Rec'd. 9-6-96 RWO

REGIONAL WATER STUDY
FOR THE
ALBEMARLE WATER RESOURCES
TASK FORCE

PREPARED FOR

THE ALBEMARLE WATER RESOURCES TASK FORCE
and
THE ALBEMARLE COMMISSION
512 S. CHURCH STREET
HERTFORD, NORTH CAROLINA 27944

PREPARED BY

HOBBS, UPCHURCH & ASSOCIATES, P.A.
290 S.W. BROAD STREET
SOUTHERN PINES, NC

JUNE, 1996

NORTH CAROLINA PROFESSIONAL SEAL 14996 ENGINEER ERIC T. WEATHERLY

8/20/96

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290 S.W. Broad Street • Post Office Box 1737 • Southern Pines, NC 28388

September 4, 1996

Regional Water Study Participants
c/o Albemarle Commission
P.O. Box 646
Hertford, N.C. 27944

RE: Submittal of Final Report
HUA No. HE 9501

Dear Study Participant:

Attached you will find the final version of the Regional Water Study. The study analyzes the existing conditions and water resources of the 16-county region of the Albemarle Commission and North Carolina, Northeast. Furthermore, the study identifies the Counties of Camden, Currituck, Dare and Pasquotank and the City of Elizabeth City as the area in greatest need of additional water resources to meet the water demands of growing communities. Feasibility analyses of several production and distribution scenarios are presented for this area.

The report is quite detailed and contains an abundance of information. Please feel free to call with any questions regarding the material presented. Eric Weatherly or Jay Johnston will be available for discussion or explanations.

As discussed at the August 19 meeting of the Albemarle Water Resources Task Force, the identified counties and municipalities must now decide on a level of cooperation and participation in a Regional Water System and pursue funding for the next phase of study - hydrogeological investigation of available deep ground water sources. Mr. Bill Owens has offered to help in pursuing financial assistance.

Southern Pines, NC • Telephone 910-692-5616 • Fax 910-692-7342
Winston-Salem, NC • Telephone 910-759-3009 • Fax 910-759-7590
Myrtle Beach, SC • Telephone 803-626-1910 • Fax 803-626-1745

Hobbs, Upchurch and Associates, P.A. appreciates the opportunity to have worked with you and hopes to be of further assistance to you in pursuing a Regional Water System.

Sincerely,
HOBBS, UPCHURCH, AND ASSOCIATES, P.A.

Jay Johnston, E.I.T

JJ/mde

Attachments

Recipients of Final Report: Regional Water Study

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Camden, NC 27921

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Currituck County
P.O. Box 39
Currituck, NC 27979

Bill Owens
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Elizabeth City, NC 27909

Clarence Skinner
Route 1, Box 780
Manteo, NC 27954

Rick Watson
North Carolina, Northeast
P.O. Box 278
Hertford, NC 27944
(919) 426-1600

Randy Keaton, Manager
Pasquotank County
P.O. Box 39
Elizabeth City, NC 27909

Dick George, Asst. Director
Albemarle Commission
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Hertford, NC 27944

Steven Harrell, Manager
City of Elizabeth City
P.O. Box 347
Elizabeth City, NC 27909

Bob Oreskovich
Dare County Water Dept.
600 Mustian St.
Kill Devil Hills, NC 27948

Les Twible
Rural Center
1300 St. Mary's St.
Suite 500
Raleigh, NC 27605

EXECUTIVE SUMMARY

REGIONAL WATER STUDY FOR THE ALBEMARLE WATER RESOURCES TASK FORCE

June, 1996

In September, 1995, the Albemarle Water Resources Task Force commissioned Hobbs, Upchurch & Associates, P.A. to perform a Regional Water Study. The purpose of the Regional Water Study was to: 1) evaluate water supply alternatives and options that might mutually benefit some or all of the systems in the region and 2) analyze water supply alternatives for the Albemarle Region.

The original Request for Proposals, dated July 14, 1995, stated, "the Contract for a Feasibility Study will be in cooperation with the Albemarle Commission, the Northeastern North Carolina Economic Development Commission, the Rural Economic Development Center, Inc. and the Counties of Camden, Chowan, Currituck, Dare, Halifax, Hertford, Hyde, Martin, Northampton, Pasquotank, Perquimans, Tyrrell, Washington and the municipalities of Columbia, Creswell, Edenton, Elizabeth City, Hertford, Kill Devil Hills, Kitty Hawk, Manteo, Nags Head, Plymouth, Roper, Southern Shores and Winfall. The Feasibility Study will include, as necessary, the counties of Beaufort, Bertie and Gates. One or more technically sound, politically acceptable and cost-effective alternatives for the region will be developed".

Hobbs, Upchurch & Associates, P.A. performed the Regional Water Study as outlined above and presents the results in this report. The report is to be used as a planning guide for evaluating regional water supply and distribution. Sections of the report evaluate

- Existing conditions of area water supplies
- Growth and population areas
- Areas in need of water
- Potential water supplies available to the region.

After identifying the areas in greatest need of water and potential water supplies, the feasibility analyses evaluate the cost of several water distribution scenarios.

The participating counties and municipalities which operate water systems are in reasonably good condition with respect to water production and supply. However, certain water systems face a greater challenge in meeting water demands, usually because community growth has outpaced water production capacity. Water production capacity is usually limited by the flow rates (production) available from individual wells and well fields. These challenged areas are identified as areas in greatest need of water since they are operating at or near their maximum production rates.

The areas identified as being in the greatest need for water correlate with areas of greatest population and growth. These areas are Elizabeth City and Pasquotank County, the Currituck and Dare County Outer Banks and mainland Currituck County. Camden County, dependent on Pasquotank County and Elizabeth City for water supply, is also in this group.

This report evaluates potential surface water and groundwater supplies for their viability as a regional source. Two water source options lie outside of the Albemarle Region: Lake Gaston (pipeline) and mine depressurization water from PCS Phosphate near Aurora, Beaufort County. Each of these potential sources can meet most of the demand of the identified needy area. However, the political feasibility of each source is questionable.

This report considers several potential surface water sources within the region, including sounds, estuaries and lakes. Poor water quality and low flow/recharge rates prohibit the use of any of the local lakes. Unpredictable fluctuations in water quality and generally brackish water prevent use of the estuaries and sounds.

The most feasible water source evaluated for this study may be local groundwater. Although some existing water systems struggle meeting demands with local groundwater supplies, research presented in Section 5 of this report suggests that there are more productive aquifer zones available to the region. These zones are generally deeper and contain elevated chloride concentrations; however, advanced treatment methods such as reverse osmosis could facilitate the use of more productive aquifer zones. Section 5 elaborates on the hydrogeologic investigation which would be necessary to locate productive aquifer zones for regional water supply.

Use of local groundwater potentially provides the least politically controversial water source, although there may be discussion over inter-community transfer of water. Local groundwater sources also provide the regional water system self governing and independent water production. Receiving water from an outside source would create dependence on the supplier as would be the case with the Lake Gaston pipeline or PCS Phosphate.

This report discusses seven water supply and distribution scenarios in Section 6 and Appendix II, including construction and operation costs for each scenario, reduced to a cost per thousand gallons of water produced annually. A table summarizing these results is presented on page 49, Section 7. Scenarios 6 and 7 present the most politically acceptable and cost effective distribution. These scenarios utilize deep groundwater from the Castle Hayne aquifer in the Elizabeth City area. Reverse osmosis treatment will remove chlorides and hardness prior to distribution to Elizabeth City, Pasquotank County, Camden County, Currituck County and Dare County.

To establish a functioning Regional Water System, the counties of Camden, Currituck, Dare and Pasquotank and Elizabeth City should open negotiations. The next step would be to establish a test well project to identify and locate viable aquifer zones capable of providing long term regional water supply. Section 5 of this report can be used as a planning guide for such a project. This project should include pilot testing for the treatability of targeted groundwater using reverse osmosis treatment.

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1. INTRODUCTION

This report is the culmination of the Regional Water Study commissioned by the Albemarle Water Resources Task Force. The Regional Water Study was performed by Hobbs, Upchurch & Associates, P.A. between September, 1995 and May, 1996. The goal of the Study was to identify long range water supply alternatives for the 16-county region encompassed by the Study Area (Figure 1). A project outline is included in Appendix 1 describing the scope of services provided to perform the Study.

The Study was accomplished by first researching the conditions of existing facilities within the Study Area, including obtaining and formulating projections for water demands in coming years. Next, numerous potential water resources were investigated, including the proposed Lake Gaston pipeline, excess mine depressurization water from PCS Phosphate in Beaufort County, various surface water sources and the various aquifers (groundwater) of the Coastal Plain. Finally, a number of regional and subregional water distribution scenarios were designed to analyze the feasibility of distributing water throughout the Study Area.

A. *Project Background*

Many areas in northeast North Carolina are faced with the constant challenge of finding sufficient amounts of water of suitable quality to serve their citizens. The member governments of the Albemarle Commission understand that their future economies depend largely on good, reliable water sources. Adequate information on water resources is needed to make decisions regarding long range management and planning for water systems of northeast North Carolina. To this end, the Albemarle Water Resources Task Force (Task Force) was formed to evaluate water resources in the region and to develop potential alternatives for long range water supply.

The Task Force consists of representatives of the Albemarle Commission, Northeastern North Carolina Economic Development (NEED) Commission and the North Carolina Division of Water Resources (DWR). The Task Force developed a plan and generated funding to perform a Regional Water Study. Funding was obtained from the Albemarle Commission, the NEED Commission and the Rural Economic Development Center. The goal of the Regional Water Study was to identify long range water supply alternatives beneficial to the 16-county region encompassed by the study (Figure 1).

B. *Engineering Methodology*

The engineering methodology used in performing this study strictly followed the description of services (listed in Appendix I).

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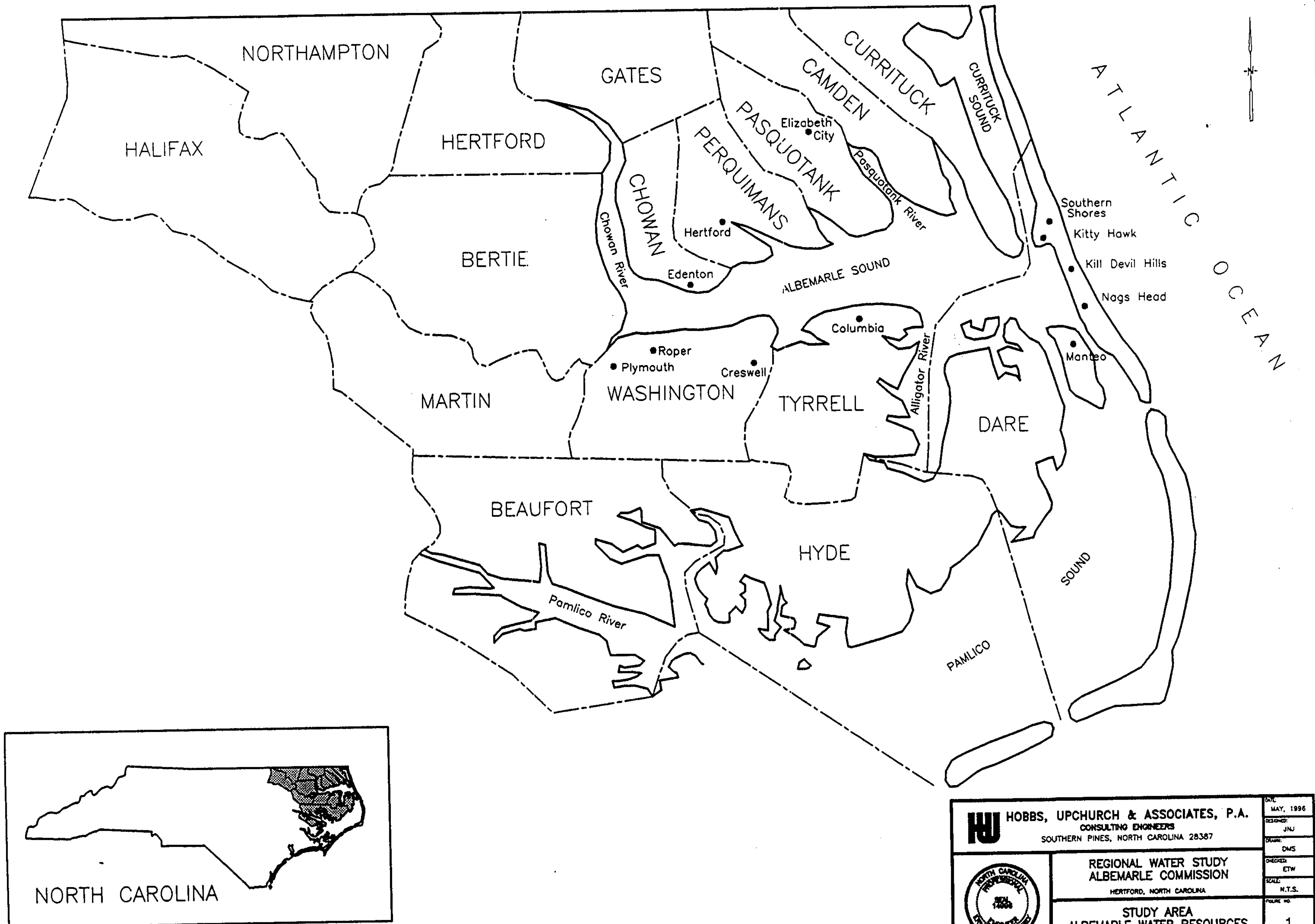


HOBBS, UPCHURCH & ASSOCIATES, P.A. CONSULTING ENGINEERS SOUTHERN PINES, NORTH CAROLINA 28387	DATE: MAY, 1996 DESIGNED: JNJ DRAWN: DMS
REGIONAL WATER STUDY ALBEMARLE COMMISSION HERTFORD, NORTH CAROLINA	CHECKED: ETW SCALE: N.T.S.
STUDY AREA ALBEMARLE WATER RESOURCES TASK FORCE	FIGURE NO. 1

i. *Visit with all Jurisdictions*

Besides a preliminary project briefing with the Albemarle Commission and efforts to begin gathering data, the first significant task was to determine the existing conditions of water systems participating in the Study. This task was accomplished by visiting or communicating with officials associated with the water system of each participant in the Water Study. Meetings and telephone conversations were conducted with each participant to determine concerns, problems, suggestions and projections of future demands. The results of these efforts are detailed in Section 2 of this report.

ii. ***Research Potential Water Sources***

The second major phase of performing the Water Study was to perform adequate research on the many potential water sources for the region. This research took many forms due to the nature and variety of potential water sources. Researching groundwater and surface water sources required both technical/academic research into existing literature and communication with individuals who have professional experience with water resources. Such individuals included well drillers, water system superintendents and hydrogeologists.

Other potential water sources such as the proposed Lake Gaston pipeline and excess mine depressurization water (DPW) from PCS Phosphate (formerly TexasGulf) required research into pragmatic and logistical issues of using each source as well as the mere availability of the source. Research into the Lake Gaston pipeline reached all the way to the offices of Senator Marc Basnight and the North Carolina Attorney General. Top level engineers and public relations officials with PCS Phosphate provided detailed information regarding excess DPW from the mine.

These topics are addressed in detail in Section 4 of this report.

iii. ***Regional Distribution Feasibility Analysis***

Using information on existing conditions of participating water systems and the range of possible water sources, a final phase of the Water Study was to formulate a variety of practical water distribution scenarios. Distribution scenarios were formulated based on a combination of an area's need for water and the availability of water source. Each scenario was formulated with detailed engineering considerations including obtaining source water, water treatment and discharge (where necessary), pumping and pressure sources, distribution networks, storage, construction and financial details.

After each scenario was formulated, a construction cost and operation and maintenance expense was calculated. These costs were then divided amongst the scenario participants in two ways:

1. Based on percent capacity used -- the cost per 1,000 gallons to each participant is based on the percent of the flow within the distribution main that is devoted to that participant. This cost accumulates in each distribution segment up to the point of delivery to the participant.

2. Divided evenly between participants -- the cost per 1,000 gallons is based on the total project cost divided by the number of participants. Here the cost per 1,000 gallons is the same for each participant.

A simplified example is provided in Section 6 of this report.

2. ANALYSIS OF PARTICIPANT WATER SYSTEMS

The following section summarizes visits and correspondence with representatives of the numerous water systems within the Study Area. Where visits with the jurisdiction were not possible, telephone or written communication was made to suffice. Information obtained from the visits and correspondence was used to produce a list of concerns, suggestions and items to be considered in the Study. Water demand projections and each system's ability to meet these future demands were also discussed. Additional information regarding individual water systems was obtained from Local Water Supply Plans (WSPs) provided by the North Carolina Division of Water Resources (DWR).

A. *Existing Conditions*

i. *Beaufort County*

Beaufort County did not choose to participate in the Regional Water Study although they are within the NEED Commission. According to WSPs submitted to DWR, Beaufort County has seven (7) water districts proposed. Districts II and III are proposed to purchase water from the Washington city water system. The remainder of the districts will be supplied by wells owned and operated by the individual districts.

Beaufort County lies in a geological area where adequate groundwater supplies can be obtained relatively easily from the Castle Hayne aquifer. Due to the availability of this groundwater resource, regionalization of water systems is not considered a necessity or priority for Beaufort County.

ii. *Bertie County*

At build-out, Bertie County will have four (4) water districts. Currently, two (2) of these districts are under construction; the remaining two (2) districts are in the funding application stage. The water systems will use groundwater as source. Preliminary results indicate that adequate flow and good quality can be expected from wells. Wells in the area are generally around 400 feet deep, screened in the Black Creek aquifer. District III hopes to obtain 400 gpm per well.

There are eight (8) existing water systems within Bertie County serving smaller areas and municipalities. Bertie County District III plans to interconnect with the towns of Windsor and Askewville. However, since Bertie County's water system is in its very early stages, with hopes of running successfully for years to come, they are not interested in participating in a regional water system at this time. None of the towns and smaller water systems in Bertie County responded to the Albemarle Commission's invitation to participate in the Study.

Bertie County Contacts

Jack Williford	County Manager
Lester Outlaw	Superintendent

iii. *Camden County*

Camden County is presently building a county-wide water system. The system is being constructed in two (2) phases. Phase 1 is complete and in operation, purchasing water from Elizabeth City. Phase 2 is under design. Negotiations are in progress toward a water purchase agreement with Elizabeth City to provide water for both phases of the Camden County Water System. Camden County has no water production facilities.

Camden County expressed concerns for regional interconnections between water systems for supplemental supply during emergency periods. Camden County and adjacent counties appear to experience periodic difficulty meeting water demands. South Mills Water Authority, a water system within Camden County, is known to have difficulty meeting system demands with their existing well field. The well field consists of approximately ten (10) 30 gpm wells screened in the surficial aquifer. South Mills currently has a moratorium on new taps to the system.

Considering these factors, Camden County is very concerned over water supply issues and views regionalization as a potential solution. Without other interconnections and/or reliable water resources, Camden County could find themselves in an emergency situation if Elizabeth City were unable to meet their internal demands and the demands of their bulk customers (Camden and Pasquotank Counties).

Camden County Contacts

John Smith	County Manager

iv. *Chowan County & Edenton*

Chowan County runs a county-wide water system which includes a recently upgraded water treatment plant with nine (9) production wells, one of which is recently installed and reportedly capable of operating at 2000-2500 gpm. According to DWR records, the county only uses five

(5) of their nine (9) wells and apparently does not have problems meeting present or future system demands. However, Chowan County did express interest in participating in the Water Study.

The Town of Edenton also expressed interest in the Water Study, although the Edenton water system does not appear to have pending difficulties meeting system demands. The Town water system presently has three (3) wells producing approximately 600,000 gallons per day (gpd). This quantity adequately meets the system demand. Since there is little area left around Edenton for growth, additional water demands are not expected.

Chowan County and Edenton Contacts

Dewey Perry	Acting Public Works Dir. (Chowan Co.)
Anne Marie Kelly	Mayor, Edenton

v. ***Currituck County***

With heavy development on the Currituck Outer Banks and the county's proximity to Chesapeake and Virginia Beach, Currituck has become one of the fastest growing counties in North Carolina. However, the county has great difficulties meeting ever-growing water demands due to difficulties obtaining adequate quality and quantities of groundwater. Such problems are inherent in the eastern-most Coastal Plain counties, as discussed in detail in Section 5 of this report.

Currituck County currently operates a 1.0 mgd water treatment plant supplied by 26 wells located near the county airport. Eight (8) additional wells are planned. Most of the wells are screened in the surficial aquifer (shallower than approximately 70 feet) and produce at very low flow rates (between approximately 30 and 150 gpm, averaging approximately 85 gpm). The low flow rates and shallow well screens are necessary primarily because of the threat of salt water intrusion. The only way for the county to meet increasing system demands is to continue to add these low efficiency wells and the raw water piping to transmit the water to the treatment facility. This, in turn, drives up construction and maintenance costs for the county and its water customers.

With these limitations to system growth, Currituck County needs alternate solutions to meet water demands. This need is amplified by the impending necessity of providing water service to their rapidly growing Outer Banks. Therefore, the county is very interested in regionalization of water service and has suggested solutions ranging from obtaining water from various Virginia sources to simply interconnecting the surrounding county water systems.

Currituck County Contacts

Bill Richardson	County Manager

vi. ***Dare County, Kill Devil Hills, Kitty Hawk, Manteo, Nags Head, Southern Shores***

Dare County and the municipalities within continue to face high annual growth rates and the demands of the peak vacation season. However, the water systems in Dare County all appear to be in reasonably good condition and able to meet water demands year-round. The Dare County Regional Water Supply System is currently completing water main extensions in Duck and Southern Shores.

Long-term water supply is of great concern for the county and towns since fresh water resources are extremely limited. The small Cape Hatteras Water Association alone requires nearly 50 wells to meet its system demands. The county currently operates one reverse osmosis (RO) water plant to treat chloride-rich groundwater and is in the process of siting a second RO plant. With the rapid growth of the county and towns, use of chloride-rich groundwater and RO treatment may continue to increase. Along with this increase will be the associated increase in the cost of water.

