	(0.014)	x			1												
LENOIR	N LENOIR WC	(0.086)	x			1												
LENOIR	PINK HILL	0.074	x			1												
MARTIN	ROBERSONVILLE	(1.025)	x	x	3	3							2	2				
MARTIN	WILLIAMSTON	(2.840)	x	x	3	3						3		2		3		
ONSLOW	JACKSONVILLE	(4.041)	x	x	2					2		1			2			
ONSLOW	ONSLOW CO	0.290	x							2		1			2			
ONSLOW	RICHLANDS	(0.139)	x		1					1								
PITT	AYDEN	(0.571)	x		1					2								
PITT	BELL ARTHUR WC	0.000	x		2							2						
PITT	BETHEL	(0.154)	x		1									3				
PITT	EASTERN PINES WC	0.000	x							2		2				3		
PITT	FARMVILLE	(1.437)	x		1	3	3							2				
PITT	GREENVILLE	4.121	x	x		1											2	
PITT	GRIFTON	(0.238)	x		1					2								
PITT	STOKES RW CORP.	(0.414)			1					2		2				3		
PITT	WINTERVILLE	(0.495)	x		1					2								
WAYNE	FORK TOWNSHIP SD	(0.890)	x		2	1		2										
WAYNE	WALNUT CREEK	(0.181)	x		1			2										
WAYNE	WAYNE WD	(1.299)	x		2	1		2	1									
WILSON	STANTONSBURG	(0.001)	x		1													

Notes:

1. Water supply alternative has sufficient capacity to meet the full predicted water system capacity deficit in 2020. Indicates recommended alternative water supply.
2. Water supply alternative does not have sufficient capacity to meet full predicted 2020 water supply deficit, represents supplemental water supply.
3. Water supply alternative is available but is not believed to be feasible due to cost, regulatory requirements, or feasibility; cannot be evaluated because quantity and quality of source is not yet known. May represent feasible alternative, but further study is needed.

X is placed under water conservation and reuse (as considered applicable) to stress need to consider methods of reducing and managing water demand and reducing water system losses, which should be considered as potential water supply alternatives.

ASR can be used to provide an emergency water supply. ASR also has been implemented to reduce or delay the capital costs of expanding supply, surface storage, or treatment. In some cases, ASR has been used to help stabilize declining aquifer water levels and reduce saltwater intrusion and land subsidence associated with over-pumping. In North Carolina, ASR is being tested by the Greenville Utilities Commission in Pitt County.

Water conservation can reduce water use by an average of 15-25 percent and save millions of dollars in supply upgrades. Water conservation is defined as any reduction in water use, waste, or loss and is accomplished by implementing programs that increase water efficiency and improve water use management practices. Conservation reduces the need for capital improvements necessary to develop new sources and therefore is a low or no cost way to decrease or eliminate shortages. Conservation strategies include creating a conservation-based rate structure that would increase charges per unit with increases in water use, reducing unaccounted for water through leakage detection and other such programs, educating the public on water supply issues, encouraging indoor conservation such as low-flow showers and reduced toilet tank holdings, and adoption of irrigation ordinances.

Water reuse, or reclaimed water, is another viable option for water systems in the capacity use area. This practice uses highly treated wastewater to supply non-potable water demands. For some systems, installing a reclaimed water system may be more cost effective than adding new water supplies and expanding treatment facilities, especially for new development areas. Reclaimed water is typically used for agricultural and landscape irrigation, toilets and urinals, groundwater recharge, industrial cooling and process water, cooling water in commercial air conditioning systems, fire protection, vehicle washing, street cleaning, and ornamental ponds and fountains. Wilson County is currently constructing a water reuse system that will be able to sell up to 5.5 million gallons of water a day at a lower cost than potable water. The county hopes to use this water for golf course irrigation and at the industrial park near the wastewater treatment plant. Goldsboro and Kinston are also planning water reuse systems.