Due to the concerns for long-term and peak-season water supply and the lack of abundant fresh water resources, the county and towns are interested in alternate water sources. Chloride-rich aquifers have already begun to be utilized. Utilization of fresh water ponds and the Alligator River on the mainland has been discussed as well as regional supply scenarios involving the Lake Gaston pipeline and PCS Phosphate. Various water conservation methods and policies have also been considered.

Dare County Contacts

Terry Wheeler	County Manager
Clarence Skinner	Dare County Commissioner
Bob Oreskovich	Water Production Superintendent, Dare Co.
Sammy Midgett	Distribution Superintendent, Dare Co.

Dare County Contacts (Continued)

Darrell Merrell	Kill Devil Hills Water Superintendent
Bob Nichol	Kitty Hawk Town Manager
Kermit Skinner	Manteo Town Manager
Webb Fuller	Nags Head Town Manager
Kern Pitts	Southern Shores Mayor
Diane Henderson	Southern Shores Council Member

vii. ***Gates County***

Gates County did not elect to participate in the Water Study although they are a member of the Albemarle Commission. Gates County feels that it has more than adequate water supply to meet present and future water demands. The county water system is supplied by three (3) wells screened in the lower Cape Fear aquifer, according to DWR records. This is the same aquifer from which heavy withdrawals in the Franklin, Virginia area are taken (at the Union Camp paper mill). Tremendous drawdown in the aquifer caused by the Union Camp withdrawal affects the Gates County wells by several feet per year (this is discussed further in Section 5 of this report).

viii. ***Halifax County***

The Halifax County water system is divided into four (4) regions which either produce water themselves or purchase water from municipal systems. The water producing regions utilize open-bore wells drilled into crystalline basement rock. These wells reportedly have low yields. DWR records indicate yields well below 50 gpm. The remaining regions purchase water from a combination of Roanoke Rapids, Weldon, Enfield and Scotland Neck. There have been some disputes over purchase amounts with the municipalities.

The primary water source for the county system is Roanoke Rapids Lake and the Roanoke River via the Roanoke Rapids water system. However, with regard to planning for future demands, studies are being conducted on ways to increase the supply and capacity of the existing county facilities.

Halifax County Contacts

Hazen Blodgett	Assistant County Manager
Frank Ralph	Water Director

ix. *Hertford County*

Hertford County is in the early stages of starting a county-wide water system. The system is proposed to consist of two districts with raw water obtained from production wells. Initial indications suggest that there is no reason to anticipate problems obtaining good quality water and sufficient quantity. This would be consistent with neighboring Gates County. Hertford County feels able to meet present and future water demands and does not have immediate interest in a regional water system.

Hertford County Contacts

Don Croft	County Manager
Bill Early	Construction & Planning Director
Bob Daughtry	Water System Coordinator

x. *Hyde County*

Hyde County has a county-wide water system serving customers in the Englehard, Fairfield and Swan Quarter areas. According to DWR records, the county system obtains water from four (4) wells screened in the Yorktown aquifer. The raw water is high in organics and requires RO treatment. However, the county meets the demands of the system with treated water. Furthermore its remote location does not offer feasible options for regional support.

Hyde County Contact

Geri Pittman	Former Interim County Manager
Tyler Pace	Current County Manager

xi. *Martin County*

Martin County does not operate a water system although several municipalities within the county do have water systems. Martin County is interested in the regional water supply concept but does not have any distribution mains with which to tie into a supply. Municipal water systems serve most areas which need water; however, the county could develop additional areas if water were available.

Martin County Contacts

Mary Lilley	Economic Development Director

xii. *Pasquotank County and Elizabeth City*

Pasquotank County operates a county distribution system and a 2.4 mgd water treatment plant. The system is fed by 19 wells which provide only 1.9 mgd. All county wells are screened in the Yorktown aquifer and produce poor to moderate flow rates. Additional wells are being developed to meet system demands. However, low flow rates and the threat of chlorides are a constant problem with wells in Pasquotank County. As discussed in Section 5 of this report, the lower Coastal Plain is challenged in trying to find adequate quantities of groundwater which is not also high in chloride concentration.

Pasquotank County is tied into the Elizabeth City system and the two systems mutually supply each other with water when needed. Pasquotank County is also tied into the Inter-County Water Association system (straddling the Perquimans and Pasquotank County line) for emergency supply purposes. Projections of the county's future demands range from an additional 0.5 mgd to 2.5 mgd. Meeting such demands with the present well configuration would not be possible and the feasibility of developing the required additional wells is not certain.

Pasquotank County is growing rapidly and outpacing the water system's ability to meet demands. Because of this, the county is very concerned with the development of a regional water supply.

Elizabeth City operates a 5.0 mgd water treatment plant but is limited to 3.5 mgd by moderate production from eight (8) wells. The same groundwater supply problem plagues Elizabeth City as does Pasquotank County. Elizabeth City is currently developing two (2) additional wells with hopes of increasing capacity to 4.5 mgd.

Elizabeth City sells some water to Pasquotank County and provides the Camden County system with all of its water. With increasing demands being placed on Elizabeth City by its bulk customers and the increasing internal demands of a rapidly growing area, Elizabeth City is also quite interested in the development of a regional water supply system to offset their deficiencies in water production.

Pasquotank County Contacts

Randy Keaton	Pasquotank County Manager
John Gregory	County Water Superintendent
Randy Harrell	County Industrial Development Director
Victor Sharpe	Elizabeth City Interium Manager
Bart Van Nieuwenhuise	Public Works Director

xiii. ***Perquimans County, Winfall and Hertford***

Perquimans County and the municipalities within feel that growth in this area has not met its potential. Availability of water is viewed as a partial inhibitor to growth; therefore, regionalization of water systems is considered a possible solution to stimulating growth. Perquimans County Water Study participants also realize the regional difficulties in obtaining adequate water supplies and believe regionalization and interconnection of water systems to be the key to meeting future water demands.

Presently, neither Perquimans County nor the municipalities experiences problems with water production. The county is planning a 0.7 mgd water treatment plant in Bethel. This is in addition to an existing 0.5 mgd plant near Winfall. Several proposed projects are expected to stimulate growth and increase water demands. These include development of NC Hwy 17 as a scenic route, a 400 acre industrial park and an additional 600 residential lots in Albemarle Plantation. Winfall has 2 wells with conventional iron removal and softening treatment. Hertford also has 2 wells with conventional treatment.

Perquimans County Contacts

Paul Gregory	County Manager
Russ Chapel	Water Superintendent
Robert Baker	County Planning Director
John Christensen	Hertford Town Manager
Parker Newbern	Water Superintendent
Fred Yates	Winfall Mayor

xiv. *Northampton County*

Northampton County operates a water system with connections to several municipalities including Jackson, Seaboard, Severn and Woodland. Northampton County is also tied into the Roanoke Rapids water system in Halifax County. Like Halifax County, Northampton County is in a geological area where adequate groundwater supplies can be obtained without great difficulty, making it possible to increase capacities when necessary. Regionalization of water systems is not considered a priority in this area.

xv. ***Tyrrell County and Columbia***

Tyrrell County and Columbia are able to meet their system demands; however, they experience some problems with water quality and THM residuals. With relatively small population and little growth, no immediate increases in water demands are expected. There is only moderate interest in a regional water system if feasible alternatives are available.

Tyrrell County Contacts

J.D. Brickhouse	County Manager
Carlisle Harrell	Columbia Town Manager

xvi. ***Washington County, Creswell, Plymouth and Roper***

Creswell and Roper operate small water systems which serve their respective communities as well as sell water to the county. The larger Plymouth water system also sells water to the county, which presently has no water production capability. Each municipality fares well meeting local demands as well as the county's demand. However, Creswell and Roper have occasional water quality problems resulting from iron and hardness and the large demands of the county.

Washington County purchases water in bulk from the municipalities to distribute to its customers. The county is in the planning stages of building a 1.0 mgd water treatment plant and extending water mains to additional areas. However, with moderate population and limited growth in the area, no difficulties in meeting demands are foreseen and regionalization of water systems is not considered a priority.

Washington County Contacts

Lee Smith	County Manager
Norman Furlough	Water Superintendent
David Twiggs	Plymouth Town Manager
James Davenport	Creswell Superintendent
Irvin Hassell	Roper Superintendent

B. *Analysis of Water-Challenged Areas*

Through visits and interviews with the participant water systems it became evident that virtually every water system feels some degree of deficiency in their ability to produce and deliver water. These perceived deficiencies were varied and included the desire for more water, greater flow rates from wells, more storage capacity and more service mains to reach additional customers. Some water systems simply wish for the finances to expand existing systems to stimulate growth in their areas. Other areas require the means to begin construction on new water systems.

Most water systems in the Study Area see a clear advantage in regionalization of water systems, particularly with respect to simple interconnection of systems for purposes of water supply during emergency conditions. However, a few areas demonstrate a clear need for help in meeting water needs, for which regionalization is viewed as a possible long-term solution. Two common factors emerge in these most water-deficient areas which serve as indicators of serious water deficiencies.

These factors are:

1. *Growth* - Some counties and municipalities in the Study Area are experiencing growth rates which far exceed their capacity for producing and distributing water. Some areas are actively pursuing water system improvements which still do not meet increasing demands or will not meet projected future demands. Some areas have put community growth on hold due to inability to provide water to new customers.

2. *Water Resources* - Some areas recognize the need to expand their water production capacity but are limited or inhibited by the availability of reliable water resources. Many portions of the Study Area are very limited in access to adequate quantities and/or good quality water. There are essentially no reliable surface water resources in the Northeast portion of the state. The hydrogeology of the lower

Coastal Plain creates generally low well flow rates and the threat of salt water intrusion.

The Water Study participants which demonstrate the greatest need for water supply assistance (regionalization) based on the above criteria are listed below.

<u>Recommended Participants for Regionalization</u>

Camden County
Currituck County
Dare County
Pasquotank County
Elizabeth City

The needs and challenges of these particular areas are summarized in Section B.1 above. Distribution scenarios to serve these and other areas are presented in Section 6 of this report.

3. GROWTH AREAS AND PROJECTED WATER DEMANDS

In the previous section, "growth" was used as one criterion for determining areas of greatest need for water. Growth is defined here as a combination of residential and industrial development and the associated increase in population. The following section elaborates on the various growth areas within the portion of the Study Area which most need water and the projected water demands associated with this growth.

A. *Growth Areas*

Understandably, growth within an area corresponds with the popularity of the area. The popularity of an area can result from a variety of factors including but not limited to:

job opportunities
affordable or alternative housing
good public utilities/facilities
good schools/hospitals
vicinity to larger cities
recreation/vacation sites

Northeastern North Carolina has many popular and growing areas. Development is ongoing along the northern Outer Banks, most notably in Currituck County. Moderate development also continues along the Albemarle Sound and many rivers of the area. Edenton, Hertford and Elizabeth City have examples of this sort of shoreline community development.

Various portions of the northeastern counties experience growth stemming from their proximity to Chesapeake and Virginia Beach. Currituck County is a primary beneficiary of this type of bedroom community growth; however, Camden and Pasquotank Counties also have this opportunity.

Elizabeth City and Pasquotank County continue to experience moderate but steady growth stimulated by the presence of the Coast Guard Station, Elizabeth City State University, the new prison and a variety of other job opportunities.

B. *Projected Water Demands*

Water demand projections for the participants of the Water Study vary widely between sources. The North Carolina Division of Water Resources database of Local Water Supply Plans (WSPs) was relied upon heavily for this study. The WSPs are filed by each licensed water system in the state and contain information on type of water source, connections between systems and projected water demands. However, these projected demands differ from those stated in other sources.

Table 1 below lists three versions of projected demands, including those listed in the WSPs. In letters to the Albemarle Commission and Task Force in 1994, the demands were stated as a supplemental daily volume. In interviews conducted for this Study, yet different numbers were offered as the projected demand. One reason for this variability may be that opinions of projections change frequently due to constantly changing conditions (growth, well production) within each water district.

This variability in demand projections caused some uncertainty in the demands to be used in formulating water sources and distribution scenarios for this Study. The result is that several demand scenarios were used, based to varying degrees on the demand projections listed in Table 1. Each water supply scenario presented in Section 6 of this report is prefaced by the Assigned Demands and the Design Concept. This portion describes the projected demands along with the water source and distribution layout. The assigned demands were based on:

1) The amount of water available from the source. In some cases such as with the Lake Gaston Pipeline or PCS Phosphate, a limited amount of water is available, which dictates the demand that can be met.

2) The specified demand. In some cases, such as with well fields, the source could be designed to meet specified demands.

TABLE 1.
VARIABILITY IN PROJECTED DEMANDS

WATER SYSTEM	1 1992 AVG. DAILY USE from DWR WSPs	2 2020 PROJECTED USE from DWR WSPs	3 1994 DESIRED PURCHASE VOLUME	4 1996 STATED DEMAND for 2020
Beaufort Co. (all districts)	0.000	3.791	NR	NA
Bertie Co. (all districts)	0.000	1.221	NR	NA
South Camden W&S Dist	0.000	0.292	0.300	1.000
Chowan County	0.930	1.070	NR	NA
Currituck County	0.453	0.737	2.500	2.000
Dare County	0.890	1.867	NR	NA
Cape Hatteras	0.698	1.480	NR	NA
Manteo	0.179	0.960	NR	NA
Kill Devil Hills	1.192	1.700	NR	NA
Nags Head	0.790	1.387	NR	NA
Gates County	0.620	0.710	NR	NA
Halifax County	1.240	3.545	NR	NA
Hyde County	0.343	0.485	NR	NA
Pasquotank County	0.855	2.000	1.000	5.000
Elizabeth City	2.190	4.440	2.500	3.000
Perquimans County	0.596	0.705	1.000	0.500
Hertford	0.277	0.374	0.400	NA
Winfall	0.051	0.054	NR	NA
Inter County Water Assoc.	0.075	0.110	NR	NA
Tyrrell County	0.156	0.231	0.250	NA
Washington County	0.240	0.314	NR	NA

1. Average Daily Use; taken from North Carolina Div. of Water Resources Local Water Supply Plan data base
2. Projected Daily Use; as above
3. Response to the Task Force (1994); **supplemental** amount which would be purchased if immediately available
4. Projected Daily Demand as stated in interviews conducted for this Regional Water Study, 1996

NR Did not respond to Task Force

NA These participants were not interviewed with respect to projected demands

Demands presented in million gallons per day (mgd)

4. POTENTIAL WATER SOURCES FOR NORTHEAST NORTH CAROLINA

Traditionally, groundwater sources have been relied upon heavily throughout the Study Area. The aquifer system of the Coastal Plain consists of ten water bearing units which correlate with geologic formations of marine origins. Each water bearing unit (aquifer) is tapped with production wells at various locations in the region. Water quality and available volumes vary between aquifers and within individual aquifers.

Surface water sources are less common in the Study Area but are used in places in the upper Coastal Plain. The Roanoke River and Roanoke Rapids Lake are used by the Roanoke Rapids and Halifax County water systems. Various creeks are used in other smaller systems. In an anomalous case in the lower coastal plain, the Nags Head water system on the Outer Banks uses a fresh water pond (Fresh Pond) as a water source.

This section of the report explores and details some of the potential water sources available to the Study Area. It includes discussions on locally available groundwater, surface water sources and external sources, namely, the Lake Gaston Pipeline and PCS Phosphate mine depressurizing water.

A. *Lake Gaston Pipeline*

Many sensitive issues surround the proposed Lake Gaston Pipeline between the lake and Virginia Beach -- water rights, inter-basin transfer, environmental impacts, etc. North Carolina and Virginia have attempted negotiations on the pipeline on several occasions but at present there is no active dialogue. However, it has been suggested, as part of a compromise to allow the 60 mgd pipeline, that 15 mgd be made available (returned) to northeastern North Carolina. This water would be made available at, as yet, undetermined locations along the pipeline.

The governments of the two states have not been able to settle the dispute and the pipeline remains a politically sensitive issue. However, the proposed 15 mgd of water potentially available can be considered as a future water source should it become a reality. An interceptor pipeline could be constructed to receive and distribute water to supplement systems suffering from deficiencies. Scenarios 1 and 2 in Section 6 outline the possible use of Lake Gaston water in the northeastern counties.

B. PCS Phosphate (formerly TexasGulf)

The PCS Phosphate mining operation is located near Aurora on the south shore of Pamlico Sound in Beaufort County. Phosphate ore is mined from the Pungo River Formation (also an aquifer) which lies above the Castle Hayne Formation and below shallower surficial deposits.

In order to mine the ore, the formations above and below the ore body must be dewatered to prevent flooding of the mine pits. This is done by large-scale withdrawal from a series of recovery wells installed in both the surficial aquifers and the Castle Hayne aquifer. Water withdrawn from the Castle Hayne serves to "depressurize" the lower aquifer, preventing upwelling of this deeper water into the mine pits.

Presently, PCS Phosphate produces an average of 30 mgd of depressurization water (DPW). Their Capacity Use Permit allows for up to 70 mgd withdrawal; however, withdrawal rates this high have not been required for many years and are not expected to reach this level. The effects of high withdrawal rates in this area are discussed in Section 5 of this report.

Of the 30 mgd of DPW removed, approximately 10 mgd is utilized by PCS. The remaining 20 mgd is discharged into Pamlico Sound. The water is hard but could be used as potable water source with minor treatment and chlorination.

PCS Phosphate has expressed a willingness to distribute the excess DPW as a public water supply source if political and community opinion was in favor of such. Scenario 5 explores the possibility of obtaining 20.0 mgd from the PCS Phosphate DPW well fields and distributing the water through several northeast counties terminating in Dare County.

C. *Surface Waters in General*

The North Carolina Coastal Plain contains numerous surface water bodies. These surface waters occur as ponds, lakes, streams, estuaries and sounds. However, despite their abundance, these surface waters are rarely useful as potable water sources due to a combination of poor water quality and slow recharge rates.

i. Lakes

There are several lakes in northeastern North Carolina large enough to be considered for water source. These include Lake Mattamuskeet, Merchants Mill Pond, Lake Phelps, Pungo Lake and New Lake. However, several factors prevent these lakes from being reliable, long-term water sources.

Water quality varies widely between lakes in the region; however, water from all the lakes would require treatment prior to use. Most lakes in the region are situated in swamps and are lined by peat beds. Lake water usually has very little hardness, likely due to having filtrated through peat deposits and not having come into contact with carbonate rich soils and aquifer materials typical of the Coastal Plain. However, due to the constant contact with peat, the lakes are high in tannic acid and organics.

Such constituents require heavy treatment, usually lead to THM (trihalomethane) residual problems in distribution systems and could cause fouling of filtration systems. Organic constituents also contribute to the poor color (tea-colored) of the lake waters. Swampy water in continuous contact with peat deposits have also been reported to contain mercury above drinking water standards.

Although water quality is an important issue, the primary drawback of area lakes is their limited supply. Most lakes of the region are situated in swamps, underlain by peat, shallow and are supplied by springs and precipitation (runoff). Groundwater recharge through the low permeability peat material is quite slow and precipitation recharge is partially offset by evaporation.

Further complicating these factors is agricultural drainage which takes place in vast expanses of Coastal Plain swamp in order to drain and cultivate farm land. Agricultural drainage is accomplished through the excavation of extensive ditch systems which locally lower the water table. Lake levels fluctuate with changes in the water table. Local lowering of the water table creates a gradient from area lakes back into the shallow surficial aquifer. During dry summer months, the water levels of lakes affected by agricultural drainage have been observed to decline dramatically. (Channels carved for agricultural drainage have also, in instances, opened conduits for salt water intrusion into lakes.)

Lake Phelps is a ready example of the limited recharge potential of Coastal Plain lakes. When the swamp around Lake Phelps was drained for agricultural use, locals quickly began to fear that the lake was going dry. More recently, fire fighting efforts nearby required large volumes of water be air-lifted from Lake Phelps. This occurred for a matter of several days. Still, the lake level was affected dramatically and required nearly three years to return to mean high water level. Furthermore, North Carolina State Park regulations state that no activities will be allowed which could alter water levels in State lakes, of which Lake Phelps is one.

ii. ***Estuaries***

Due to near sea level ground elevations and low relief of the lower Coastal Plain, rivers form wide, slow-flowing estuaries at their confluence with the sounds. Estuaries are fed by fresh water draining from inland seaward. In the estuaries, fresh water mixes with brackish sound water. The degree of mixing depends on many factors, mostly seasonal. However, due to negligible currents in the sluggish estuaries there is little flushing from inland fresh water and water which becomes brackish can remain so for long periods.

Another factor which contributes to variations in water quality in estuaries is wind driven current. Wind driven currents can drive brackish water from the sounds considerable distances inland into estuaries. Then, due to limited flushing as mentioned above, the slug of brackish water can remain upstream for periods ranging from days to months. It is difficult to predict either when these wind events will occur or how long they will last.

The unpredictability of water quality in estuaries prevents their use as water sources. This has been seen in Elizabeth City and Edenton. These two cities each experienced problems with brackish water infiltrating their water intakes and fouling their treatment plants. The unpredictable nature of the salt water influxes coupled with indefinite duration of affectation caused each city to abandon their river intake for more reliable raw water sources.

iii. Sounds

The North Carolina sounds are vast expanses of open water supplied by fresh water draining through the estuaries and mixing with the ocean through the inlets of the Outer Banks. The water quality of the sounds varies widely over time and space but is everywhere intermediate between fresh water and sea water. Flushing of fresh water through estuaries is minimal due to the relatively low flow compared with the great volume of the sounds. Furthermore, net flow is frequently inland due to wind driven and tidal currents. This effect causes periodic (and unpredictable) surges of brackish water well into the estuaries.

Some authorities have classified the sounds, or portions of them, as fresh water bodies; however, from the standpoint of a potable water source, at no place in the sounds can consistently fresh water be found. Even estuaries vary in water quality enough so that Elizabeth City and Edenton have abandoned intakes on the Pasquotank and Chowan Rivers, respectively. Were sound water to be used for raw source water, measures (and their expenses) would have to be taken to handle the variability of water quality. This likely would require extensive membrane treatment with high pressure requirements to treat the high chlorides present in sound water..

D. *Groundwater*

Of the potential water sources discussed thus far in this report section, none hold a great deal of promise due to either political, hydrologic or water quality factors. Although there are difficulties which must be overcome in order to utilize Coastal Plain groundwater sources, utilizing local groundwater sources holds the greatest promise for a long term water source independent of external entities. Because of this an entire report section has been devoted to presentation of many Coastal Plain groundwater issues. The following section discusses in detail the hydrogeology and potential groundwater source areas of the Study Area and elaborates on how to pursue reliable, long-term production wells for a regional water system.

5. HYDROGEOLOGY OF THE STUDY AREA

To some degree, hydrogeologic investigations of the North Carolina Coastal Plain date to the turn of this century. Early studies were performed to record water levels in various tapped water bearing zones (aquifers) and to attempt to quantify water reserves in an area of the State that was becoming increasingly more populated. As the geologic understanding of the Coastal Plain grew and more wells were installed in the various aquifers, the base of hydrogeologic data grew and thus the quality and scope of hydrogeologic investigations improved.

By the 1960's there was much interest in understanding the water resources of the Coastal Plain due to continued civilian population growth and increasing numbers of government and military establishments. Several agencies devoted funds to studying the Coastal Plain water resources including the United States Geological Survey (USGS), the North Carolina Division of Environmental Management Groundwater Section and the Division of Water Resources. The results of these agencies' efforts through the 1980's can be observed in numerous reports on the hydrogeologic framework of various sub-regions of the Coastal Plain. Some of these reports have become the cornerstone for researching and understanding the hydrogeology of coastal communities. Perhaps every county and municipal water system east of Interstate 95 has referred to the same research to locate water sources for their water systems.

With respect to researching the hydrogeology of the North Carolina Coastal Plain, this study is no different. Numerous investigations and research papers were reviewed in order to target areas for reliable and long-term groundwater sources. Certain papers provide an overview of the entire Coastal Plain, while others are specific to areas covering just several counties. A bibliography of the materials and conversations used in researching the hydrogeology of the Albemarle Commission Study Area is provided at the end of this report.

A. *Hydrologic Overview*

The North Carolina Coastal Plain extends from the Fall Line, the division with the Piedmont Province, to the Atlantic coast and covers approximately 40% of the State. Coastal Plain geology consists primarily of marine, marginal marine, inter-tidal and fluvial deposits. These deposits are characterized by alternating and lenticular (discontinuous) strata of sands, clays, shells, gravels and limestone.

Underlain by crystalline basement rocks, Coastal Plain sediments range from just a few feet in thickness at the Fall Line to as great as 10,000 feet at Cape Hatteras. Each strata of sediments is characterized by its depositional environment, which varied throughout transgressive and regressive cycles of the ancient Atlantic Ocean.

Several geologic units have been identified and mapped in the North Carolina Coastal Plain. In hydrogeologic terms these units generally correspond with aquifers of the same name; however, it is possible for clayey confining layers to create multiple water bearing layers within one geologic unit. The geologic units of the North Carolina Coastal Plain are presented in Figure 2. The "stragraphic column" is the chronologic order in which each geologic unit was deposited - oldest at the bottom, youngest at the top.

B. *Finding Adequate Groundwater Sources*

Each of the aquifers listed above are capable of producing water to some degree. However, the viability of obtaining water from any given Coastal Plain aquifer depends on a variety of factors. Some of these factors are:

1. *Aquifer Permeability* - the ability or ease at which water can flow within the aquifer. Generally, courser sands with low clay content have greater permeability than clays and fine sands. Porous limestone also has generally high permeability. Permeability can vary between aquifers and within a single aquifer.

2. *Depth to Aquifer* - The cost of well construction is proportional to aquifer depth. Well construction is more demanding with depth and larger pumps are required. Also, in the lower Coastal Plain, water quality generally diminishes with increasing depth (chloride concentrations increase), pushing the cost and sometimes the technical feasibility of water treatment above practical limits.

	GEOLOGIC UNITS	AQUIFERS & CONFINING UNITS
Quaternary Deposits:	Surficial Deposits	Surficial Deposits
Tertiary Deposits:	Yorktown Formation	Yorktown confining unit Yorktown Aquifer
	Eastover Formation	Pungo River confining unit
	Pungo River Formation	Pungo River Aquifer
	Belgrade Formation	
	River Bend Formation	Castle Hayne confining unit
	Castle Hayne Formation	Castle Hayne Aquifer
	Beaufort Formation	Beaufort confining unit Beaufort Aquifer
Cretaceous Deposits:	Peedee Formation	Peedee confining unit Peedee Aquifer
	Black Creek Formation	Black Creek confining unit
	Middendorf Formation	Black Creek Aquifer
	Cape Fear Formation	Upper Cape Fear confining unit & Aquifer Lower Caper Fear confining unit & Aquifer

Figure 2. Stratigraphic Column showing North Carolina Coastal Plain geologic units and their corresponding hydrogeologic units.

Modified from Winner and Coble, 1989.

3. *Thickness of Aquifer* - Aquifer thickness can play a role in efficiency of water production. A thin aquifer (water bearing zone) confined above and below by lower permeability deposits is limited in its production capacity relative to a thicker or less confined aquifer. This is due to greater storage and recharge in thicker and less confined aquifers.

   Sometimes, as is the case with the widely utilized Yorktown aquifer, the overall nature of the aquifer is of lower permeability than several thin layers of coarser material contained within the unit. Here the difficulty is finding these thin zones and successfully screening them to produce enough water.

4. *Degree of Confinement* - Recharge to confined aquifers is inhibited by the confining layer. If the withdrawal rate from the aquifer is greater than the recharge rate, the aquifer could eventually "dry up". For thicker or shallower aquifers, this is not such an issue because storage and recharge is greater; for thinner or deeper aquifers, the water reserve may be rapidly depleted due to less storage and insufficient recharge.

Due to these considerations it is often necessary to devote significant time and effort in siting a well or well field. As many water systems in the northeastern portion of the Study Area experience, finding an efficient or even sufficient aquifer to tap is often difficult and costly. This is not so much the case for the southern, central and western portions of the Study Area. Due to depostional characteristics and the generally eastward dip of Coastal Plain strata (see Figure 3), these areas are capable of tapping the Castle Hayne aquifer or the deeper Cretaceous aquifer system. These are more efficient and accessible aquifers with generally better water quality in the southern, central and western portions of the Study Area.

C. *Water Bearing Zones*

i. *Cretaceous Aquifer System*

Throughout much of the Study Area, the Cretaceous aquifer system is very deep and presents an economic challenge to well installation. This aquifer is also high in chloride concentrations in the eastern portions of the Study Area. However, in the northwestern Coastal Plain, the Cretaceous aquifer is quite productive. In Franklin, Virginia, the Cretaceous aquifer has been pumped heavily for industrial use since the early 1940's. Due to continual pumpage in Franklin, surpassing 30 million gallons per day (mgd)

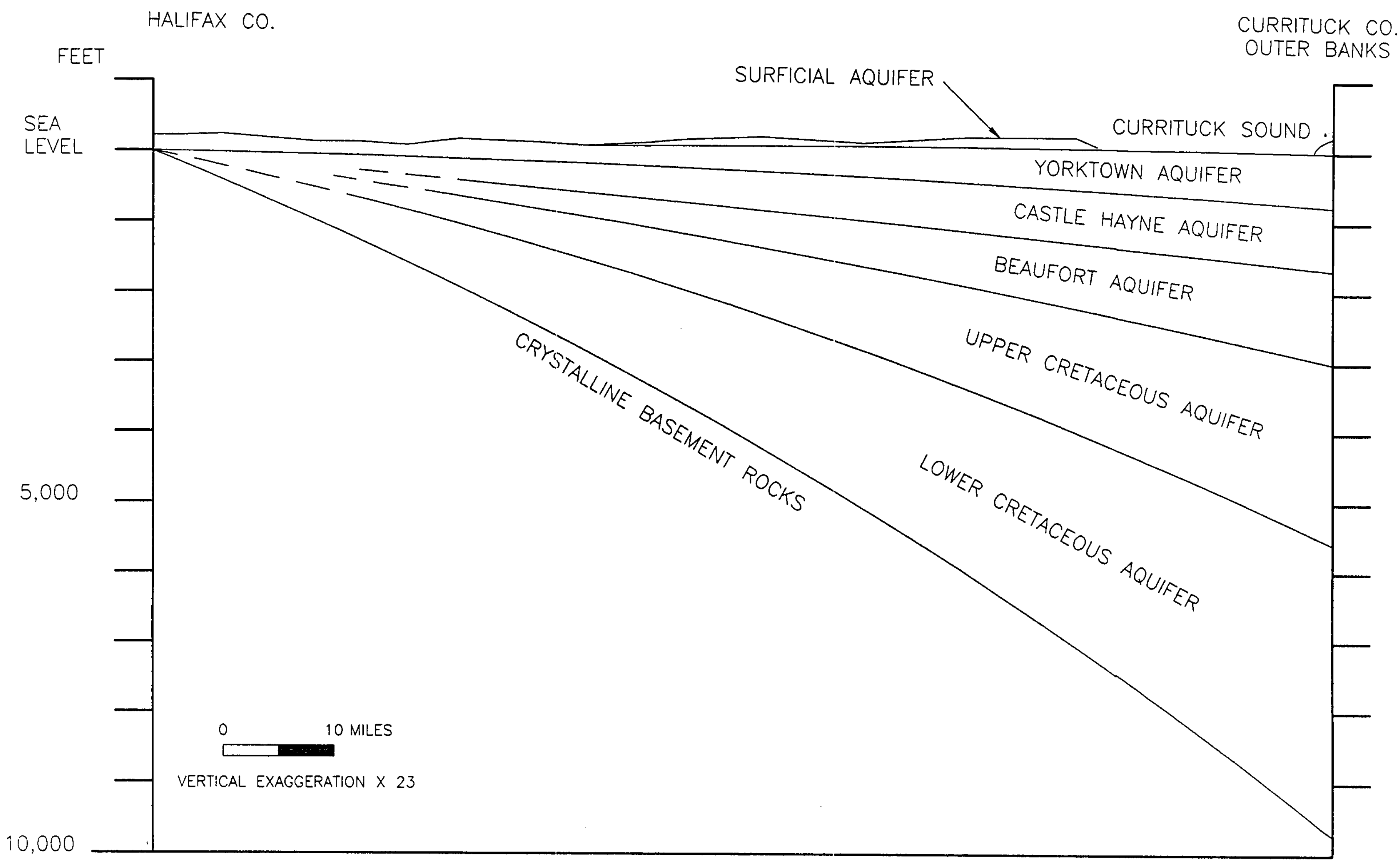


FIGURE 3 — GENERALIZED GEOLOGIC SECTION OF NORTHERN STUDY AREA

in the mid-1960's, drawdown effects in the Cretaceous aquifer extend as far south as the Albemarle Sound and east into Currituck County.

Despite the significant drawdown, production from the aquifer appears unchanged. The drawdown effects are generally limited to the Cretaceous aquifer, although lowering the head (pressure) in the Cretaceous aquifer does allow for seepage from the shallower aquifer through the confining layer. However, no significant effects have been reported in the overlying Beaufort and Castle Hayne aquifers.

ii. ***Castle Hayne Aquifer***

In the central and southern portion of the Study Area, the Castle Hayne aquifer is a prolific water producer. Numerous water systems have wells screened in the Castle Hayne, which is one of the State's most productive aquifers. The Castle Hayne is characterized by alternating beds of limestone, sandy limestone and sand, grading increasingly to sand and silty or clayey sand toward the bottom of the unit. Although Castle Hayne water is hard and often high in chlorides, the Castle Hayne also contains extensive freshwater-bearing zones, though mostly in the southern Study Area.

North of the Albemarle Sound, the Castle Hayne contains considerable less limestone, grading to sandy limestone and silty sand. Here the unit is much thinner and less permeable than in the southern Study Area. In Pasquotank County, the Castle Hayne occurs around 450 feet deep and averages approximately 50 feet thick. The unit is deeper and thicker to the east. Castle Hayne water quality in the northeastern Study Area is rather high in chlorides (3000 ppm) and hardness.

As an example of the available water from the Castle Hayne in the central Coastal Plain, consider the mine dewatering process at PCS Phosphate (formerly TexasGulf) in Aurora, Beaufort County. Since the mine began operation in 1965, an average of 50 mgd of water has been pumped from the underlying Castle Hayne to prevent mine pits from flooding with upwelling water. Despite the extremely large withdrawal rate, the drawdown effect (cone of depression) is isolated to an approximate 15-20 mile radius around the mine. Furthermore, the cone of depression is at steady state, that is, it does not increase with continued pumping of the aquifer. This is likely due to recharge rates to the Castle Hayne estimated in this area to be between 75-140 mgd and the high permeability of the limestone aquifer.

There are few reported instances of PCS Phosphate's dewatering process affecting any nearby wells. Even with the Washington/Beaufort County well field 20 miles to the northwest and operating at as much as 4.2 mgd, surrounding communities appear to be relatively unaffected by the heavy withdrawals from the Castle Hayne.

iii. *Yorktown and Surficial Aquifers*

In the northeast portion of the Study Area, the Yorktown Formation and surficial deposits are commonly tapped for groundwater. The Yorktown is overlain by surficial sand and clay deposits and averages approximately 460 feet thickness, typical thickness near Pasquotank County, thickening eastward to greater than 1,000 feet on the Outer Banks.

The Yorktown is predominated by fine sands with varying amounts of clay and silt, interbedded with thin layers (usually less than 10 feet) of coarse sands and shell beds. A pebble conglomerate basal layer has been reported in some areas, usually where the Castle Hayne and Beaufort aquifers are absent. Generally, the Yorktown is finer-grained in the shallower portions and coarser in the deeper portions. Overall, Yorktown deposits are relatively fine-grained with low to moderate permeability. Considerably higher permeability can be expected in the coarse sand and shell beds. Shell beds have been reported laterally continuous up to 6 miles.

The Yorktown being predominantly fine-grained and lower permeability, well yields are often less than desirable for water system production. Reported well yields range from 5 gallons per minute (5 gpm) to as much as 400 gpm in the Yorktown aquifer. Typical well yields are 50-150 gpm, with greater yields occurring in larger diameter wells and those wells screened in coarser, more permeable zones.

The surficial aquifer overlies the Yorktown throughout Currituck, Camden, Pasquotank and Perquimans Counties and the eastern portions of Gates and Chowan Counties. The surficial deposits range between only a few feet thick in Gates, Perquimans and Chowan Counties to greater than 150 feet in mainland Currituck County.

Surficial deposits consist of interbedded sand, clay, gravel and peat underlain by a clayey confining layer. The confining bed separates the surficial and Yorktown aquifers and limits mixing of waters of the two aquifers. The surficial aquifer is recharged by infiltration of surface and precipitation water and is, therefore, predominantly fresh except near the saline sounds and estuaries. The Yorktown, on the other hand, is fresh water in the upper and westward areas due to flushing by fresh water through the confining layer. Water quality tends toward higher chloride concentrations deeper and eastward in the aquifer due to less extensive flushing. Wells screened near the gradational freshwater - saltwater interface may draw saline water when over-pumped.

D. *Groundwater-Challenged Areas*

The northeastern-most portion of the Study Area is faced with a unique problem with respect to siting reliable, long-term groundwater sources. Much of the remainder of the Study Area is advantaged in that it has better access to the more productive Castle Hayne aquifer and the Cretaceous aquifer system.

The production capacity of the Castle Hayne aquifer in the Central Coastal Plain is largely due to its lithology and structure. There the Castle Hayne contains molluscan mold and bryozoan-echinoid skeletal sandy limestone. This means the limestone is very porous with abundant void space, making the aquifer highly permeable.

Unfortunately for the areas north of the Albemarle Sound, this lithology grades to a sandy, clayey limestone, pinching out near the Virginia border. The Castle Hayne north of the Albemarle Sound is thinner and less permeable than in the Central Coastal Plain. However, test well results reported in various literature indicate that greater individual well yields are available from the Castle Hayne than from the shallower Yorktown and surficial aquifers.

The western and southern portions of the Study Area have easier access to the Cretaceous aquifer system since it is shallower in these areas (see Figure 3). To the east and northeast the Cretaceous aquifer system grows deeper and higher in chlorides, reducing its viability as a groundwater source.

Therefore, water systems in the northeastern Study Area typically rely on the Yorktown and surficial aquifers for groundwater. As described in Section C.iii above, the Yorktown is the more productive of these two aquifers, with typical well yields between 50-150 gpm. However, these well yields are troublesome for municipal or county water systems with water demands sometimes 3.5 mgd and greater. It would require over 30 wells producing 150 gpm (12 hr/day) to meet a 3.5 mgd demand.

The problem with such a scenario is two-fold.

1. Multi-well well fields require large amounts of land and plumbing. These requirements lead to expenses which push up the cost of water.

2. With numerous wells pumping within a localized area of an aquifer, the drawdown is cumulative and the effects are recognized in all wells. This effect is amplified in lower permeability zones characteristic of the Yorktown and surficial aquifers. To avoid this drawdown effect, wells must be installed at greater spacing, further increasing costs in plumbing.

The obvious solution is to find aquifer zones in which wells can be screened to produce greater yields, thus requiring fewer wells. However, such zones are difficult to find in the northeastern Study Area. The following section discusses various possible solutions.

E. *Finding Sufficient Groundwater Sources*

Water systems in the northeast Study Area understand the difficulty of finding efficient well screening zones. A few 500 gpm wells would be far more desirable than many 150 gpm wells. However, few wells in the area produce as much as 400 gpm and some wells produce 30 gpm or less. Therefore, finding sufficient groundwater sources generally means constructing numerous wells, frequently leading to the type of problems discussed above.

The solution to these problems is to focus on siting sufficient groundwater sources in a way which reduces or eliminates the frustrations of a multi-well system.

i. *Screening Multiple Zones*

It is generally understood that groundwater can be obtained at virtually any depth below land surface in the Coastal Plain, though the quantity and quality will vary. With some practical experience and research into references such as those in this report's bibliography, consultants, well drillers and water system superintendents learn where to obtain sufficient quantities of water of acceptable quality. However, when water system demands outpace production, new wells must be added in water bearing zones which may be stretched to or near their capacity. The focus must then be on finding other productive aquifer zones. This could mean screening wells in multiple aquifers, including deeper ones with elevated chloride concentrations. In many cases, obtaining greater quantities of groundwater will mean facing higher degrees of water treatment.

In the northeastern counties, a possible solution to having multiple low flow wells and chronic drawdown threats is to screen wells in a combination of the surficial, Yorktown, Castle Hayne and even Cretaceous aquifers. The key is to carefully log the subsurface lithology while the well is being drilled in order to accurately locate the thicker and coarser-grained zones of greatest permeability and greatest potential production capacity. Single wells may be screened in multiple zones or individual wells can be screened in shallow, intermediate or deep zones.

As discussed in Section C above, potentially greater yields may be obtained in the Castle Hayne and Cretaceous aquifers than the shallower aquifers. Water systems using relatively low flow wells screened in the surficial and Yorktown aquifers may considerably increase their raw water production capacity by installing wells in these zones. This effect may also be achieved by drilling into the basal Yorktown gravels, where present. The keys to finding productive zones must be stressed:

1. The technical skill must be present to find these zones. A clear understanding of the lithologies and target depths of the aquifers must be present when drilling. The productive water bearing zones are frequently laterally discontinuous, so that pilot or test holes must be drilled in order to find the zone. In addition, it is good practice to thoroughly test an aquifer zone before installing a well permanently. In all, there must be patience and willingness to finance and perform the preliminary work necessary to construct a useful well.

2. Targeting deeper and/or more eastward aquifers means accepting greater water treatment demands due to the increased chloride concentrations (hardness and iron may also require more treatment). Higher chloride concentrations generally require reverse osmosis (RO) treatment. RO treatment is more costly than traditional aeration, filtration and softening treatment. RO treatment also comes with the complications of siting and permitting a discharge point for the saline concentrate.

ii. ***Screening Exclusively in the Yorktown Aquifer***

It has been suggested that the answer to adequate groundwater supply in the northeastern Study Area is to utilize numerous wells in the Yorktown aquifer (references 6 & 14). This is a legitimate solution, especially from the perspective of water quality and water treatment costs, since fresh(er) water can be obtained from the Yorktown.

Many water systems in this area utilize wells screened in the Yorktown with moderately favorable results. However, many of these same water systems would prefer fewer wells with higher efficiency rather than additional wells with the same moderate production. This can potentially be accomplished in the Yorktown aquifer taking the following into consideration:

1. As with any well construction, particular care must be taken to find the most permeable and productive zones in the aquifer. As discussed in Section i. above, the technical expertise, time, testing, patience and financial backing must be available to find these zones.

2. Well spacing is important when screening multiple wells within one aquifer. This is due to the cumulative

effect of multiple well drawdowns. Additionally, multiple withdrawal points in a relatively focused area can produce "salt water intrusion events". These can be prevented with adequate well spacing and appropriate pumping rates. Salt water intrusion events can be remediated usually by ceasing pumping in the affected wells to allow the saline intrusion cone to recede or disperse.