Mine dewatering produces an effluent water that can be used as a water source. Within the 15-county area, sand and gravel quarries in the Surficial aquifer and aggregate quarries in the Castle Hayne aquifer represent potential water sources. Abandoned quarries act as reservoirs storing groundwater that flows in from shallow aquifers. Active mines and quarries keep their pits dry by pumping water that seeps into the pit or installing a series of dewatering wells around the pit. Martin Marietta owns and operates three aggregate quarries in the area that produce excess quantities of water. These quarries are located in New Bern, Maysville and Richlands. The sustainable yield of these quarries is not known. Martin Marietta is currently undertaking a study to quantify the amount of excess water that is being produced at each of the sites. The water withdrawn from these quarries would require treatment as surface water, although low turbidity might allow less expensive treatment methods.

Regionalization and inter-system water purchases, most often looked upon as strategies for securing water, offer potential sources of water for the region. Approximately 4 percent of the public water supply in the area is currently purchased by one system from another. Typically, smaller systems purchase water from larger systems with excess supply. Spurred in part by the Central Coastal Plain Capacity Use Area Rule, some systems are considering purchasing water from systems outside the area or outside the restricted portion of the region. Inter-system purchase is relatively easy to initiate, but may not provide long-term security of supply (agreements can be changed) and the price of purchased water is often high. Rocky Mount has become a major regional supplier in the northwestern part of the area. Tarboro, Greenville and Kinston will likely become significant regional water suppliers in the future.

Proposed alternatives and associated costs

The final step of the study involved narrowing the list of options to those that were considered viable for each affected system, then developing a cost estimate for that option. In cases where a joint solution was available, costs for the joint solution were also developed.

The recommendations for each system were based on a ranking of alternatives that considered location, yield, feasibility and environmental and regulatory factors. The analysis is intended to highlight promising water supply alternatives and to provide information for general planning purposes. Additional engineering studies will be required to fully and properly evaluate the feasibility of developing any specific water supply alternative. The cost estimate represents the probable costs to construct a treatment plant and pipeline facilities in 2002 dollars.

More detailed descriptions are available in the technical report prepared by Golder Associates.

Table 2

Recommended Water Supply Alternatives and Probable Costs for Affected Public Water Systems

Central Coastal Plain Capacity Use Area

COUNTY	WATER SYSTEM	POTENTIAL ALTERNATIVE WATER SUPPLIES	ESTIMATED COSTS (in millions)
CRAVEN	CRAVEN CO	Castle Hayne aquifer Neuse River (J)	$14 to $44 (J)
CRAVEN	NEW BERN	Castle Hayne aquifer Neuse River (J)	$21 to $44 (J)
DUPLIN	BEULAVILLE	Peedee aquifer Purchase from Duplin Co.	$0.28
DUPLIN	CHINQUAPIN WA	Peedee aquifer Purchase from Duplin Co.	$0.28
DUPLIN	DUPLIN CO WD A	Peedee aquifer Purchase from Duplin Co. Purchase from Neuse Regional WASA Northeast Cape Fear River (J)	
DUPLIN	DUPLIN CO WD B	Peedee aquifer Purchase from Duplin Co. Northeast Cape Fear River (J)	$0.28 to $6.7 (J)
DUPLIN	DUPLIN CO WD F	Black Creek aquifer (J) Peedee aquifer Purchase from Duplin Co. Northeast Cape Fear River (J)	$0.28 to $6.7 (J)
DUPLIN	GREENEVERS	Water Conservation and Loss Reduction Emergency Connection with Duplin Co.	NA
EDGECOMBE	CONETOE	Purchase from Edgecombe County WSD Bedrock, Yorktown, or Surficial aquifers	NA
EDGECOMBE	PINETOPS	Bedrock, Yorktown, or Surficial aquifers Purchase from Edgecombe County	NA
GREENE	GREENE CO	Purchase water from Neuse Regional WASA (J) Contentnea Creek (J)	$2.8 (J) to $10.6 (J)
GREENE	SNOW HILL	Purchase water from Neuse Regional WASA (J) Contentnea Creek (J)	$2.8 (J) to $10.6 (J)
JONES	JONES CO	Peedee aquifer Castle Hayne aquifer Purchase from Neuse Regional WASA	$0.56 to $2.3
LENOIR	DEEP RUN WC	Neuse River (Neuse Regional WASA) (J)	$ 55 (J)
LENOIR	KINSTON	Neuse River (Neuse Regional WASA) (J) Aquifer storage and recovery	$ 55 (J)
LENOIR	LA GRANGE	Surface water from the Neuse River (J)	$ 55 (J)
LENOIR	N LENOIR WC	Neuse River (Neuse Regional WASA) (J)	$ 55 (J)
LENOIR	PINK HILL	Neuse River (Neuse Regional WASA) (J)	$ 55 (J)
MARTIN	ROBERSONVILLE	Yorktown or Surficial aquifers Purchase water from Martin County Castle Hayne aquifer (J) Roanoke River (J)	$0.25 to $30 (J)
MARTIN	WILLIAMSTON	Surficial aquifer Brackish groundwater Castle Hayne aquifer (J) Roanoke River (J)	$12 to $30 (J)
ONSLOW	JACKSONVILLE	Castle Hayne aquifer Surface water from Martin-Marietta quarry	$17 to $25
ONSLOW	ONSLOW CO	Expansions to existing Castle Hayne WTPs Surface water from Martin-Marietta Quarry	$34 to $38

Table 2

Recommended Water Supply Alternatives and Probable Costs for Affected Public Water Systems

Central Coastal Plain Capacity Use Area

COUNTY	WATER SYSTEM	POTENTIAL ALTERNATIVE WATER SUPPLIES	ESTIMATED COSTS (in millions)
ONSLOW	RICHLANDS	Peedee aquifer Purchase water from Onslow County	< $0.44
PITT	AYDEN	Peedee aquifer Purchase water from adjacent water systems	$0.5 to $1
PITT	BETHEL	Surficial aquifer Purchase water from Greenville Utilities Commission	$0.5 to $1.5
PITT	FARMVILLE	Surficial aquifer Pump storage reservoir Tar River Purchase water from Greenville Purchase water from Greene County Purchase withdrawal allocation from other permitted water users	$5.5 to $7
PITT	GREENVILLE	Excess capacity for ADD, deficit on MDD, use existing K wells and ASR to meet peak demand, expand SWTP	NA
PITT	GRIFTON	Peedee aquifer Purchase water from adjacent water systems	$0.56
PITT	WINTERVILLE	Peedee aquifer Purchase water from Greenville Utilities Commission	$0.56
WAYNE	FORK TOWNSHIP SD	Purchase water from adjacent water systems Neuse River (J)	$ 0.0 to 26 (J)
WAYNE	WALNUT CREEK	Unrestricted Cretaceous aquifer Purchased water from adjacent water systems	$0.8
WAYNE	WAYNE WD	Unrestricted Cretaceous aquifers (J) Neuse River (J) Purchase water from Goldsboro	$15 (J) to $26 (J)
WILSON	STANTONSBURG	Purchase from Wilson or County system	NA

Total probable cost range for affected public water systems $153 to $ 247

Information was not provided for three non-profit water systems in Pitt County due to insufficient supply and demand data.

(J) indicates joint solution with other systems.

Economic Assessment

Water supply and economic development

North Carolina has a vast network of local organizations and state agencies dedicated to bringing economic prosperity and a high quality of life to citizens in all parts of the state. Their shared goal is to provide jobs for North Carolina families and communities by attracting new businesses and helping existing businesses to grow and prosper. In the 15 counties that are a part of this study, creating and retaining jobs is critical to survival.

An essential component of successful economic development – one that is often taken for granted – is the guarantee of a safe, reliable supply of water. Location decisions for most business and industry are predicated on the availability of both water and sewer. Simply put, no water = no economic future.

The people in the 15 counties that comprise the Central Coastal Plain have historically relied on traditional industries such as agriculture and manufacturing for jobs. Tobacco, corn, cotton, and the swine and poultry industries have provided the majority of agricultural jobs. In fact, Pitt, Wilson and Wayne counties have been three of the state's top 10 counties in tobacco production for more than 50 years. Work in manufacturing has been concentrated in textiles, apparel, chemicals and automobile-related production. Jobs in these industries have been significantly affected by the general economic recession and by industry-specific trade practices. In the last five years, manufacturing job losses have escalated to crisis proportions as more than 10,000 jobs have been lost to plant closings and downsizing.