3. Greater well productivity and lesser chloride concentrations can be expected in areas where the aquifer recharge rate is higher. This occurs in areas where both the surface infiltration rate is higher and where upper confining layers are less affective or absent. Close attention to borehole lithology may help to determine this along with attention to the characteristics of the soil series in the area (with respect to infiltration). Figure 4 provides a general overview of infiltration capacities in the Coastal Plain.

iii. *Screening Exclusively in the Deeper Aquifers*

Although the Castle Hayne has less productive aquifer characteristics north of the Albemarle Sound than in the southern Study Area, limited reports suggest it to be more productive than overlying aquifers. Although there would be more stringent water treatment demands due to higher chloride concentrations and greater well construction costs for deeper wells, reliance on the Castle Hayne aquifer may be a solution to long-term raw water supply without the requirement of an excessive number of wells.

Since there is limited experience or research in utilizing the Castle Hayne in this area for water supply, a test well program would need to be completed prior to any decision to install production wells. Such a test well program should involve drilling, exploration and installation of an adequate test well system to determine the chemistry and productivity of the aquifer. Only after this should a decision to use the Castle Hayne be made.

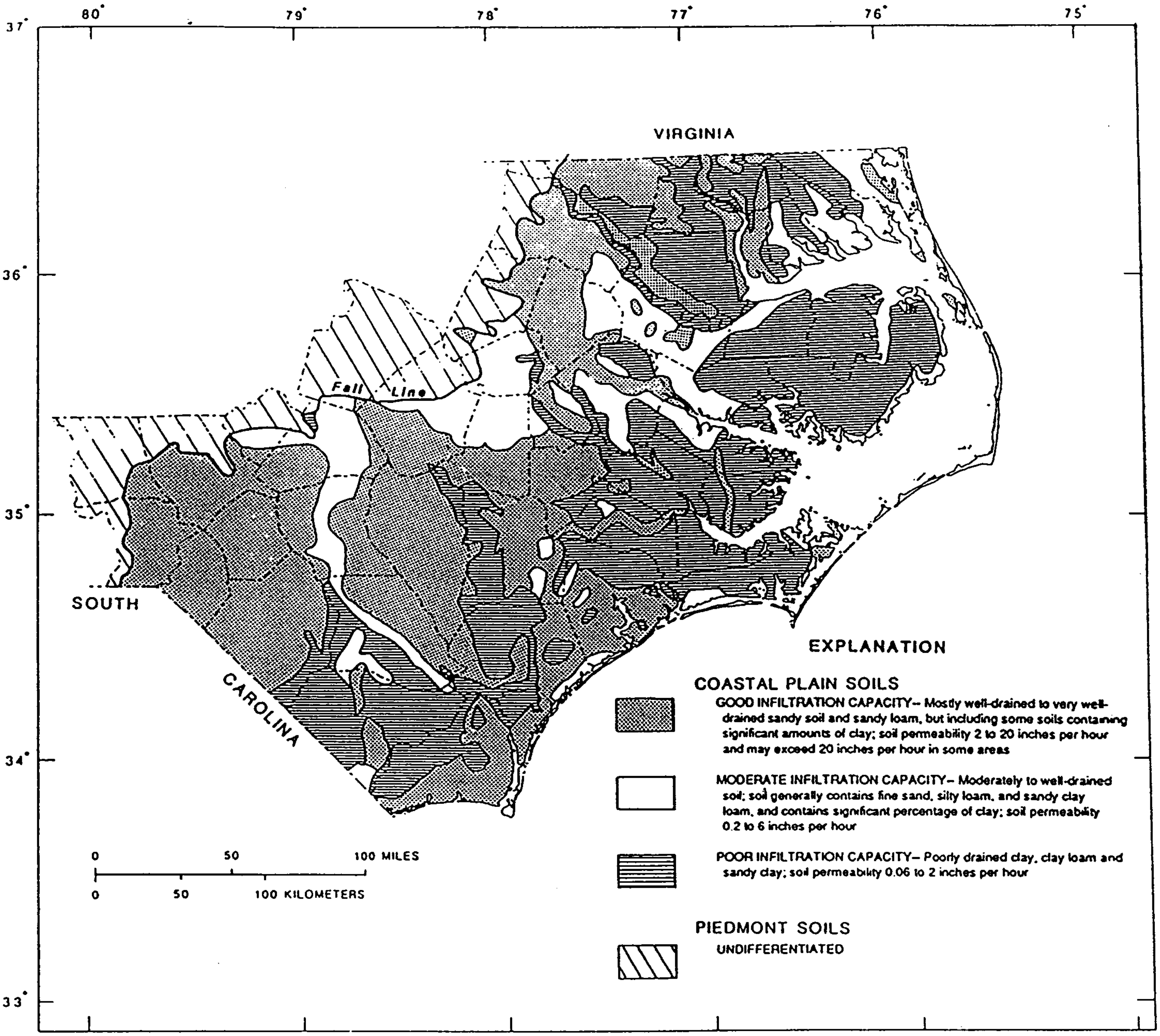


Figure 4. Infiltration Capacities of Surface Soils in the North Carolina Coastal Plain

Excerpt from Winner and Coble, 1989

Little is known of the water production capacity of the Beaufort and deeper Cretaceous aquifers in the northeastern Study Area. The lithology of these units (interbedded sands, clays and shell beds) suggests that permeable zones exist in the deeper aquifers. The thickness of the aquifers suggests great water reserve potential. As discussed in Section C.i. above, the Franklin, Virginia area obtains tremendous water volumes from the deeper aquifer system.

The obvious drawbacks of utilizing the deeper aquifer system are the cost of siting permeable zones, installing deep wells and treating saline water. However, limited research suggests that there are zones with chloride concentrations less than 1000 ppm. As with the Castle Hayne, a thorough test well program should be executed prior to the installation of production wells in any of the Cretaceous aquifers. It must also be accepted that RO treatment would be required to treat water from either of the deeper aquifers.

6. ANALYSIS OF DISTRIBUTION AND SOURCE SCENARIOS

The previous sections of this report have presented and discussed the existing water supply and demand conditions within the Study Area. The areas most in need of additional water supply have been sited as well as potential water sources to meet area demands.

This report section analyzes several distribution and source scenarios, focusing on the areas of greatest water need and the potentially feasible water sources. Each scenario was formulated with detailed engineering considerations including obtaining source water, water treatment and discharge (where necessary), pumping and pressure sources, distribution networks, storage, construction and financial details.

After each scenario was formulated, a construction cost and operation and maintenance expense was calculated. These costs were then divided amongst the scenario participants in two ways:

1. Based on percent capacity used -- the cost per 1,000 gallons to each participant is based on the percent of the flow within the distribution main that is devoted to that participant. This cost accumulates in each distribution segment up to the point of delivery to the participant.

2. Divided evenly between participants -- the cost per 1,000 gallons is based on the total project cost divided by the number of participants. Here the cost per 1,000 gallons is the same for each participant.

A simplified example is provided below in Figure 5. Each scenario is presented showing first the demands of the participants and the design concept of the distribution layout. A schematic distribution layout is provided with each scenario. An itemized cost estimate is then presented for each segment of distribution main , the water treatment and production facilities, where applicable. Segments are separated by the points of delivery to the participants (see distribution schematics). Each point of delivery includes a ground storage tank, booster pump station and master meter for delivery of water into each participant's existing system.

All the project costs are appropriately distributed, as described above, amongst the scenario participants, the debt service is calculated and the water cost per 1,000 gallons is calculated based on the assigned demand. Following this presentation is commentary on key points of the scenario including it's overall feasibility.

A. *Explanation of Distribution and Source Scenarios*

Seven scenarios are presented in Appendix II covering various distribution and water source alternatives. A general description of each scenario is as follows:

Scenario 1 - 10 MGD total flow from Lake Gaston pipeline.. Service to Camden County, Currituck County, Elizabeth City and Pasquotank County.

Scenario 2 - 15 MGD total flow from Lake Gaston pipeline. Service to Camden County, Currituck County, Dare County, Elizabeth City and Pasquotank County.

Scenario 3 - 6 MGD total flow from 14 wells drawing water from the Yorktown Aquifer in Chowan County area. Service to Camden County, Chowan County, Currituck County, Elizabeth City, Pasquotank County and Perquimans County.

Scenario 4 - 20 MGD total flow from the mine dewatering operation at PCS Phosphate. Service to Beaufort County, Camden County, Chowan County, Currituck County, Dare County, Elizabeth City, Pasquotank County, Perquimans County and Washington County.

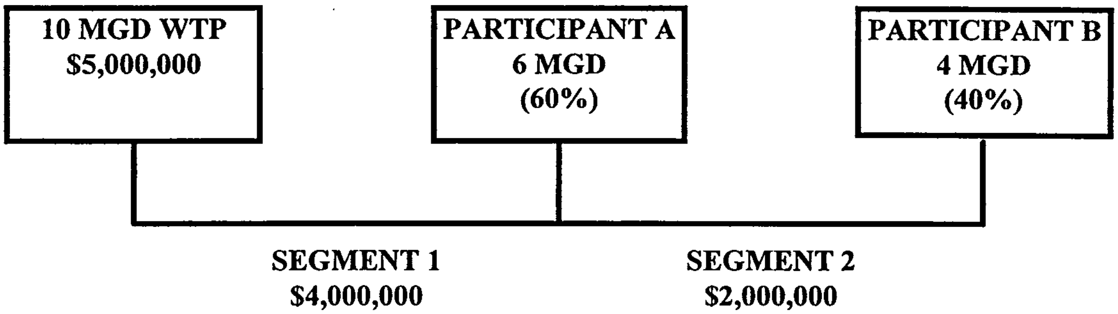
Scenario 5 - 10.5 MGD total flow from 25 wells drawing water from the Yorktown Aquifer with a well field system along Hwy. 37 beginning in Winfall and extending north toward Gates County. Service to Camden County, Currituck County, Elizabeth City, Perquimans County and Pasquotank County.

Scenario 6 - 13 MGD total flow from 35 wells drawing water from the Castle Hayne Aquifer in the Elizabeth City Area with RO water treatment. Service to Camden County, Currituck County, Dare County, Elizabeth City and Pasquotank County. Costs are also presented for not servicing the Outer Banks in Currituck County and Dare County.

Scenario 7 - Same as Scenario 6 except 16 MGD total flow.

FIGURE 5

EXAMPLE DISTRIBUTION SCENARIO



Cost Breakdown
(Percent Capacity)

	Participant A	Participant B
10 MGD WTP (60% / 40%)	$ 3,000,000	$ 2,000,000
Segment 1 (60% / 40%)	$ 2,400,000	$ 1,600,000
Segment 2 (0 % / 100%)	$ -0-	$ 2,000,000
Total	$ 5,400,000	$ 5,600,000
Debt Service (20-yr, 5.15%)	$ 438,840	$ 455,091
Annual Water Use (1000 gallons)	2,190,000	1,460,000
Cost / 1000 gallons	$ 0.20	$ 0.32

Cost Breakdown
(Divided Evenly)

Total Project Cost	$ 11,000,000
Debt Service (20-yr, 5.15%)	$ 893,929
Total Annual Water Use (1000 gallons)	3,650,000
Cost / 1000 gallons to Participants A & B	$ 0.25

Each scenario culminates in a final cost per 1000 gallons of treated water to each participant. Cost per 1000 gallons of water is based on a debt service and an operation and maintenance cost. Treated water is delivered to a selected point of delivery for each participant. Each point of delivery utilizes a ground storage tank, booster pump station and master meter. A finished water pump station located at the central treatment facility will maintain water in each ground storage tank. The booster pump station will draw water from the ground storage tank and be sized to fill each participant's elevated storage tank(s). Telemetry will be utilized to operate the booster pumps, maintaining tank water levels. Points of delivery were selected to optimize use of each participant's existing infrastructure with minimal upgrades.

Sizing for ground storage tanks was based on 6 hours of demand, or one-quarter of the average daily demand. Basic pipe sizing was provided to maintain a pipe velocity between 2 feet per second and 4 feet per second. Hydraulic modeling was performed for several scenarios utilizing the KYPIPE computer model "CYBERNET". Debt service calculations were based on a 20 year loan at an interest rate of 5.15%. No grant monies were considered in this study.

Section 4 of this report discusses the possible water sources for the Albemarle region. Among those discussed, the most feasible of them, based on water quality and available quantity, were considered in distribution scenarios. These potential water sources were the Lake Gaston pipeline, PCS Phosphate depressurizing water and groundwater from the Yorktown and Castle Hayne aquifers.

Two scenarios are presented utilizing wells in the Yorktown Aquifer in the Chowan County area and the Perquimans County area. Scenario 3 utilizes a well field in Chowan County based on previous research which indicated potentially higher well yields in the Valhalla area. Although individual wells yields in the Winfall area are reportedly low, Scenario 5 utilizes Yorktown-screened wells in northwestern Perquimans County extending toward Gates County. This scenario was selected based on previous research which indicated potentially higher well yields in this area and generally increasing well yields westward from Pasquotank County. Higher permeability surface soils are present in this area which may allow greater aquifer recharge.

Scenarios 6 and 7 are devoted to drilling wells in the Castle Hayne aquifer and utilizing RO water treatment. Much of the treatment requirements were obtained from a study prepared by Piedmont Olsen Hensley entitled "Reverse Osmosis Water Treatment Pilot Study" dated August, 1995. Their study analyzed results of a test well with a pilot RO treatment plant. A 4" gravel packed well was constructed at the Elizabeth City well field to a depth of 469' followed by 25' of screen. A pilot-scale RO plant, supplied by Filmtec Corporation, was used to treat the saline groundwater. The raw water tested in the RO pilot plant contained an average of 6,200 ppm TDS (total dissolved solids) and 3,300 ppm chlorides. (Note: ppm = parts per million = milligrams per liter.) The pilot study indicated this water to be fully treatable with the proposed design and operating parameters (applicable to a full-scale plant) as follows:

Sulfuric Acid Dose:	150-180 mg/l
Anti-Scalant Dose:	2-4 mg/l
Design Feed Pressure:	350 psi
Design Flux Rate:	15 gdf
Design Recovery Rate:	75%
TDS Rejection:	98%

These parameters and the associated costs of treatment are subject to change with any changes in raw water quality. Water with lower chloride concentrations was observed in a test well in Morgans Corner with a similar screened depth. Variability in groundwater quality over small distances and depths is common throughout the region.

The Study also presented projected operating expenses for a new membrane filtration system as follows:

Power:	$0.42/1000 gal
Chemicals:	$0.26/1000 gal
Maintenance:	$0.10/1000 gal
Cartridge Filter Replacement:	$0.01/1000 gal
Membrane Filter Replacement:	$0.10/1000 gal

These figures from the Piedmont Olsen Hensley pilot study were used in part to formulate operation and maintenance costs for the RO treatment scenarios presented in this study.

An issue with RO treatment that is considered in this study is concentrate disposal. Reverse osmosis treatment of chloride-rich water produces wastewater that is very concentrated in chlorides. This wastewater must be disposed. Under Scenarios 6 and 7, the concentrate is discharged to the Pasquotank River, a typical disposal method. Several discussions were held with the Department of Environment, Health and Natural Resources (DEHNR) regarding concentrate disposal. Key issues of concern in the Pasquotank River are anoxic salinity wedges, salinity and chloride levels, salinity tolerant species and toxicity. DEHNR first indicated that the proposed discharge could not be located on the Pasquotank River north of the Coast Guard Base. DEHNR later indicated that it may be possible to locate a discharge as far north as Knobbs Creek on the Pasquotank River. Discharge scenarios are presented for both locations.

The RO treatment facility scenarios are presented in a fashion to illustrate the effects of construction in phases. The cost structure is shown with the treatment facility built to 50% capacity and 100% capacity. Construction to 50% capacity includes the site, site structures, process piping, etc. Treatment facility construction is performed such that it is readily expandable from 50% to 100% capacity without need for upgrades. Transmission mains are sized and installed for 100% capacity since it would be impractical and very expensive to upgrade the lines as plant capacity increases.

Because the most feasible water sources are on the mainland, a water main across the Currituck Sound would be necessary in order to provide water service to the Currituck and Dare County Outer Banks. The scenarios incorporating service to the Outer Banks illustrate a Currituck Sound crossing at Aydlett. This crossing is shown as both subaqueous (installed along the bottom of the sound) and bridge-attached on the proposed Mid-County Bridge. The Department of Transportation has indicated that the bridge design can accommodate a maximum of two (2) 12" attached water mains The bridge attachment installation is more economical than a subaqueous crossing, however, flow is limited by pipe size. Scenarios presented for the Outer Banks illustrate maximum possible flow available by bridge attachment with two (2) 12" water mains as well as a subaqueous crossing through a 24" water main.

7. CONCLUSIONS

A. *Need for Water Supply Assistance Within the Study Area*

In the early stages of this Study, each participant was interviewed to discuss the particular needs and concerns of each participating water system. Results of these interviews are presented in Section 2 of this report. Through these efforts it became clear that certain portions of the Study Area need help in meeting present and future water demands while other areas do not. Much of this report has focused on those areas determined most in need of water resources:

Currituck County
Camden County
Pasquotank County
Elizabeth City
Dare County

Due to continuing growth and declining fresh water resources, these are areas of particular concern with respect to long-term water supply.

The remaining participants of the Water Study, for a variety of reasons, do not have the same concerns with respect to long-term water supply. Primary among the reasons are 1) limited growth and 2) existing adequate water resources to meet projected water demands. The Study participants for which long-term water supply does not appear to be an immediate concern, at least at present, are listed below.

Bertie County	Perquimans County*
Chowan County	Hertford, Winfall
Edenton	Northampton County
Halifax County	Tyrell County
Hertford County	Columbia
Hyde County	Washington County
Martin County	Creswell, Plymouth, Roper

* Perquimans County is on the borderline of needing water supply assistance and is therefore included in several of the distribution scenarios.

NOTE: Beaufort and Gates Counties are included in the Study Area but did not elect to participate in the Study.

B. *Water Resources Available to the Study Area*

Considerable research into potential water sources for northeastern North Carolina was conducted for this Study. Generally, the potential water resources are surface water and groundwater. Specifically, this report addresses lakes, estuaries and sounds under the surface water category and the many aquifers of the region under the groundwater category.

i. Surface Water

The lakes, estuaries and sounds within the Study Area hold little promise for long-term water supply due to poor and erratic water quality. Additionally, the lakes of the region may simply not contain sufficient and replenishable volumes of water. Use of estuaries and sounds as water source would require advanced (and expensive) water treatment techniques such as reverse osmosis. With reverse osmosis comes the difficulties of managing a discharge for the concentrate effluent.

Another surface water source potentially available to northeast North Carolina is Lake Gaston via the proposed pipeline to Virginia Beach. Since the idea for the pipeline originated, there has been persistent political opposition preventing its construction. A final decision on the pipeline is pending approval by the Federal Energy Resource Commission and further political negotiations between North Carolina and Virginia.

As part of the negotiations between the two states a concession has been offered where 15 mgd of the proposed 60 mgd total flow be given back to northeastern North Carolina to be used in water deficient areas. Two scenarios using Lake Gaston pipeline water were presented. However, since the time frame for construction of the pipeline or the final conditions of agreement are unknown, it cannot be assumed that Lake Gaston pipeline water is an available option.

ii. Groundwater

As discussed in considerable detail in Section 5 of this report there are numerous water bearing units within the aquifer system of the lower Coastal Plain. The major aquifers are illustrated in Figure 3. Even the deepest of the aquifers (1000 - 2000 feet) are available to Coastal Plain communities with the construction of deep production wells.

Water quality and available quantities vary within and between aquifers. Historically, the deeper and more eastern aquifers have been considered too high in chlorides to be useful as drinking water source. At the same time, the shallower and fresher aquifers often yield very low volumes or flow rates.

With improving membrane treatment technology, techniques such as reverse osmosis have made more raw water sources available for use despite high chloride concentrations. Increased productivity from many well fields may be recognized by supplementing with deeper wells and providing reverse osmosis treatment.

Hydrogeological research (a test well program) would be necessary to confirm the feasibility of utilizing deeper aquifers. However, existing research suggests the deeper aquifer system to be a viable option if the chloride levels can be managed. The Castle Hayne, Beaufort and Cretaceous aquifers appear to have potential for long-term water sources for northeast North Carolina.

The Castle Hayne, in areas south of the Albemarle Sound, is a very productive aquifer. Some interest has been expressed in utilizing excess water from mine depressurization (dewatering) at PCS Phosphate near Aurora, Beaufort County. Mine operations remove approximately 30 mgd of groundwater from the Castle Hayne to prevent flooding of mine pits. Approximately 20 mgd of this water is discharged to Pamlico Sound.

Some suggestions have been offered to distribute this wasted water to areas of the Coastal Plain in need of water. Politically, this may not be feasible due to opposition to distributing local water reserves to non-local receivers. The question of the legalities of inter-basin transfer of water also lingers. However, for the sake of comparison, a scenario for distribution of PCS Phosphate water was presented.

C. *Feasibility of Distribution*

Several water sources and distribution scenarios were presented in the previous section. From an engineering and construction perspective, each of these scenarios are feasible. However, certain of these scenarios are less feasible than others due to political and hydrogeologic reasons.

The Lake Gaston pipeline scenarios (1 and 2) are unlikely to occur (anytime soon) due to political differences between North Carolina and Virginia. Participation in these scenarios would also mean that the regional water system would be reliant on the pipeline to maintain water supply. The regional water system would be better served to control their own water source.

The PCS Phosphate scenario (4) could face considerable local opposition to distributing such a large quantity of water away from the area. The question of inter-basin transfer of water could also play a role in such a scenario. Additionally, there are many unanswered questions regarding arrangements which would need to be made with PCS: who runs the facility, will mine dewatering be maintained such that 20 mgd will be reliably supplied and how long will mine operations last in Aurora?

Two scenarios (3 and 5) utilize groundwater sources which are outside of the area of greatest water needs. Although water is supplied in a supplemental capacity within the source area, there could still be community/political resistance to distributing water away from the locality of the source. Additionally, the stated well flow rates were assumed based on existing but limited research and may be overstated. The ability of these targeted aquifer zones to serve as a viable long term water source would have to be borne out with hydrogeologic investigation. However, if such investigation indicated lower than stated flow rates, then additional wells would be required along with associated raw water piping. This could create additional community resistance and would create increased water costs.