In addition to job losses, these eastern counties have been devastated by four major hurricanes – Fran, Dennis, Bertha and Floyd – in the last decade. Business and agricultural losses from Hurricane Floyd and related flooding were estimated at $6 billion, making it the most costly natural disaster in the state's history. Nine of the 15 counties in the Central Coastal Plain Capacity Use Area were considered to have severe impacts from the storm.

These economic events of the past few years have taken place against a backdrop of persistently high poverty and low median household incomes. Twelve of the 15 counties are identified by the North Carolina Department of Commerce as economically distressed. Eight have experienced poverty above 18 percent for three or more decades (Table 3).

Yet, in spite of these difficulties, the region has its bright spots and major accomplishments. The university and medical center in Greenville have anchored growth in Pitt County. The towns of New Bern and Jacksonville grew by 33 and 122 percent respectively in the last decade, and Pitt, Greene and Duplin counties all grew by more than 20 percent. Major new industries such as QVC, Wachovia Dealer Service Center and MasterBrands Cabinets have chosen one of the 15 counties of this region as their new home.

For a region that is working hard to move beyond joblessness and poverty, being positioned to retain these industries and recruit others is critical. Running out of water for

Table 3

Population and Economic Status
Central Coastal Plain Capacity Use Area

County	Tier 2002	Pop 2000	% Population Change 1990-2000	Unemployment Rate 2001	Median Household Income 1999	% Living in Poverty 1999	Manufacturing Layoffs 1997-2001	% Change Labor Force in 1990-2000
Beaufort	1	44,958	6.3%	9.6	$31,066	19.5%	895	-4.3%
Carteret	4	59,383	13.0%	4.9	$38,344	10.7%	170	13.6%
Craven	4	91,436	12.0%	5.2	$35,966	13.1%	327	7.9%
Duplin	2	49,063	22.7%	6.3	$29,890	19.4%	938	7.8%
Edgecombe	1	55,606	-1.7%	9.6	$30,983	19.6%	432	-15.7%
Greene	2	18,974	23.3%	6.2	$32,074	20.2%	30	20.3%
Jones	1	10,381	10.3%	5.5	$30,882	16.9%	0	-0.7%
Lenoir	2	59,648	4.1%	8.1	$31,191	16.6%	3,211	3.3%
Martin	1	25,593	2.1%	8.2	$28,793	20.2%	422	-8.2%
Onslow	3	150,355	0.3%	4.5	$33,756	12.9%	150	14.6%
Pamlico	2	12,934	13.7%	4.6	$34,084	15.3%	0	7.5%
Pitt	4	133,798	24.0%	6.0	$32,868	20.3%	2,464	15.7%
Washington	1	13,723	-2.0%	7.2	$28,865	21.8%	260	-1.0%
Wayne	3	113,329	8.3%	5.4	$33,942	13.8%	440	1.2%
Wilson	3	73,814	11.7%	8.3	$33,116	18.5%	263	3.8%
15-County Area	**N/A**	**912,995**	**9.5%**	**6.4**	**N/A**	**16.4%**	**10,002**	**6.3%**

personal use and for business and industry is not an option. The momentum that has been built by the people of this region to succeed cannot be hampered by lack of water and the planning necessary for a sustainable water supply in the future.

The economic impact model

To address the relationship between water resources and economic development, the Rural Center engaged the assistance of resource economists at the Research Triangle Institute. The purpose of their work was to identify and quantify the economic impacts that water users in the region were likely to experience.

The Research Triangle Institute constructed an economic model using three major categories of data: economic, demographic and water use.

- Economic data were gathered from IMPLAN (input-output economic data grouped into 25 economic sectors for modeling), the North Carolina Department of Commerce and county and municipal managers.
- Demographic data were compiled from the North Carolina and United States Departments of Commerce.
- Water use data were extracted from the U.S. Geological Survey, the Department of Environment and Natural Resources and private sector sources.

From this data, a baseline characterization was developed for the year 2000. Economic outputs (goods and services), population and water use were then projected to the year 2020. From these projections, the researchers were able to develop the capital costs of new water supplies and the costs of annualized operations and maintenance.