The scenarios likely to present the least political resistance and promote the most regional self-reliance are the ones using groundwater sources within the area of greatest water needs, more specifically, within the area to be supplied the greatest amount of water. These are Scenarios 6 and 7 which utilize groundwater in the Elizabeth City/Pasquotank County area, receivers of the most water, and distribute to Camden, Currituck and Dare Counties.

By producing the water within the area in which it would be distributed, community/political opposition may be minimized. Furthermore, having water production facilities within the area to be served provides for independence and control of water production.

The following table presents a summary of the water costs/1000 gallons for each participant in each scenario. The ranking of scenarios from least expensive to most expensive is: Lake Gaston pipeline, Yorktown aquifer wells in Perquimans County, Yorktown aquifer wells in Chowan County, RO treatment of deep wells in Elizabeth City area and PCS Phosphate water.

SUMMARY OF COSTS/1000 GALLONS

($/1000 GALLONS)

PARTICIPANT	SCENARIO																	
	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b	6c	6d	7a	7b	7c	7d
Currituck County	0.90	1.12	1.41	1.35	2.87	1.67	3.31	2.80	2.28	1.46	2.88	4.18	2.43	3.27	2.77	3.24	2.46	3.07
Camden County	1.11	1.12	1.13	1.35	1.90	1.67	2.71	2.80	1.63	1.46	2.24	2.89	2.43	3.27	2.23	2.80	2.46	3.07
Elizabeth City	1.12	1.12	1.13	1.35	1.69	1.67	2.57	2.80	1.39	1.46	2.05	2.52	2.43	3.27	2.10	2.53	2.46	3.07
Pasquotank County	1.18	1.12	1.16	1.35	1.56	1.67	2.50	2.80	1.34	1.46	2.06	2.53	2.43	3.27	2.09	2.53	2.46	3.07
Dare County	0	0	1.91	1.35	0	0	3.83	2.80	0	0	3.61	5.55	2.43	3.27	3.11	3.77	2.46	3.07
Chowan County	0	0	0	0	1.00	1.67	2.09	2.80	0	0	0	0	0	0	0	0	0	0
Perquimans County	0	0	0	0	1.34	1.67	2.34	2.80	1.25	1.46	0	0	0	0	0	0	0	0
Beaufort County	0	0	0	0	0	0	1.34	2.80	0	0	0	0	0	0	0	0	0	0
Washington County	0	0	0	0	0	0	1.81	2.80	0	0	0	0	0	0	0	0	0	0

LEGEND

1a: Lake Gaston Pipeline, 10 mgd, 100% build-out
1b: Lake Gaston Pipeline, 10 mgd, equal cost among participants
2a: Lake Gaston Pipeline, 15 mgd, 100% build-out
2b: Lake Gaston Pipeline, 15 mgd, equal costs among participants
3a: Yorktown Aquifer Wells in Chowan Co., 6.0 mgd, 100% build-out
3b: Yorktown Aquifer Wells in Chowan Co., 6.0 mgd, equal cost among participants
4a: PCS Phosphate in Aurora, 20 mgd, 100% build-out
4b: PCS Phosphate in Aurora, 20 mgd, equal cost among participants
5a: Yorktown Aquifer Wells extending from Winfall to Gliden, 10.5 mgd, 100% build-out
5b: Yorktown Aquifer Wells extending from Winfall to Gliden, 10.5 mgd, equal cost among participants
6a: RO Water Treatment Facility, 13 mgd, 100% build-out
6b: RO Water Treatment Facility, 13 mgd, 50% build-out
6c: RO Water Treatment Facility, 13 mgd, 100% build-out, equal cost among participants
6d: RO Water Treatment Facility, 13 mgd, 50% build-out, equal cost among participants
7a: RO Water Treatment Facility, 16 mgd, 100% build-out
7b: RO Water Treatment Facility, 16 mgd, 50% build-out
7c: RO Water Treatment Facility, 16 mgd, 100% build-out, equal cost among participants
7d: RO Water Treatment Facility, 16 mgd, 50% build-out, equal cost among participants

8. RECOMMENDATIONS

It is clear from this study that the most water-deprived portions of the Study Area could benefit from combining water production efforts to form a Regional Water System. The most feasible option for forming such a system, based on political, financial, independence of operation and water availability aspects, is to pursue deep well water production with reverse osmosis (RO) treatment in the Elizabeth City area. Distribution should begin with the counties of Camden, Currituck, Dare and Pasquotank and Elizabeth City. Therefore, it is the recommendation of this study that the Albemarle Water Resources Task Force pursue formation of a regional water system as described in Scenarios 6 and 7.

The system should be sized to provide the Outer Banks with the greatest amount of water possible (Scenario 7) in order to meet ever-increasing water demands there. This also increases the cost effectiveness of providing water. Negotiations should be initiated between Camden County, Currituck County, Dare County, Pasquotank County and Elizabeth City to create a governing water district. The Institute of Governments can provide the needed guidance in the formation of a governing entity.

The Task Force should establish a test well drilling project to identity aquifer zones capable of producing adequate water supplies for long term regional planning. This project should place extensive focus on long term water quality and long term aquifer yield (available quantity). Scenarios 6 and 7 include test wells at a cost of $60,000 each. However, these test wells are for basic reassurance that the correct aquifer zone is reached prior to installation of the full-scale production wells. A test well program (hydrogeologic investigation) adequate for designing a well field capable of long term water supply must involve very focused and comprehensive investigation. It will be necessary to design a scope of work for a test well program to include at a minimum

1. *Expertise and coordination in site selection* -- this report has utilized existing research to choose the an area near Elizabeth City to site Castle Hayne or deeper wells. Other local areas may serve equally well such the area around Morgans Corner where a Division of Water Resources test well has been drilled. Some consideration must also be given to the availability and cost of land. The Camden County peninsula between the Pasquotank and North Rivers, mostly farmland, may be a good area to site wells. It has also been suggested that land may be available in the Pasquotank County Commerce Park area.
2. *Expert well drilling and construction* -- from previous experience, it is evident that some low yield wells are the result of improper well installation and construction. Any test well program must be performed by qualified and conscientious well drillers supervised by an experienced geologist with a clear focus on the goal of the project.

3. *Proper pump sizing and usage* -- the appropriate pumps must be used for drawdown tests to obtain optimum results from aquifer drawdown testing. Additionally, pumps must be operated at appropriate flow rates, continually and for an adequate length of time.
4. *Proper monitoring and instrumentation* -- this must include all necessary monitor wells auxiliary to the pumping well, in adequate numbers and appropriately spaced, equipped with the proper flow and water level monitoring instrumentation.
5. *Expertise in compiling and modeling pump test results* -- experienced personnel must be present to receive and compile data including accurate well drilling logs and aquifer drawdown data. This data is necessary for creating a computer model to predict aquifer performance over the lifetime of the well field. Computer modeling must be performed appropriately by experienced and qualified operators.
6. *Proper and thorough chemical analysis* -- prior to performing any pilot treatment studies, the quality of raw water must be known. Chemical quality must be obtained by experienced personnel using accepted sampling protocol, sampling at appropriately selected intervals and times.

This project should also incorporate pilot testing to determine treatability of any targeted groundwater. Pilot testing will help determine the required design parameters for RO treatment. Based on our experience with the time required to receive such permits, it is recommended to formally apply for a NPDES permit for concentrate discharge as soon pilot test results are available.

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APPENDIX I

Contract for Engineering Services

Including

Scope of Services

CONTRACT FOR ENGINEERING SERVICES

Regional Water Study
For The
Albemarle Water Resources Task Force

This AGREEMENT made this 21st _ day of September, 1995, by and between the ALBEMARLE COMMISSION, hereinafter called the OWNER, and HOBBS, UPCHURCH & ASSOCIATES, P.A., hereinafter called the ENGINEER.

WHEREAS, the OWNER intends to perform a "Regional Water Study" to identify long-range water supply alternatives beneficial to the region, hereinafter called the PROJECT.

NOW, THEREFORE, the OWNER and ENGINEER, for the consideration hereinafter named, agree as follows:

The ENGINEER agrees to perform for the above named PROJECT professional services as hereinafter set forth.

The OWNER agrees to compensate the ENGINEER for services as hereinafter provided.

I. ENGINEERING SERVICES:

The ENGINEER agrees to perform for the above named PROJECT professional services as herein set forth.

HOBBS, UPCHURCH & ASSOCIATES, P.A. will address the issues to evaluate water supply alternatives and options that might be mutually beneficial to some or all of the systems in the region and prepare an analysis of water supply alternatives for the Albemarle Region. As proposed in the original Request for Proposals dated July 14, 1995, the

Contract for a Feasibility Study will be in cooperation with the Albemarle Commission, the Northeastern North Carolina Economic Development Commission, the Rural Economic Development Center, Inc. and the Counties of Camden, Chowan, Currituck, Dare, Halifax, Hertford, Hyde, Martin, Northampton, Pasquotank, Perquimans, Tyrrell, Washington; and the municipalities of Columbia, Creswell, Edenton, Elizabeth City, Hertford, Kill Devil Hills, Kitty Hawk, Manteo, Nags Head, Plymouth, Roper, Southern Shores and Winfall. The Feasibility Study will include, as necessary, the Counties of Beaufort, Bertie and Gates. One or more technically sound, politically acceptable and cost-effective alternatives for the region will be developed.

<u>DESCRIPTION OF SERVICES (General Scope of Responsibilities)</u>
The Feasibility Study will include the following:

1. <u>Project Briefing</u>
   Meet with the Albemarle staff and representatives from the region and the State of North Carolina to discuss the project objectives and identify available information and assistance to be provided by the Commission and others.

2. <u>Visit with all Jurisdictions</u>
   The consulting engineering firm (ENGINEER) will visit or correspond with officials of each participating system. These visits will produce a listing of concerns, suggestions, and items to be considered in the Feasibility Study.

3. <u>Preliminary Data Review</u>
   Following the visits with the system, the ENGINEER will perform a preliminary review of documents which the regional governments or the N.C. Division of Water Resources has available. Prepare and furnish to the Commission a list of documents that are required for further analysis and reference.

4. <u>Acquisition of New Data</u>
   The acquisition of any new data that requires more than a very modest cost will probably not be practical due to the limited funds available for this study.

5. Review of Current Capacities and Projected Needs

Projections of raw and finished water needs for all public water systems will be provided by the Commission staff and the North Carolina Division of Water Resources. The location and capacities of existing water and wastewater plants will be furnished by the Commission staff. The ENGINEER will review this data and determine the need for any additional existing information. The existing information will be provided by the Commission staff.

6. Review of Hydrological Data

The ENGINEER will review and evaluate existing hydrological data as appropriate.

7. Alternatives to be Considered

A. Ground Water

Use of Good Quality Local Aquifers. Most systems within the area currently use ground water. (Elizabeth City and Nags Head use or have used surface water in whole or in part.) Obtaining good quality water from suitable aquifers is becoming more difficult. This alternative source may meet the long-range need for some systems and not for others.

B. Surface Water

Elizabeth City at one time used large amounts of surface water. It will completely abandon this emergency source in 1995. During adverse weather conditions, the Pasquotank River became an unsuitable source due to high salinity. There were also problems with total organic carbons. Hertford has used the Perquimans River as a source of water and Nags Head uses local surface water lakes as a source to supplement their water supply.

C. Importing Water From Other Areas

1) Texasgulf Surplus via Pipeline. Feasibility Study by the firm of Hazen and Sawyer has addressed this alternative to some extent. (A copy of this report will be made available). The ENGINEER would use this report and tailor it as a water supply alternative for the systems in the Albemarle Region.

2) As a result of recent developments regarding the Lake Gaston pipeline, 15 mgd of water may be available from southeastern Virginia. The feasibility of importing water from the cities of Virginia Beach, Chesapeake, and Norfolk are to be determined.

D. Desalinization

The upper reaches of Currituck Sound, as well as Back Bay, are possible sources. During a high percentage of time, Back Bay is virtually a fresh-water source. Moreover, it is relatively unpolluted and has a very large volume. There are also saline ground water sources on the outer banks and in other locations in the region.

North Carolina has considerable experience with desalinization at Ocracoke Island and in Dare County. Plants are also being considered elsewhere on the North Carolina coast. Determining the potential of desalinization for specific areas would be the focus for evaluating this alternative.

E. Conjunctive Use

The option of using ground water and surface water in a unified regional management system in the Albemarle Region may be a satisfactory long-range alternative. Several years ago, the N.C. Division of Water Resources studied the possibility of a limited unified system. This study showed that sufficient water was available for Virginia Beach by using only the Norfolk and Portsmouth Lakes, the existing pumping facilities on the Nottoway and Blackwater Rivers, and intermittent pumping from existing wells during critical drought periods.

In the last few years, the City of Chesapeake has explored the possibility of recharging local aquifers with freshwater, which could then be recovered during dry periods. This option has been evaluated and acted upon by the City of Chesapeake. Pilot facilities have been constructed in the Chesapeake area. The addition of a ground water recharge-withdrawal capability would make a conjunctive use system even more attractive. This alternative could provide additional system capability.

F. Regional Opportunities

The ENGINEER will review opportunities for regional cooperation in water purchases and in raw and finished water production. The possibility that some of the water systems might reduce their water supply costs by joint cooperation and/or privatization or a large regional water treatment plant is to be explored. Both the advantages and disadvantages of such an alternative will be discussed. Cost estimates of regional versus individual town water supply development are to be developed. Any identified economies of scale should be documented based on similar savings (examples) in other North Carolina systems.

G. Other Alternatives
After addressing alternatives listed above, the ENGINEER can evaluate other options that have a reasonably high potential for providing an economical water supply.

8. Development of Alternatives
Enough work will be done on each alternative to distinguish between alternatives. A rough comparison of each alternative's cost and technical considerations will be prepared. The alternatives will be defined as the ENGINEER sees them.

The ENGINEER and the Commission staff will interactively scrutinize the alternatives concerning technical, political, legal, and implementation aspects.

9. Report on Evaluation
The ENGINEER will prepare a description and a cost estimate of each alternative. The final report will also consider feasibility of alternatives, evaluation of environmental impacts, and other factors that would affect feasibility of the alternatives. The report will recommend long-range alternatives for the region's water systems outlining the rationale for each recommendation.

II. PAYMENT:

The OWNER agrees to pay the ENGINEER for services noted in Section I as herein set forth.

Total lump sum fee for the PROJECT is $42,000.00.

The ENGINEER shall receive progress payments based on monthly estimates as submitted to the OWNER by the ENGINEER.

III. ADDITIONAL SERVICES:

Should the ENGINEER be required to render "additional services" in connection with related work upon which the scope does not apply, the ENGINEER shall receive additional compensation for such additional services at the hourly rates as specified on the Standard

Fee Schedule attached hereto in Exhibit "A" for the hours actually worked by the appropriate classification of employee or at a subsequently negotiated lump sum fee. Such "additional services" shall not be undertaken without prior written approval of the OWNER.

IV. CONTRACT MODIFICATIONS AND PROVISIONS

It is agreed by the parties hereto that the appropriate adjustments in any fixed and/or lump sum payments shall be made in the event that the physical scope of the PROJECT, time for completion, or services required are materially increased or decreased beyond that contemplated at this time.

In the event such changes are necessary, the ENGINEER shall be paid for those services completed to the date of notification for change by the OWNER. If such notification occurs during the interim, the ENGINEER and OWNER shall negotiate the level of work effort accomplished and the associated sum due the ENGINEER for payment.

In the event the ENGINEER has not performed according to the terms of the AGREEMENT for any reason including but not limited to substantial and unjustified delays in work without approval of the OWNER, the ENGINEER is found incapable of performing the class of work specified, or breach of the terms of the contract, the OWNER may in its sole discretion declare the ENGINEER in default of the terms of the AGREEMENT. Upon declaration by the OWNER of the default of the ENGINEER, the ENGINEER shall be furnished written notice of such default at the last known address which ENGINEER has provided to the OWNER. If the ENGINEER has not satisfied such default within ten (10) days from the date of the default, the OWNER shall consider the AGREEMENT terminated and in such termination agree to pay the ENGINEER for work performed on or before the date of such termination. Said payment to be for manhours performed at the hourly rate herein specified in Exhibit "A". The failure of the OWNER at any time to require performance by the ENGINEER of any provision hereof shall in no way affect the right of the OWNER hereafter to enforce same.

IV. DURATION OF PROJECT

The ENGINEER will furnish the completed feasibility study within 300 days from the date of the executed Contract.

The OWNER and ENGINEER each binds himself, his partners, successors, executors, administrators and assigns to the other party to the AGREEMENT and to the partners, successors, executors, administrators and assigns of each other party in respect to all covenants of the AGREEMENT.

IN WITNESS HEREOF, the parties hereto each herewith subscribe the same in triplicate this 21 day of September, 1995.

HOBBS, UPCHURCH & ASSOCIATES, P.A.

BY: [signature]
Fred M. Hobbs, P.E., President

Witness: [signature]
Eric T. Weatherly, P.E., Project Manager

ALBEMARLE COMMISSION

BY: [signature]
Hal Walker, Executive Director

Witness: [signature]
Ruth Mengel, Office Manager

EXHIBIT "A"

HOBBS, UPCHURCH & ASSOCIATES, P.A.

FEE SCHEDULE

Hobbs, Upchurch & Associates is pleased to offer our clients a competitive rate structure. Our firm aggressively pursues the ocntrol of overhead and quality in an effort to maintain the highest level of professional service at the most reasonable project costs.

ENGINEER - GRADE IV	$75.00/HOUR
ENGINEER - GRADE III	$65.00/HOUR
ENGINEER - GRADE II	$52.00/HOUR
ENGINEER - GRADE I	$45.00/HOUR
REGISTERED LANDSCAPE ARCHITECT	$45.00/HOUR
SURVEYOR - GRADE II	$48.00/HOUR
SURVEYOR - GRADE I	$42.00/HOUR
CONSTRUCTION MANAGER	$55.00/HOUR
COMPUTER SYSTEMS SPECIALIST	$55.00/HOUR
TECHNICIAN - GRADE IV	$40.00/HOUR
TECHNICIAN - GRADE III	$35.00/HOUR
TECHNICIAN - GRADE II	$30.00/HOUR
TECHNICIAN - GRADE I	$25.00/HOUR
SURVEY CREW	$65.00/HOUR
SECRETARY - GRADE II	$30.00/HOUR
SECRETARY - GRADE I	$25.00/HOUR

Hobbs, Upchurch & Associates, P.A. hourly rates are inclusive of all expenses and are reflective of our competitive pricing.

Specific projects may be addressed through the hourly rate format or based on mutually agreed upon lump sum fees as may be negotiated based on a well defined scope of services.

The ultimate aim of our services and fees is to provide the client with professional assistance in a timely and cost conscious basis.

APPENDIX II

Design Data and

Cost Analysis

SCENARIO 1a

10.0 mgd raw water obtained from Lake Gaston pipeline at Chesapeake
Treatment provided in North Carolina by regional water association
Service to Currituck Co., Camden Co., Pasquotank Co. & Elizabeth City

Assigned Demand for Year 2020:

Currituck Co.	=	1.0 mgd
Camden Co.	=	1.0 mgd
Elizabeth City	=	3.0 mgd
Pasquotank Co.	=	5.0 mgd
		10.0 mgd

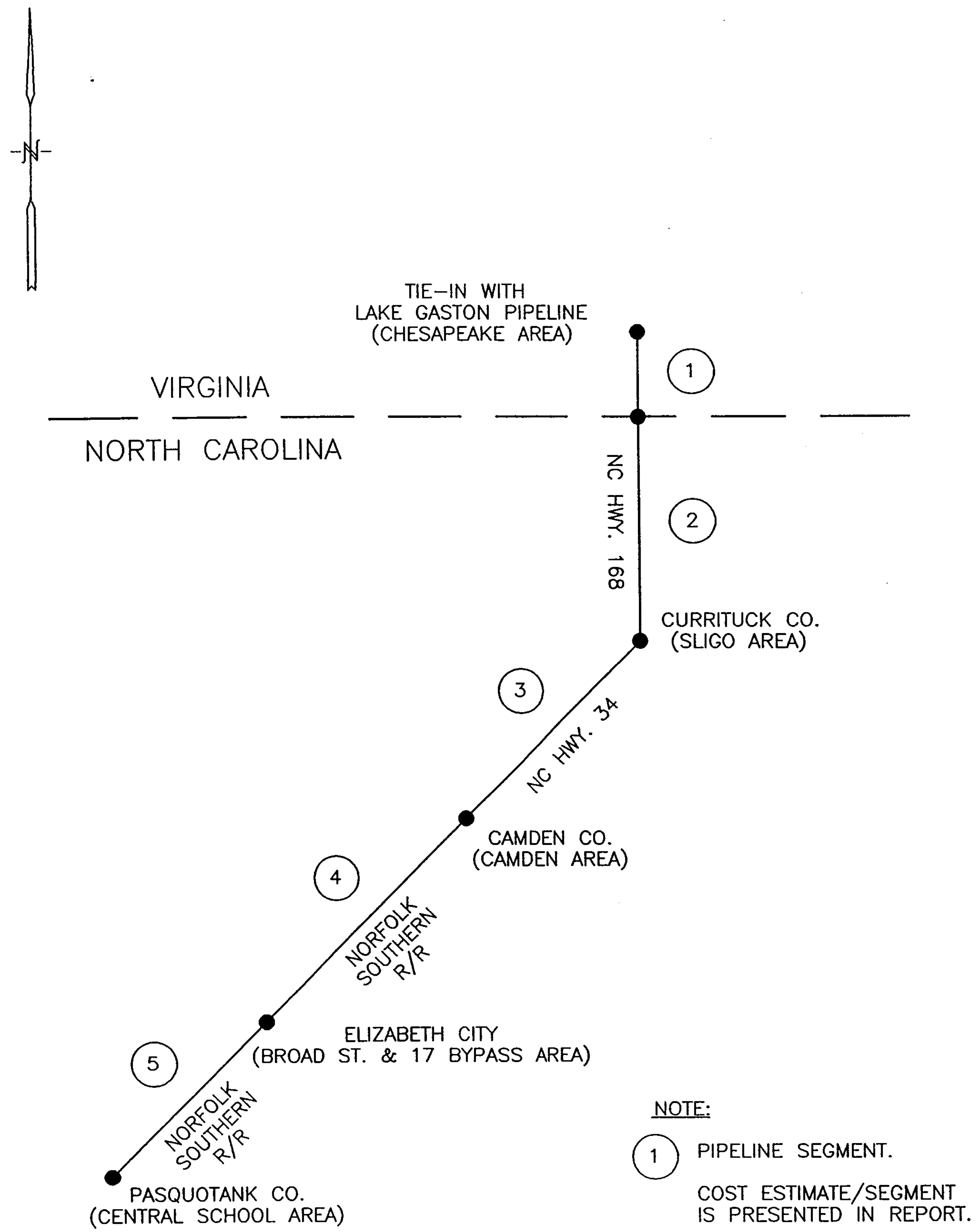
Design Concept:

Water will be obtained from the pipeline near Chesapeake, Virginia and brought to a 3 million gallon ground storage tank in northern Currituck County. Here treatment will be provided at a new 10 mgd water treatment plant. A booster pump station will force treated water through the distribution system to selected points of delivery (shown in schematic). At each point of delivery, a ground storage tank, meter vault and booster pump station will be installed to maintain water levels in each participant's elevated storage tank.

The transmission main is broken into segments extending between points of delivery. Cost to each participant is based on percent capacity of each segment from the Virginia tie-in to their point of delivery.

Operation and Maintenance costs for Scenario 1 are derived as follows:

Power	$0.14
Chemicals	0.10
Salary	0.05
Maintenance Costs	0.05
Total	$0.34/1000 gallons



NOTE:

(1) PIPELINE SEGMENT.

COST ESTIMATE/SEGMENT IS PRESENTED IN REPORT.

HOBBS, UPCHURCH & ASSOCIATES, P.A.
CONSULTING ENGINEERS
SOUTHERN PINES, NORTH CAROLINA 28387

NORTH CAROLINA PROFESSIONAL SEAL 14996 ENGINEER ERIC T. WEATHERLY

REGIONAL WATER STUDY
ALBEMARLE COMMISSION
HERTFORD, NORTH CAROLINA

DISTRIBUTION SCHEMATIC
SCENARIO 1

DATE	MAY, 1996
DESIGNED	JNJ
DRAWN	DMS
CHECKED	ETW
SCALE	NTS
FIGURE NO.	6

Transmission Main Cost Estimate:

Segment 1	
21,000 LF 30" Water Main @ $90.00/LF	$1,890,000
500 LF River Crossing @ $350.00/LF	175,000
2,500,000 Gallon Ground Storage Tank	580,000
10 mgd Booster Pump Station	500,000
	$3,145,000
Segment 2	
51,500 LF 30" Water Main @ $90.00/LF	$4,635,000
800 LF River Crossing @ $350.00/LF	280,000
	$4,915,000
Segment 3	
58,200 LF 30" Water Main @ $90.00/LF	$5,238,000
3,500 LF River Crossing @ $350.00/LF	1,225,000
	$6,463,000
Segment 4	
16,600 LF 24" Water Main @ $60.00/LF	$996,000
800 LF River Crossing @ $325.00/LF	260,000
	$1,256,000
Segment 5	
15,000 LF 24" Water Main @ $60.00/LF	$900,000
200 LF River Crossing @ $325.00/LF	65,000
	$965,000

SCENARIO 1

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5
Currituck Co.	10.00%	10.00%	0.00%	0.00%	0.00%
Camden Co.	10.00%	10.00%	11.11%	0.00%	0.00%
Pasquotank Co.	50.00%	50.00%	55.56%	62.59%	100.00%
Elizabeth City	30.00%	30.00%	33.33%	37.50%	0.00%
Dare Co.	0.00%	0.00%	0.00%	0.00%	0.00%
% Currituck Co.	$314,500	$491,500	$0	$0	$0
% Camden Co.	$314,500	$491,500	$718,039	$0	$0
% Pasquotank Co.	$1,572,500	$2,457,500	$3,590,843	$785,000	$965,000
% Elizabeth City	$943,500	$1,474,500	$2,154,118	$471,000	$0
% Dare Co.	$0	$0	$0	$0	$0
	$3,145.00	$4,915,00	$6,463,000	$1,256,000	$965,000

<u>Water Treatment Plant Cost:</u>

10 mgd Water Treatment Plant	=	$8,000,000
Currituck Co. (10%)	=	800,000
Camden Co. (10%)	=	800,000
Elizabeth City (30%)	=	2,400,000
Pasquotank Co. (50%)	=	4,000,000

Total Cost to Participants:

Currituck Co.	
Transmission Main	$806,000
Water Treatment	800,000
300,000 Gallon Ground Storage Tank	167,000
1.0 mgd Booster Pump Station	125,000
Meter Vault	35,000
	$1,933,000
Engineering & Administration (20%)	386,600
Contingencies (10%)	193,300
	$2,512,900
Camden Co.	
Transmission Main	$1,524,100
Water Treatment	800,000
300,000 Gallon Ground Storage Tank	167,000
1.0 mgd Booster Pump Station	125,000
Meter Vault	35,000
	$2,651,100
Engineering & Administration (20%)	530,200
Contingencies (10%)	265,100
	$3,446,400
Elizabeth City	
Transmission Main	$5,043,200
Water Treatment	2,400,000
750,000 Gallon Ground Storage Tank	278,000
3.0 mgd Booster Pump Station	225,000
Meter Vault	50,000
	$7,996,200
Engineering & Administration (20%)	1,599,200
Contingencies (10%)	799,600
	$10,395,000

Pasquotank Co.

Transmission Main	$9,370,900
Water Treatment	4,000,000
1,250,000 Gallon Ground Storage Tank	361,000
5.0 mgd Booster Pump Station	250,000
Meter Vault	50,000
	$14,031,900
Engineering & Administration (20%)	2,806,400
Contingencies (10%)	1,403,200
	$18,241,500
Total Project Cost	$34,595,800

Debt Service: (20 year loan @ 5.15% interest)

Participant	Total Cost		Yearly Debt Service
Currituck Co.:	$2,512,900	==>	204,300/yr
Camden Co.	3,446,600	==>	280,200/yr
Elizabeth City	10,395,000	==>	845,150/yr
Pasquotank Co.	18,241,500	==>	1,483,050/yr

Cost/1000 gallons:

Currituck Co.		
	Debt Service	$0.56
	O& M	0.34
		$0.90
Camden Co.		
	Debt Service	$0.77
	O& M	0.34
		$1.11
Elizabeth City.		
	Debt Service	$0.78
	O& M	0.34
		$1.12
Pasquotank Co.		
	Debt Service	$0.82
	O& M	0.34
		$1.18

SCENARIO 1b

COST/1000 GALLONS DIVIDED EQUALLY

Assigned Demands for Year 2020:

Currituck Co.	=	1.0 mgd
Camden Co.	=	1.0 mgd
Pasquotank Co.	=	3.0 mgd
Elizabeth City	=	5.0 mgd
		10.0 mgd

Design Concept:

The design concept for Scenario 1b is the same as Scenario 1a. This scenario illustrates a different method to calculate the cost per 1000 gallons of water. Instead of calculating the cost per participant based on percent capacity, the cost is divided equally between the participants.

Total Project Cost: = $ 34,595,800

Debt Service: (20 year loan @ 5.15% interest) $ 2,812,650/yr

Cost per/1000 gallons: (based on 10 mgd)

Debt Service	$0.78
O&M	$0.34
	$1.12

Commentary on Scenario 1

- This scenario provides quite low water costs while meeting the projected total water demands of the stated participants; i.e., the regional water supply could virtually replace the existing county and municipal water supply systems.
- The low water costs result from obtaining raw water free of charge from the Lake Gaston pipeline. This is a concession that Virginia has proposed in order to receive approval for the pipeline project. Under the proposal, up to 15 mgd would be returned to northeast North Carolina.
- The feasibility of this scenario rests primarily on the political negotiations (stalemate) lingering over this issue. It is not known the length of time required to resolve this issue and thus when such a project could be executed.
- It was assumed the point of water delivery from Virginia is on Highway 168 approximately 4 miles north of the state line. This is subject to change depending on the location of the Lake Gaston pipeline.

SCENARIO 2a

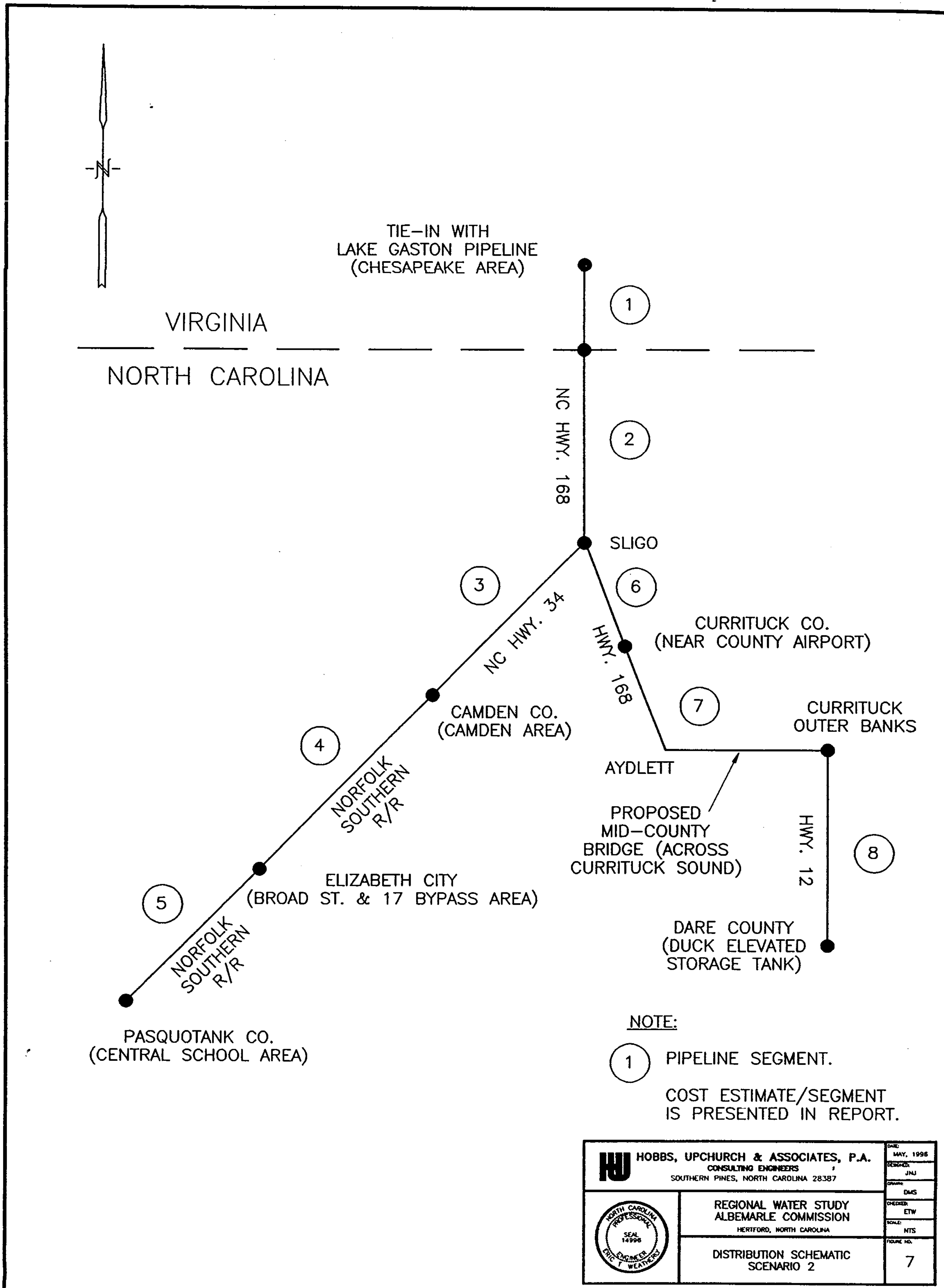
15 mgd raw water obtained from Lake Gaston pipeline at Chesapeake.
Treatment provided in North Carolina at a new 15 mgd plant in Currituck Co.
Service to Currituck Co., Camden Co., Pasquotank Co., Dare Co., & Elizabeth City.

Assigned Demands for Year 2020:

Currituck Co.	=	3.0 mgd (2.0 mgd to Outer Banks)
Camden Co.	=	1.0 mgd
Pasquotank Co.	=	3.0 mgd
Dare Co.	=	3.0 mgd
Elizabeth City	=	5.0 mgd
		15.0 mgd

Design Concept:

The same as Scenario 1a, except that 15 mgd is drawn from Virginia via the Lake Gaston pipeline and distributed amongst the previously served counties as well as Dare Co. The 15 mgd is based on the proposed compromise of returning some Lake Gaston water back to North Carolina, as discussed previously in Section 4. Delivery to the Currituck and Dare County Outer Banks is provided through a 24" subaqueous-installed water main across the Currituck Sound at Aydlett. Operation and Maintenance cost are assumed the same as Scenario 1.



N
TIE-IN WITH
LAKE GASTON PIPELINE
(CHESAPEAKE AREA)
1
VIRGINIA
NORTH CAROLINA
NC HWY. 168
2
SLIGO
3
NC HWY. 34
6
HWY. 168
CURRITUCK CO.
(NEAR COUNTY AIRPORT)
CAMDEN CO.
(CAMDEN AREA)
7
CURRITUCK
OUTER BANKS
4
NORFOLK
SOUTHERN
R/R
AYDLETT
PROPOSED
MID-COUNTY
BRIDGE (ACROSS
CURRITUCK SOUND)
HWY. 12
8
ELIZABETH CITY
(BROAD ST. & 17 BYPASS AREA)
5
NORFOLK
SOUTHERN
R/R
DARE COUNTY
(DUCK ELEVATED
STORAGE TANK)
PASQUOTANK CO.
(CENTRAL SCHOOL AREA)
NOTE:
1 PIPELINE SEGMENT.
COST ESTIMATE/SEGMENT
IS PRESENTED IN REPORT.
HOBBS, UPCHURCH & ASSOCIATES, P.A.
CONSULTING ENGINEERS
SOUTHERN PINES, NORTH CAROLINA 28387
MAY, 1996
JNJ
DMS
ETW
NTS
REGIONAL WATER STUDY
ALBEMARLE COMMISSION
HERTFORD, NORTH CAROLINA
DISTRIBUTION SCHEMATIC
SCENARIO 2
7

Transmission Main Cost Estimate:

Segment 1

21,000 LF 36" Water Main @ $130.00/LF	$ 2,730,000
500 LF River Crossing @ $450.00/LF	225,000
5,000,000 Gallon Ground Storage Tank	945,000
15 mgd Booster Pump Station	750,000
	4,650,000

Segment 2

51,500 LF 36" Water Main @ $130.00/LF	$6,695,000
800 LF River Crossing @ $450.00/LF	360,000
	$7,055,000

Segment 3

58,200 LF 30" Water Main @ $90.00/LF	$5,238,000
3,500 LF River Crossing @ $350.00/LF	1,225,000
	$6,463,000

Segment 4

16,600 LF 30" Water Main @ $90.00/LF	$1,494,000
1,000 LF River Crossing @ $350.00/LF	350,000
	$1,844,000

Segment 5

15,000 LF 24" Water Main @ $60.00/LF	$900,000
200 LF River Crossing @ $325.00/LF	65,000
	$965,000

Segment 6

32,100 LF 24" Water Main @ $60.00/LF	$1,926,000
500 LF River Crossing @ $325.00/LF	162,500
	$2,088,500

Segment 7

52,700 LF 24" Water Main @ $60.00/LF	$3,162,000
23,500 LF Currituck Sound Crossing @ $325.00/LF	7,637,500
5 mgd Booster Pump Station	250,000
	$11,049,500

Segment 8

60,000 LF 20" Water Main @ $55.00/LF	$3,300,000

SCENARIO 2

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8
Currituck Co.	20.00%	20.00%	0.00%	0.00%	0.00%	50.00%	40.00%	0.00%
Camden Co.	7.00%	7.00%	11.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Elizabeth City	20.00%	20.00%	33.00%	38.00%	0.00%	0.00%	0.00%	0.00%
Pasquotank Co.	33.00%	33.00%	56.00%	62.00%	100.00%	0.00%	0.00%	0.00%
Dare Co.	20.00%	20.00%	0.00%	0.00%	0.00%	50.00%	60.00%	100.00%
% Currituck Co.	$930,000	$1,411,000	$0	$0	$0	$1,044,250	$4,419,800	$0
% Camden Co.	$325,500	$493,850	$710,930	$0	$0	$0	$0	$0
% Elizabeth City	$930,000	$1,411,000	$2,132,790	$700,720	$0	$0	$0	$0
% Pasquotank Co.	$1,534,500	$2,328,150	$3,619,280	$1,143,280	$965,000	$0	$0	$0
% Dare Co.	$930,000	$1,411,000	$0	$0	$0	$1,044,250	$6,629,700	$3,300,000
Total Segment $	$4,650,000	$7,055,000	$6,463,000	$1,844,000	$965,000	$2,088,500	$11,049,500	$3,300,000

Water Treatment Plant Cost:

15 mgd Water Treatment Plant	=	$12,000,000
Currituck Co. (20%)	=	2,400,000
Camden Co. (7%)	=	840,000
Elizabeth City (20%)	=	2,400,000
Pasquotank Co. (33%)	=	3,960,000
Dare Co. (20%)	=	2,400,000

Total Cost to Participants

Currituck Co.

Transmission Main	$7,805,100
Water Treatment	2,400,000
300,000 Gallon Ground Storage Tank	167,000
1.0 mgd Booster Pump Station	125,000
1.0 mgd Meter Vault	35,000
500,000 Gallon Ground Storage Tank	229,000
2.0 mgd Booster Pump Station	200,000
2.0 mgd Meter Vault	40,000
	$11,001,100
Engineering & Administration (20%)	2,200,300
Contingencies (10%)	1,100,100
	$14,301,500

Camden Co.

Transmission Main	$1,530,300
Water Treatment	840,000
300,000 Gallon Ground Storage Tank	167,000
1.0 mgd Booster Pump Station	125,000
Meter Vault	35,000
	$2,697,300
Engineering & Administration (20%)	539,500
Contingencies (10%)	269,700
	$3,506,500

Elizabeth City

Transmission Main	$5,174,600
Water Treatment	2,400,000
750,000 Gallon Ground Storage Tank	278,000
3.0 mgd Booster Pump Station	225,000
Meter Vault	50,000
	$8,127,600
Engineering & Administration (20%)	1,625,500
Contingencies (10%)	812,800
	$10,565,900

Pasquotank Co.

Transmission Main	$9,590,300
Water Treatment	3,960,000
1,250,000 Gallon Ground Storage Tank	361,000
5.0 mgd Booster Pump Station	250,000
Meter Vault	50,000
	$14,211,300
Engineering & Administration (20%)	2,842,300
Contingencies (10%)	1,421,200
	$18,474,800

Dare Co.

Transmission Main	$13,315,000
Water Treatment	2,400,000
750,000 Gallon Ground Storage Tank	278,000
3.0 mgd Booster Pump Station	225,000
Meter Vault	50,000
	$16,268,000
Engineering & Administration (20%)	3,253,600
Contingencies (10%)	1,626,800
	$21,148,400

Total Project cost	$67,997,100

Debt Service: (20 year loan @ 5.15% interest)

Participant	Total Cost		Yearly Debt Service
Currituck Co.	$14,301,500	==>	$1,162,750/yr
Camden Co.	3,506,500	==>	285,100/yr
Elizabeth City	10,565,900	==>	859,000/yr
Pasquotank Co.	18,474,800	==>	1,502,000/yr
Dare Co.	21,148,400	==>	$1,719,400/yr

Cost/1000 gallons:

Currituck Co.		
	Debt Service	$1.07
	O& M	0.34
		$1.41
Camden Co.		
	Debt Service	$0.79
	O& M	0.34
		$1.13
Elizabeth City		
	Debt Service	$0.79
	O& M	0.34
		$1.13
Pasquotank Co.		
	Debt Service	$0.82
	O& M	0.34
		$1.16
Dare Co.		
	Debt Service	$1.57
	O& M	0.34
		$1.91

SCENARIO 2b

COST/1000 GALLONS DIVIDED EQUALLY

Assigned Demands:

Currituck Co.	=	3.0 mgd
Camden Co.	=	1.0 mgd
Elizabeth City	=	3.0 mgd
Pasquotank Co.	=	5.0 mgd
Dare Co.	=	3.0 mgd
		15.0 mgd

Total Project Cost: $67,997,100

Debt Service: (20 year loan @ 5.15% interest) $ 5,528,200/yr

Cost/1000 gallons: (Based on 15 mgd)

Debt Service	$1.01
O& M	0.34
	$1.35

Commentary on Scenario 2

- This scenario again provides quite low water costs using essentially "free" water from the Lake Gaston pipeline.
- The projected total water demands for the year 2020 are met for Currituck, Camden and Pasquotank Counties and Elizabeth City. The regional water supply could virtually replace their existing water production systems.
- Dare County is provided a supplemental 3.0 mgd to offset the County's northern Outer Banks demand.
- The same political difficulties discussed in Scenario 1 apply here which adversely affect the feasibility of this project. Additionally, use of Lake Gaston pipeline water means reliance on an outside entity to maintain flow to the region. It is more practical that a water system be independent and self reliant.
- Additional upgrades would be required to the Dare County water infrastructure to utilize the additiional 3.0 mgd.