Finally, an economic model was constructed to simulate the impacts of increased water costs in markets for industrial and commercial products. Residential demand was characterized as "price inelastic" based on the most recent studies available from the American Social Science Institute. That means that residential consumption changes little in response to increasing costs. Industrial and commercial elasticity of demand varied depending upon the water use of the industry/business. The model provided a way to examine the changes in output, income and employment that may result as utilities, industries, businesses and households adjust their behavior in response to the increased costs of water.

Economic impact assessment results

Two important points emerged from the economic impact analysis.

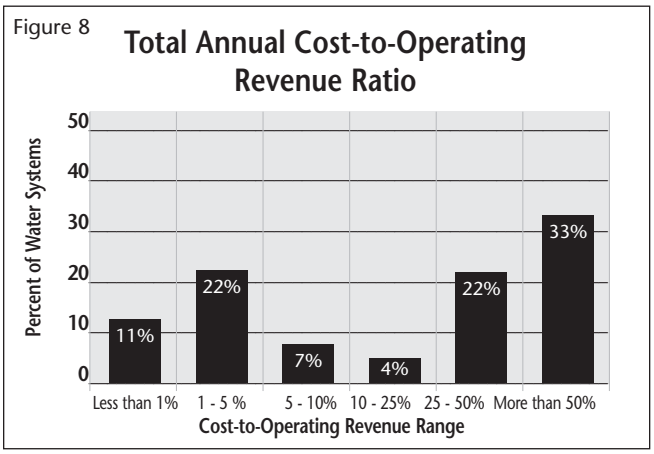
First, developing new water supply sources will be expensive. It is estimated that the annual cost of developing alternative sources will be more than $30 million per year, with lump sum capital costs of $216 million. These costs will be incurred primarily by water systems, which in turn will pass them along to customers in the form of higher costs for water.

The $216 million in capital costs (2002 dollars) is significantly more than the estimate of $40-$75 million provided by the Division of Water Resources and contained in the fiscal note to the rule. The magnitude of these costs could easily be overwhelming for individual water systems – crystallizing the need for advance planning and effective overall management of water resources in this region.

Households, businesses, and institutions in the region will feel the pinch of the increasing cost of water. But, because the cost of water is a fairly small share of household budgets and overall production costs, the economic impacts on the overall economy are projected to be small. The total economic impact on the region is estimated to be a reduction in output (goods and services) of approximately $47 million. This amount includes the direct cost of developing new resources and the indirect and induced multiplier effects as those costs ripple through the economy. This represents less than 1 percent of estimated total regional output of $61 billion.

Second, while the costs and impacts appear modest when compared to the economy of the region as a whole, they are very large investments for the water systems. One way to measure this impact is to compare the annual estimated costs of developing new supplies (building and operating new treatment plants and other system components) to the amount of revenue currently generated by public water systems to pay for operation and maintenance. For comparison purposes, a cost-to-operating revenue ratio of 5 percent or more is generally considered to be significant. For 55 percent of systems studied, the annual cost-to-operating revenue ratio is estimated to be greater than 25 percent (Figure 8). The bottom line for most of the systems affected by the rule is that financing costs of the required improvements will be immense. Rate increases alone will not generate enough money to finance the needed improvements. Accessing sources of revenues such as grants will be critical.

Figure 8



Conclusion: A siren call for better management

The Central Coastal Plain Capacity Use Area Rule will require water users to cut back on use of overused aquifers and increase use of other water sources (including alternative aquifers, surface water and other sources) over a 16-year period. The rule will become effective on August 1, 2002, and covers a 15-county area east of I-95 to the coast. Counties covered by the rule include Beaufort, Carteret, Craven, Duplin, Edgecombe, Greene, Jones, Lenoir, Martin, Onslow, Pamlico, Pitt, Washington, Wayne, and Wilson. Depending on the zone in which a regulated water user falls, the water user will be required to reduce water use from Cretaceous aquifer wells over a 16-year period by up to 75 percent. The purpose of the rule is to protect the long-term productivity of aquifers within the designated area and to allow the use of groundwater for beneficial uses at rates that do not exceed the recharge rate of the aquifers.