SCENARIO 3a

Well field installed in Chowan County, producing 6.0 mgd.
Water distribution to Chowan, Perquimans, Pasquotank, Camden and Currituck Counties and Elizabeth City.
Treatment provided at new water treatment plant (WTP) in Chowan County.

Assigned Demands for Year 2020:

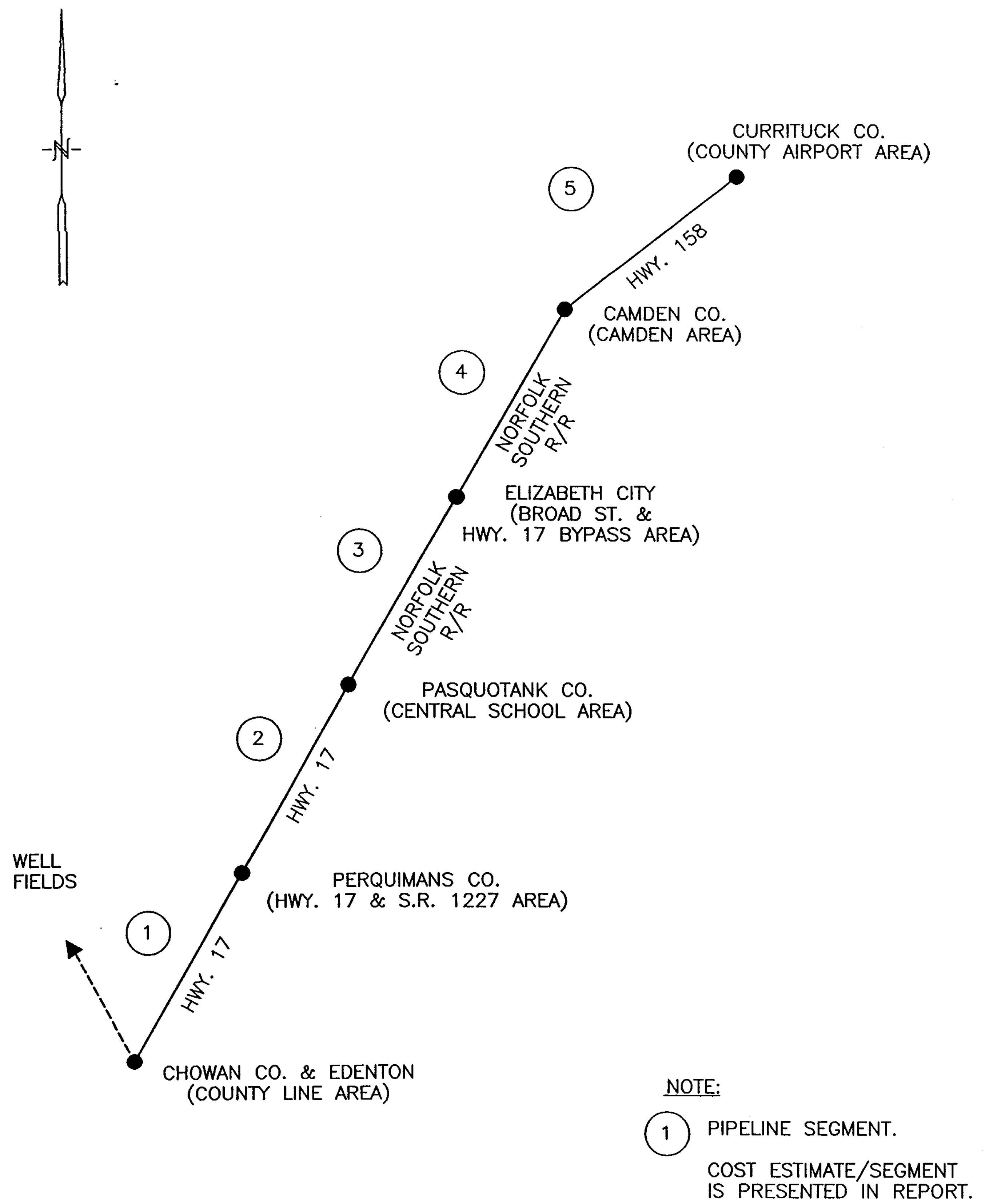
Chowan Co.	=	0.5 mgd
Perquimans Co.	=	0.5 mgd
Pasquotank Co.	=	2.5 mgd
Elizabeth City	=	1.5 mgd
Camden Co.	=	0.5 mgd
Currituck Co.	=	0.5 mgd
		6.0 mgd

Design Concept:

Chowan County reportedly has some very good producing wells, one of which is said to produce in excess of 1000 gpm. Past research indicates potential for high well yields in the Chowan County area. In this scenario, 14 - 600 gpm wells are installed in Chowan County, supplying 6.0 mgd. The water is treated at a new WTP located in the County and distributed to the above participants. Construction of such a well field would necessarily require exploration into the technical feasibility prior to its undertaking.

Operation and Maintenance costs for Scenario 3 are derived as follows:

Power	$0.20
Chemicals	0.10
Salary	0.05
Maintenance Costs	0.10
Total	$0.45/1000 gallons



NOTE:

(1) PIPELINE SEGMENT.

COST ESTIMATE/SEGMENT IS PRESENTED IN REPORT.

WATER SOURCE:
CHOWAN CO. WELLS

HOBBS, UPCHURCH & ASSOCIATES, P.A. CONSULTING ENGINEERS SOUTHERN PINES, NORTH CAROLINA 28387		DATE: MAY, 1996 DESIGNED: JNJ
NORTH CAROLINA PROFESSIONAL SEAL 14996 ENGINEER	REGIONAL WATER STUDY ALBEMARLE COMMISSION HERTFORD, NORTH CAROLINA	DRAWN: DMS CHECKED: ETW SCALE: NTS
	DISTRIBUTION SCHEMATIC SCENARIO 3	FIGURE NO. 8

Transmission Main Cost Estimate:

Segment 1

81,000 LF 24" Water Main @ $60.00/LF	$ 4,860,000
3,300 LF River Crossing @ $325.00/LF	1,072,500
	5,932,500

Segment 2

62,300 LF 24" Water Main @ $60.00/LF	$3,738,000
3,500 LF River Crossings @ $325.00/LF	1,137,500
	$4,875,500

Segment 3

15,000 LF 18" Water Main @ $50.00/LF	$750,000
1,000 LF River Crossings @ $250.00/LF	250,000
	$ 1,000,000

Segment 4

16,600 LF 12" Water Main @ $25.00/LF	$415,000
1,000 LF River Crossings @ $150.00/LF	150,000
	$565,000

Segment 5

49,000 LF 12" Water Main @ $25.00/LF	$1,225,000
3,000 LF River Crossing Pipe @ $150.00/LF	450,000
	$1,675,000

SCENARIO 3

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5
Chowan Co.	0%	0%	0%	0%	0%
Perquimans Co.	9.1%	0%	0%	0%	0%
Pasquotank Co.	45.4%	50.0%	0%	$0	0%
Elizabeth City	27.3%	30.0%	60.0%	$0	0%
Camden Co.	9.1%	10.0%	20.0%	50.0%	0%
Currituck Co.	9.1%	10.0%	20.0%	50.0%	100.0%
Chowan	$0	$0	$0	$0	$0
Perquimans Co.	$539,858	$0	$0	$0	$0
Pasquotank Co.	$2,693,355	$2,437,750	$0	$0	$0
Elizabeth City	$1,619,573	$1,462,650	$600,000	$0	$0
Camden Co.	$539,858	$487,550	$200,000	$282,500	$0
Currituck Co.	$539,858	$487,550	$200,000	$282,500	$1,675,000
TOTAL SEGMENT	$5,932,500	$4,875,500	$1,000,000	$565,000	$1,675,000

Well Field and Water Treatment Plant Cost:

6.0 mgd Water Treatment Plant	$4,000,000
1,500,000 Gallon Ground Storage Tank	422,000
6.0 mgd Booster Pump Station	450,000
2 Test Wells @ $15,000	30,000
14 - 500 gpm Wells @ $150,000	2,100,000
Raw Water Transmission Main	
35,000 LF 24" Water Main @ $60.00/LF	2,100,000
	$9,102,000

Chowan Co. (8.3%)	=	755,500
Perquimans Co. (8.3%)	=	755,500
Pasquotank Co. (41.8%)	=	3,804,500
Elizabeth City (25.0%)	=	2,275,500
Camden Co. (8.3%)	=	755,500
Currituck Co. (8.30%)	=	755,500

Total Cost to Participants

Chowan Co.

Transmission Main	$0.0
Water Production and Treatment	755,500
100,000 Gallon Ground Storage Tank	100,000
0.5 mgd Booster Pump Station	100,000
Meter Vault	30,000
	$ 985,500
Engineering & Administration (20%)	197,100
Contingencies (10%)	98,600
	$1,281,200

Perquimans Co.

Transmission Main	$539,900
Water Production and Treatment	755,500
100,000 Gallon Ground Storage Tank	100,000
0.5 mgd Booster Pump Station	100,000
Meter Vault	30,000
	$ 1,525,400
Engineering & Administration (20%)	305,100
Contingencies (10%)	152,600
	$1,983,100

Pasquotank Co.

Transmission Main	$5,131,100
Water Production and Treatment	3,804,500
600,000 Gallon Ground Storage Tank	250,000
2.5 mgd Booster Pump Station	300,000
Meter Vault	45,000
	$ 9,530,600
Engineering & Administration (20%)	1,906,100
Contingencies (10%)	953,100
	$12,389,800

Elizabeth City

Transmission Main	$3,682,300
Water Production and Treatment	2,275,500
400,000 Gallon Ground Storage Tank	198,000
1.5 mgd Booster Pump Station	180,000
Meter Vault	40,000
	$ 6,375,800
Engineering & Administration (20%)	1,275,200
Contingencies (10%)	673,600
	$8,288,600

Camden Co.

Transmission Main	$1,509,900
Water Production and Treatment	755,500
100,000 Gallon Ground Storage Tank	100,000
0.5 mgd Booster Pump Station	100,000
Meter Vault	30,000
	$ 2,495,400
Engineering & Administration (20%)	499,100
Contingencies (10%)	249,600
	$3,244,100

Currituck Co.

Transmission Main	$3,185,000
Water Production and Treatment	755,500
100,000 Gallon Ground Storage Tank	100,000
0.5 mgd Booster Pump Station	100,000
Meter Vault	30,000
	$ 4,170,500
Engineering & Administration (20%)	834,100
Contingencies (10%)	417,100
	$5,421,700

Total Project Cost	$32,608,500

Debt Service: (20 year loan @ 5.15% interest)

Participant	Total Cost		Yearly Debt Service
Chowan Co.	$ 1,281,200	=	$ 104,200/yr
Perquimans Co.	1,983,100	=	161,300/yr
Pasquotank Co.	12,389,800	=	1,007,300/yr
Elizabeth City	8,288,600	=	673,900/yr
Camden Co.	3,244,100	=	263,800/yr
Currituck Co.:	5,421,700	=	440,800/yr

Cost/1000 gallons:

Chowan Co.		
	Debt Service	$0.58
	O& M	0.45
		$1.03
Perquimans Co.		
	Debt Service	$0.89
	O& M	0.45
		$1.34
Pasquotank Co.		
	Debt Service	$1.11
	O& M	0.45
		$1.56
Elizabeth City.		
	Debt Service	$1.24
	O& M	0.45
		$1.69
Camden Co.		
	Debt Service	$1.45
	O& M	0.45
		$1.90
Currituck Co.		
	Debt Service	$2.42
	O& M	0.45
		$2.87

SCENARIO 3b

COST/1000 GALLONS DIVIDED EQUALLY

Assigned Demands for Year 2020:

Chowan Co.	=	0.5 mgd
Perquimans Co.	=	0.5 mgd
Pasquotank Co.	=	2.5 mgd
Elizabeth City	=	1.5 mgd
Camden Co.	=	0.5 mgd
Currituck Co.	=	0.5 mgd
		6.0 mgd

Total Project Cost:	$32,608,500
Debt Service: (20 year loan @ 5.15% interest)	$ 2,651,100/yr

Cost/1000 gallons: (Based on 6.0 mgd)

Debt Service	$1.22
O& M	0.45
	$1.67

Commentary on Scenario 3

- This scenario provides a supplemental amount of water to each of the participants. In order to met projected demands for 2020, each participant would necessarily have to continue operating their water treatment facilities. (Camden County would continue purchasing water). However, the supplemental regional supply would allow for wells and treatment plants to be "throttled back" to comfortable, easily maintained levels.

- A liberal flow rate per well (600 gpm) based on limited existing research was chosen for this scenario. It is not known whether flow rates this high can be achieved. Lower actual flow rates would necessitate installation of more wells and raw water piping, raising the cost of water. Hydrogeologic investigation would be necessary to determine actual potential flow rates prior to final design of such a project.

- The feasibility of such a project would also hinge on political and community willingness to distribute water out of the county.

SCENARIO 4a

20.0 mgd obtained from mine dewatering operation at PCS Phosphate. Treatment provided by new water treatment plant near Aurora.
Treated water is distributed through Beaufort, Washington, Chowan, Perquimans, Pasquotank, Camden, Currituck and Dare Counties.

Assigned Demands for Year 2020:

Beaufort Co.	=	1.5 mgd
Washington Co.	=	0.5 mgd
Chowan Co.	=	1.5 mgd
Perquimans Co.	=	1.5 mgd
Pasquotank Co.	=	5.0 mgd
Elizabeth City	=	3.0 mgd
Camden Co.	=	1.0 mgd
Currituck Co.	=	3.0 mgd (2.0 mgd to Outer Banks)
Dare	=	3.0 mgd
		20.0 mgd

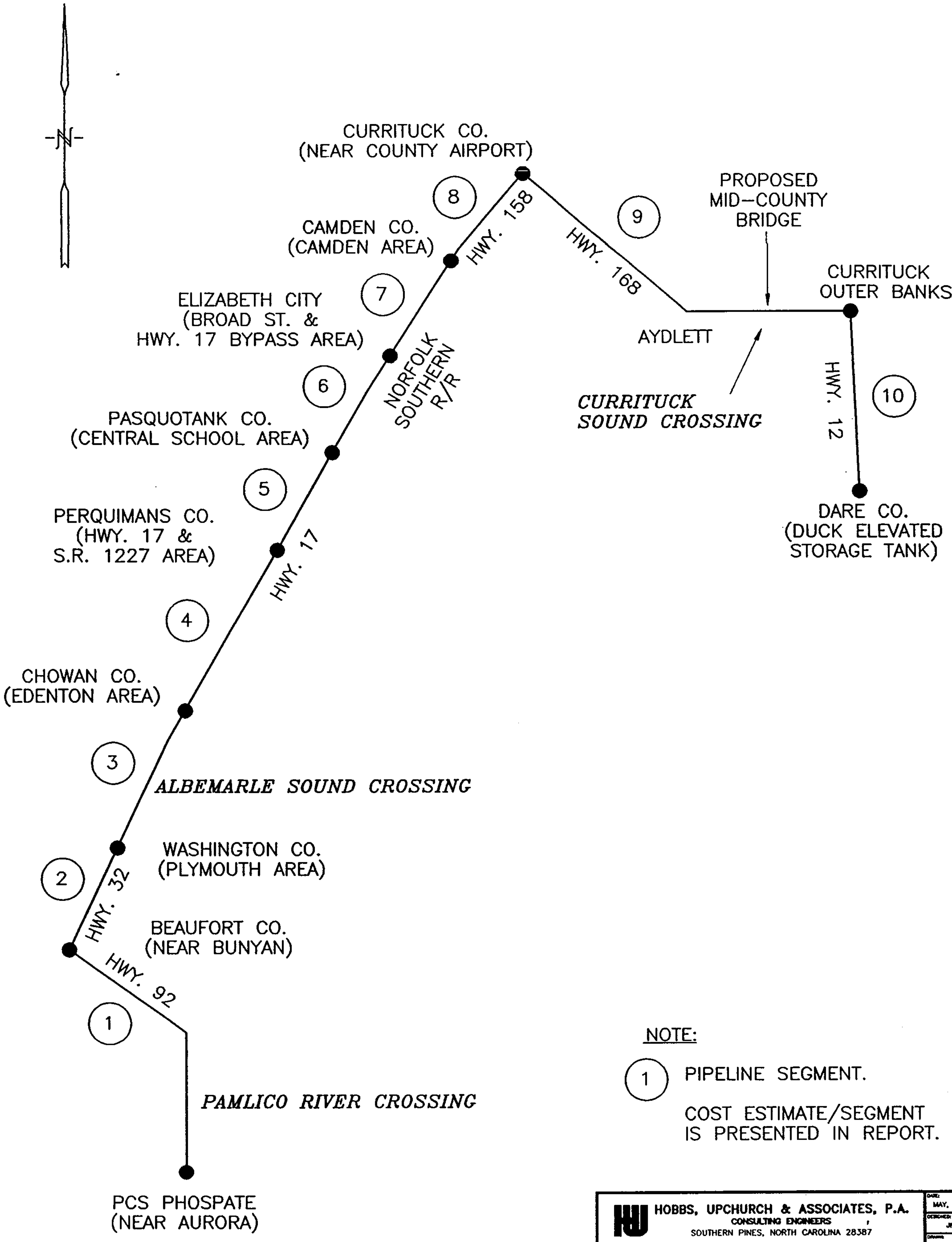
Design Concept:

PCS Phosphate generates approximately 30 mgd of good quality groundwater through dewatering and depressurizing activities. PCS is permitted for up to 70 mgd groundwater withdrawal. The depressurizing water (DPW) flows through open channels, discharging approximately 20 mgd of unused water into the Pamlico River.

In this design concept, a collection basin is constructed in a downstream position on the DPW channel. Treatment provided by new 20 mgd plant; booster pumps will charge the distribution main and transport water to northeastern North Carolina participants.

Operation and maintenance costs for Scenario 4 are derived as follows:

Power	$0.20
Chemicals	0.10
Salary	0.05
Maintenance Costs	0.05
Total	$0.45/1000 gallons



HOBBS, UPCHURCH & ASSOCIATES, P.A.
CONSULTING ENGINEERS
SOUTHERN PINES, NORTH CAROLINA 28387

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 14996 ERIC T. WEATHERLY

REGIONAL WATER STUDY
ALBEMARLE COMMISSION
HERTFORD, NORTH CAROLINA

DISTRIBUTION SCHEMATIC
SCENARIO 4

DATE:	MAY, 1996
DESIGNED:	JNJ
DRAWN:	DMS
CHECKED:	ETW
SCALE:	NTS
FIGURE NO.	9

Transmission Main Cost Estimate:

Segment 1	
81,500 LF 48" Water Main @ $175.00/LF	$ 14,262,500
21,000 LF River Crossing @ $500.00/LF	10,500,000
	24,762,500
Segment 2	
140,700 LF 48" Water Main @ $175.00/LF	$24,622,500
Segment 3	
63,700 LF 42" Water Main @ $155.00/LF	$9,873,500
27,700 LF River Crossings @ $450.00/LF	12,465,000
	$23,338,500
Segment 4	
80,600 LF 42" Water Main @ $155.00/LF	$12,493,000
3,300 LF River Crossings @ $450.00/LF	1,485,500
	$13,978,000
Segment 5	
62,300 LF 42" Water Main @ $155.00/LF	$9,656,500
3,500 LF River Crossings @ $450.00/LF	1,575,000
	$11,231,500
Segment 6	
15,000 LF 30" Water Main @ $90.00/LF	$1,350,000
1,000 LF River Crossing Pipe @ $350.00/LF	350,000
	$1,700,000
Segment 7	
16,600 LF 30" Water Main @ $90.00/LF	$1,494,000
1,000 LF River Crossing Pipe @ $350.00/LF	350,000
	$1,844,000
Segment 8	
49,000 LF 24" Water Main @ $60.00/LF	$2,940,000
3,000 LF River Crossing Pipe @ $325.00/LF	975,000
	$4,015,000

Segment 9

57,000 LF 24" Water Main @ $60.00/LF	$3,420,000
24,000 LF Currituck Sound Crossing Pipe @ $325.00/LF	7,800,000
5 mgd Booster Pump Station	250,000
	$11,470,000

Segment 10

60,000 LF 20" Water Main @ $55.00/LF	$3,300,000

SCENARIO 4

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9	Segment 10
Beaufort Co.	7.5%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Washington Co.	2.5%	2.8%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Chowan Co.	7.5%	8.1%	8.3%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Perquimans Co.	7.5%	8.1%	8.3%	9.4%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Pasquotank Co.	25.0%	27.0%	27.8%	30.0%	33.0%	0.00%	0.00%	0.00%	0.00%	0.00%
Elizabeth City	15.0%	16.2%	16.7%	18.2%	20.0%	30.0%	0.00%	0.00%	0.00%	0.00%
Camden Co.	5.0%	5.4%	5.5%	6.0%	7.0%	10.0	14.0%	0.00%	0.00%	0.00%
Currituck Co.	15.0%	16.2%	16.7%	18.2%	20.0%	30.0%	43.0%	50.0%	40.0%	0.00%
Dare Co.	15.0%	16.2%	16.7%	18.2%	20.0%	30.0%	43.0%	50.0%	60.0%	100.00%
% Beaufort Co.	$1,857,188	$0	$0	$0	$0	$0	$0	$0	$0	$0
% Washington Co.	$619,063	$689,430	$0	$0	$0	$0	$0	$0	$0	$0
% Chowan Co.	$1,857,188	$1,994,423	$1,937,096	$0	$0	$0	$0	$0	$0	$0
% Perquimans Co.	$1,857,188	$1,994,423	$1,937,096	$1,313,932	$0	$0	$0	$0	$0	$0
% Pasquotank Co.	$6,190,625	$6,648,075	$6,488,103	$4,193,400	$3,706,395	$0	$0	$0	$0	$0
% Elizabeth City	$3,714,375	$3,988,845	$3,897,530	$2,543,996	$2,246,300	$510,000	$0	$0	$0	$0
% Camden Co.	$1,238,125	$1,329,615	$1,283,618	$838,680	$786,205	$170,000	$258,160	$0	$0	$0
% Currituck Co.	$3,714,375	$3,988,845	$3,897,530	$2,543,996	$2,246,300	$510,000	$792,920	$2,007,500	$4,588,000	$0
% Dare Co.	$3,714,375	$3,988,845	$3,897,530	$2,543,996	$2,246,300	$510,000	$792,920	$2,007,500	$6,882,000	$3,300,000
Total Segment $	$24,762,500	$24,622,500	$23,338,500	$13,978,000	$11,231,500	$1,700,000	$1,844,000	$4,015,000	$11,470,000	$3,300,000

Water Treatment Plant Cost:

20 mgd Water Treatment Plant (with softening bypass)	$18,000,000
Piping, Pumps, Power Transformers	9,500,000
5 MG Ground Storage Tank	945,000
Pumping Station (pumps, motors, control valves)	1,700,000
Chemical Feed Station	280,000
Emergency Power	350,000
SCADA System	300,000
	$30,130,000

Cost Distribution

Beaufort Co. (7.5%)	=	$2,259,800
Washington Co. (2.5%)	=	753,300
Chowan Co. (7.5%)	=	2,259,800
Perquimans Co. (7.5%)	=	2,259,800
Pasquotank Co. (25%)	=	7,532,500
Elizabeth City (15%)	=	4,519,500
Camden Co. (5.0%)	=	1,506,500
Currituck Co. (15%)	=	4,519,500
Dare Co. (15%)	=	4,519,500
		$30,130,000

Total Cost to Participants:

Beaufort Co.