Many of the alternatives examined and recommended in this study will cost millions of dollars to develop, likely translating to higher water bills for all consumers. As we have shown, many of the local governments that will be faced with decisions that will cost money and commit future resources, are already fiscally challenged. Relatively low median incomes and high rates of poverty speak volumes about the population that will likely be paying for the water resource alternatives that are pursued. Aiming to do their very best for the local citizens by providing essential services at a reasonable cost and provide for a solid economic future, local governments in the Central Coastal Plain will be faced with having to balance economic fairness with environmental protection. Difficult choices must be made, and leaders of these local communities will need good quality information, technical assistance and funding to reach effective solutions.

Recommendations

❑ **Move forward with the Central Coastal Plain Capacity Use Area Rule** to protect the area's water resources for the future and prevent stagnation of the economy. The cost to develop new water supplies will be significant, but as demonstrated in the report, the protection of our water supplies is essential. We must encourage systems to be strategic about making improvements to yield the best value for the dollar for both consumers and people of the state.

❑ **Support the designation by the State Infrastructure Council of a Water Resources Study Committee.** The impact of the Central Coastal Plain Capacity Use Rule on public water suppliers in the region demonstrates that long-term planning and management of water resources throughout the state is needed to avoid similar situations elsewhere. Such planning and management might require changes in current state policy (e.g. water use permitting). This committee should examine the current laws and regulations that date back to 1967 to determine the adequacy and functionality of those laws and regulations to address current day water supply conditions. Recommendations for modification of those laws and regulations should be made to the full council and by the council to the membership of the General Assembly.

❑ **Support water supply planning statewide.** All public water supply systems, including those not required to reduce Cretaceous aquifer withdrawals, should initiate planning to meet future demands. Planning for future system improvements and supply is critical in this 15-county region as it is in many other areas of the state struggling with drought and population demand that outstrips supply.

❑ **Ramp up public education efforts around water resources and conservation.** Decisions on how to manage and develop our water resources will be made easier if people understand more about our water resources. Becoming more educated on where we get our drinking water and how it is used by the various consumers – residents, business, and industry – is a vital first step toward protecting that resource for the future. Raising our level of understanding on the finite nature of our water resources is essential for making good local decisions and developing statewide policy.

❑ **Evaluate and coordinate economic development policies to work effectively with water resources.** For example, while pharmaceutical and biotechnology companies are desirable recruits for our state because they provide desirable jobs, these industries have water intensive processes. Planning for their location, particularly in this 15-county region, should include a water resource assessment.

❑ **Encourage strategies aimed at reducing overall demand from the Cretaceous aquifer system.** Such strategies might include: regionalization and consolidation of systems, water conservation and reclamation.

❑ **Encourage public water supply providers in the 15-county region to continue efforts to assess their drinking water systems and line sizes** and to place priority on these improvements that support increased system efficiency.

❑ **State environmental agencies should support non-traditional means of obtaining, moving and storing water.** Desalination, reverse osmosis, aquifer storage and recovery and water recycling achieved through water reclamation are recent technology/process advances that encourage efficient use of water resources. These technologies are not widely used yet in North Carolina, but are common practices in other states that have confronted similar water shortage problems.

❑ **Direct local governments within the capacity use area to the Capacity Building Grants Program** administered by the Rural Center. More detailed engineering studies and cost estimates are needed for individual systems to make decisions about which alternative to pursue. In particular, resources should be focused on systems within the region that have the fewest options that are obviously feasible and cost-effective. These systems include those in Farmville, Robersonville, and Williamston and on systems with small customer bases that may have trouble paying for planning and feasibility studies.

❑ **Encourage the N.C. Department of Environment and Natural Resources to routinely monitor water levels and water quality of the Cretaceous aquifer system** to assess the effect of the mandated withdrawal reductions. The Cretaceous aquifer system can still be a tremendously productive water supply for the Central Coastal Plain. As directed by the Central Coastal Plain Capacity Use Area Rule, the withdrawal reductions should be relaxed, locally or regionally, if monitoring demonstrates that aquifer conditions dramatically improve.

❑ **Support future investment in the state's monitoring well network.** Several counties within the capacity use area would benefit from additional monitoring wells. The monitoring well network should be located to accurately reflect aquifer conditions throughout the region, both close to and away from pumping centers. It may be desirable to involve other groups, such as universities or the U.S. Geological Survey, in funding and carrying out the monitoring.

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