Transmission Main	$1,857,200
Water Production and Treatment	2,259,800
500,000 Gallon Ground Storage Tank	229,000
1.5 mgd Booster Pump Station	165,000
Meter Vault	40,000
	$ 4,551,000
Engineering & Administration (20%)	910,200
Contingencies (10%)	455,100
	$5,916,300

Washington Co.

Transmission Main	$1,308,500
Water Production and Treatment	753,300
200,000 Gallon Ground Storage Tank	145,000
0.5 mgd Booster Pump Station	100,000
Meter Vault	35,000
	$ 2,341,800
Engineering & Administration (20%)	468,400
Contingencies (10%)	234,200
	$3,044,400

Chowan Co.

Transmission Main	$5,789,000
Water Production and Treatment	2,259,800
500,000 Gallon Ground Storage Tank	229,000
1.5 mgd Booster Pump Station	165,000
Meter Vault	40,000
	$ 8,482,800
Engineering & Administration (20%)	1,696,600
Contingencies (10%)	848,300
	$11,027,700

Perquimans Co.

Transmission Main	$7,103,000
Water Production and Treatment	2,259,800
500,000 Gallon Ground Storage Tank	229,000
1.5 mgd Booster Pump Station	165,000
Meter Vault	40,000
	$ 9,796,800
Engineering & Administration (20%)	1,959,400
Contingencies (10%)	979,700
	$12,735,900

Pasquotank Co.

Transmission Main	$27,227,000
Water Production and Treatment	7,532,500
1,250,000 Gallon Ground Storage Tank	361,000
5.0 mgd Booster Pump Station	250,000
Meter Vault	50,000
	$ 35,420,500
Engineering & Administration (20%)	7,084,100
Contingencies (10%)	3,542,100
	$46,046,700

Elizabeth City

Transmission Main	$16,901,000
Water Production and Treatment	4,519,500
750,000 Gallon Ground Storage Tank	278,000
3.0 mgd Booster Pump Station	225,000
Meter Vault	50,000
	$ 21,973,500
Engineering & Administration (20%)	4,394,700
Contingencies (10%)	2,197,400
	$28,565,600

Camden Co.

Transmission Main	$5,904,500
Water Production and Treatment	1,506,500
300,000 Gallon Ground Storage Tank	225,000
1.0 mgd Booster Pump Station	125,000
Meter Vault	35,000
	$ 7,796,000
Engineering & Administration (20%)	1,559,200
Contingencies (10%)	779,600
	$10,134,800

Currituck Co.

Transmission Main	$24,289,500
Water Production and Treatment	4,519,500
300,000 Gallon Ground Storage Tank	167,000
1.0 mgd Booster Pump Station	125,000
1.0 mgd Meter Vault	35,000
500,000 Gallon Ground Storage Tank	229,000
2.0 mgd Booster Pump Station	200,000
2.0 mgd Meter Vault	40,000
	$ 29,605,000
Engineering & Administration (20%)	5,921,000
Contingencies (10%)	2,960,500
	$38,486,500

Dare Co.

Transmission Main	$29,883,500
Water Production and Treatment	4,519,500
750,000 Gallon Ground Storage Tank	278,000
3.0 mgd Booster Pump Station	225,000
Meter Vault	50,000
	$ 34,956,000
Engineering & Administration (20%)	6,991,200
Contingencies (10%)	3,495,600
	$45,442,800

Total Project Cost	$201,400,800

Debt Service: (20 year loan @ 5.15% interest)

Participant	Total Cost		Yearly Debt Service
Beaufort Co.	$ 5,916,300	=	$ 480,800/yr
Washington Co.	3,044,400	=	247,400/yr
Chowan Co.	11,027,700	=	896,200/yr
Perquimans Co.	12,735,900	=	1,035,000/yr
Pasquotank Co.	46,046,800	=	3,742,100/yr
Elizabeth City	28,565,600	=	2,321,500/yr
Camden Co.	10,134,800	=	823,700/yr
Currituck Co.:	38,486,500	=	3,128,950/yr
Dare Co.	45,442,800	=	3,693,000/yr

Cost/1000 gallons:

Beaufort Co.		
	Debt Service	$0.89
	O& M	0.45
		$1.34
Washington Co.		
	Debt Service	$1.36
	O& M	0.45
		$1.81
Chowan Co.		
	Debt Service	$1.64
	O& M	0.45
		$2.09
Perquimans Co.		
	Debt Service	$1.89
	O& M	0.45
		$2.34
Pasquotank Co.		
	Debt Service	$2.05
	O& M	0.45
		$2.50
Elizabeth City		
	Debt Service	$2.12
	O& M	0.45
		$2.57

Camden Co.		
	Debt Service	$2.26
	O& M	<u>0.45</u>
		$2.71
Currituck Co.		
	Debt Service	$2.86
	O& M	<u>0.45</u>
		$3.31
Dare Co.		
	Debt Service	$3.38
	O& M	<u>0.45</u>
		$3.83

SCENARIO 4b

COST/1000 GALLONS DIVIDED EQUALLY

Assigned Demands for Year 2020:

Beaufort Co.	=	1.5 mgd
Washington Co.	=	0.5 mgd
Chowan Co.	=	1.5 mgd
Perquimans Co.	=	1.5 mgd
Pasquotank Co.	=	5.0 mgd
Elizabeth City	=	3.0 mgd
Camden Co.	=	1.0 mgd
Currituck Co.	=	3.0 mgd (2.0 mgd to Outer Banks)
Dare Co.	=	3.0 mgd
		20.0 mgd

Total Project Cost: $201,400,800

Debt Service: (20 year loan @ 5.5%) $ 16,373,900/yr

Cost/1000 gallons:(based on 20 mgd)

Debt Service	$2.25
O& M	0.45
	$2.70

Commentary on Scenario 4

- This scenario meets the projected total demands for 2020 for Currituck, Chowan, Perquimans, Camden and Pasquotank Counties and Elizabeth City. These counties could virtually shut down their water production facilities and utilize solely regionally supplied water.

- A supplemental amount is provided to Beaufort, Washington and Dare Counties. These counties could "throttle back" their water production facilities to comfortable, easily maintained levels.

- The primary difficulty with this scenario is again political. Community willingness and questions of interbasin transfer could inhibit such a project. Arrangements between PCS Phosphate and a regional water system would need to be forwarded. Additionally, it is not known how long PCS Phosphate will mine this area and, thus, operate the dewatering facility.

- The issue of self reliance exists here as with the Lake Gaston pipeline scenarios.

SCENARIO 5a

10.5 mgd ultimate available capacity from a well field system along Hwy 37 beginning in Winfall and proceeding north toward Gates County. Wells screened in the Yorktown aquifer.

Assigned Demands for Year 2020:

Pasquotank Co.	=	5.0 mgd
Camden Co.	=	1.0 mgd
Currituck Co.	=	1.0 mgd
Perquimans Co.	=	0.5 mgd
Elizabeth City	=	3.0 mgd
		10.5 mgd

Design Concept:

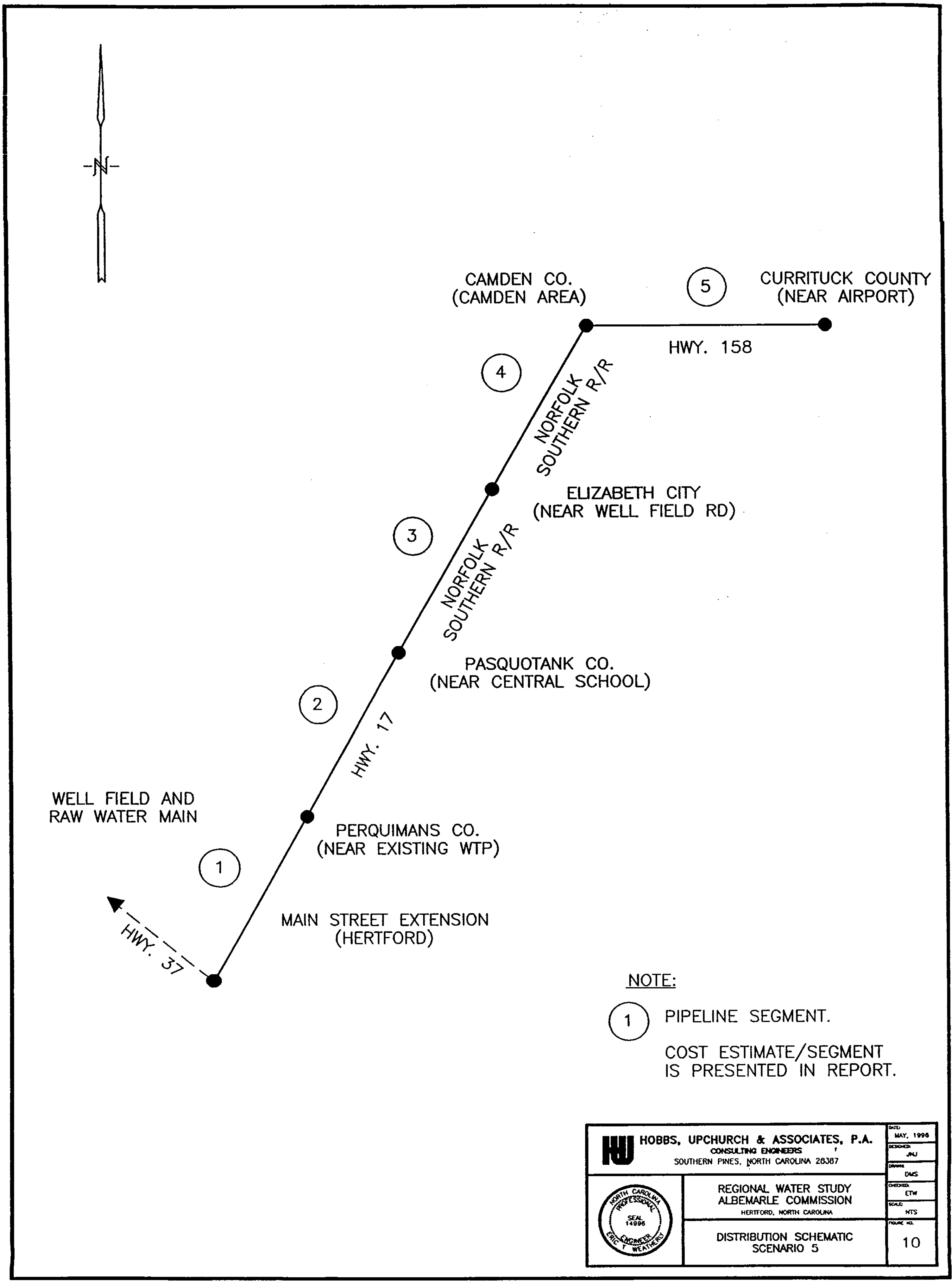
Water quality and available quantity from wells in the Yorktown is better here than areas to the east. A flow of 600 gpm per well is assumed for this scenario with well spacing at 2500 feet. A raw water main of the required length will be constructed along Hwy 37 with a proposed treatment facility near Winfall.

The 10.5 mgd water treatment facility will contain conventional iron removal and water softening equipment. A transmission main will be constructed along Hwy 17 to each point of delivery.

Operation and maintenance costs for Scenario 4 are derived as follows:

Power	$0.20
Chemicals	0.25
Salary	0.05
Maintenance Costs	0.05
Total	$0.55/1000 gallons

NOTE: The assumed well flow of 600 gpm is very liberal. Actual flow rates in this area lie in the 200 gpm range. It was assumed that improved well construction in a basal Yorktown gravel could produce better flow rates. FURTHERMORE, the feasibility of this scenario may be questionable since community opinion may be against distributing a greater percentage of Perquimans County water out of the county.


N
CAMDEN CO.
(CAMDEN AREA)
5
CURRITUCK COUNTY
(NEAR AIRPORT)
HWY. 158
4
NORFOLK SOUTHERN R/R
ELIZABETH CITY
(NEAR WELL FIELD RD)
3
NORFOLK SOUTHERN R/R
PASQUOTANK CO.
(NEAR CENTRAL SCHOOL)
2
HWY. 17
WELL FIELD AND
RAW WATER MAIN
PERQUIMANS CO.
(NEAR EXISTING WTP)
1
MAIN STREET EXTENSION
(HERTFORD)
HWY. 37
NOTE:
1 PIPELINE SEGMENT.
COST ESTIMATE/SEGMENT
IS PRESENTED IN REPORT.
HOBBS, UPCHURCH & ASSOCIATES, P.A.
CONSULTING ENGINEERS
SOUTHERN PINES, NORTH CAROLINA 28387
REGIONAL WATER STUDY
ALBEMARLE COMMISSION
HERTFORD, NORTH CAROLINA
DISTRIBUTION SCHEMATIC
SCENARIO 5
NORTH CAROLINA PROFESSIONAL SEAL 14996 ENGINEER ERIC T. WEATHERLY
MAY, 1996
JNJ
DMS
ETW
NTS
10

Transmission Main Cost Estimate:

Segment 1

11,600 LF 36" Water Main @ $130.00/LF	$ 1,508,000

Segment 2

63,700 LF 36" Water Main @ $130.00/LF	$ 8,281,000

Segment 3

10,400 LF 24" Water Main @ $60.00/LF	$ 624,000
200 LF 24" River Crossings @ $325.00/LF	65,000
	$ 689,000

Segment 4

22,000 LF 16" Water Main @ $45.00/LF	$ 990,000
1,000 LF 16" River Crossings @ $200.00/LF	200,000
	$ 1,190,000

Segment 5

24,500 LF 16" Water Main @ $45.00/LF	$ 1,102,500
1,500 LF 16" River Crossings @ $200.00/LF	300,000
24,500 LF 12" Water Main @ $25.00/LF	612,500
1,500 LF 12" River Crossings @ $150.00/LF	225,000
	$ 2,240,000

SCENARIO 5

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5
Perquimans Co.	5.00%	0.00%	0.00%	0.00%	0.00%
Pasquotank Co.	47.00%	50.00%	0.00%	0.00%	0.00%
Elizabeth City	28.00%	30.00%	60.00%	0.00%	0.00%
Camden Co.	10.00%	10.00%	20.00%	50.00%	0.00%
Currituck Co.	10.00%	10.00%	20.00%	50.00%	100.00%
% Perquimans Co.	$ 75,400	$0	$0	$0	$0
% Pasquotank Co.	$ 708,760	$4,140,500	$0	$0	$0
% Elizabeth City	$ 422,240	$2,484,300	$413,400	$0	$0
% Camden Co.	$ 150,800	$828,100	$137,800	$595,000	$0
% Currituck Co.	$ 150,800	$828,100	$137,800	$595,000	$2,240,000
Total Segment $	$ 1,508,000	$8,281,000	$689,000	$1,190,000	$2,240,000

Production and Treatment Cost Estimate:

10.5 Water Treatment Plant			=	$ 8,000,000
500,000,000 Ground Storage Tank			=	1,000,000
10.5 MGD Booster Pumping Station			=	500,000
25-600 GPM Wells @ $140,000			=	3,500,000
62,500 LF Raw Water Main				
15,625 LF 30" @ $90.00	=	$1,406,250		
15,625 LF 24" @ $60.00	=	$ 937,500		
15,625 LF 20" @ $55.00	=	$ 859,375		
15,625 LF 16" @ $45.00	=	$ 703,125		
				$ 3,906,250
				$16,907,000

Cost Distribution

Camden Co. (10%)	=	1,690,700
Currituck Co. (10%)	=	1,690,700
Elizabeth City (28%)	=	4,733,960
Pasquotank Co. (47%)	=	7,946,290
Perquimans Co. (5%)	=	845,350
		$16,907,000

Total Cost to Participants:

Camden Co.	
Transmission Main	$1,711,700
Water Production and Treatment	1,690,700
300,000 Gallon Ground Storage Tank	167,000
1.0 mgd Booster Pump Station	125,000
Meter Vault	35,000
	$3,729,400
Engineering & Administration (20%)	745,900
Contingencies (10%)	373,000
	$ 4,848,300
Currituck Co.	
Transmission Main	$ 3,951,700
Water Production and Treatment	1,690,700
300,000 Gallon Ground Storage Tank	167,000
1.0 mgd Booster Pump Station	125,000
Meter Vault	35,000
	$5,969,400
Engineering & Administration (20%)	1,193,900
Contingencies (10%)	597,000
	$ 7,760,300
Elizabeth City	
Transmission Main	$ 3,319,940
Water Production and Treatment	4,733,960
750,000 Gallon Ground Storage Tank	278,000
3.0 mgd Booster Pump Station	225,000
Meter Vault	50,000
	$8,606,900
Engineering & Administration (20%)	1,721,400
Contingencies (10%)	860,700
	$11,189,000

Pasquotank Co.	
Transmission Main	$ 4,849,260
Water Production and Treatment	7,946,290
1,250,000 Gallon Ground Storage Tank	361,000
5.0 mgd Booster Pump Station	250,000
Meter Vault	50,000
	$13,456,550
Engineering & Administration (20%)	2,691,310
Contingencies (10%)	1,345,655
	$17,493,600
Perquimans Co.	
Transmission Main	$ 75,400
Water Production and Treatment	845,350
200,000 Gallon Ground Storage Tank	145,000
0.5 mgd Booster Pump Station	100,000
Meter Vault	35,000
	$1,200,750
Engineering & Administration (20%)	240,150
Contingencies (10%)	120,075
	$1,561,000
TOTAL	$42,852,200

Debt Service: (20 year loan @ 5.15% interest)

Participant	Total Cost		Yearly Debt Service
Camden Co.	$4,848,300	==>	394,200/yr
Currituck Co.:	$7,760,300	==>	630,950/yr
Elizabeth City	11,189,000	==>	909,700/yr
Pasquotank Co.	17,493,600	==>	1,422,250/yr
Perquimans Co.	1,561,000	==>	126,950/yr

Cost/1000 gallons:

Camden Co.		
	Debt Service	$1.08
	O& M	0.55
		$1.63
Currituck Co.		
	Debt Service	$1.73
	O& M	0.55
		$2.28
Elizabeth City		
	Debt Service	$0.84
	O& M	0.55
		$1.39
Pasquotank Co.		
	Debt Service	$0.78
	O& M	0.55
		$1.34
Perquimans Co.		
	Debt Service	$0.70
	O& M	0.55
		$1.25

SCENARIO 5b

COST/1000 GALLONS DIVIDED EQUALLY

Assigned Demands for Year 2020:

Camden Co.	=	1.0 mgd
Currituck Co.	=	1.0 mgd
Elizabeth City	=	3.0 mgd
Pasquotank Co.	=	5.0 mgd
Perquimans Co.	=	0.5 mgd
		10.5 mgd

Total Project Cost: $42,852,200

Debt Service: (20 year loan @ 5.15% interest) $ 3,483,900/yr

Cost/1000 gallons:(based on 10.5 mgd)

Debt Service	$0.91
O& M	0.55
	$1.46

Commentary on Scenario 5

- This scenario would provide the total 2020 demand for Camden County, Pasquotank County, Elizabeth City and the Currituck mainland. Supplemental water supply would be provided to Perquimans County and it's interconnected systems.

- A liberal flow rate per well (600 gpm) based on limited existing research was chosen for this scenario. Actual flow rates of wells in the county are more in the range of 200 gpm. It was assumed that improved well construction in basal Yorktown gravels may achieve significantly higher flow rates. This would need substantiating by hydrogeologic investigation. However, lower flow rates would necessitate installation of more wells and raw water piping, raising the cost of water.

- The feasibility of such a project would also hinge on political and community willingness to distribute water out of the county.

SCENARIO 6a

Well field and RO treatment facility constructed north of Elizabeth City. Wells will be located in the Castle Hayne aquifer.
Distribution to Elizabeth City, Pasquotank, Camden, Currituck and Dare Counties. Service to Currituck and Dare Outer Banks provided by 2-12" water mains attached to the proposed Mid-County bridge at Aydlett.

Assigned Demands for Year 2020:

Elizabeth City	=	3.0 mgd
Pasquotank Co.	=	5.0 mgd
Camden Co.	=	1.0 mgd
Currituck Co.	=	2.0 mgd
Dare Co.	=	2.0 mgd
		13.0 mgd

Design Concept:

A test well into the Castle Hayne aquifer has been piloted with R.O. treatment by Elizabeth City. This information was used to develop a centrally located well field and treatment facility north of Elizabeth City.

A 13.0 MGD RO water treatment plant is proposed in the area of the existing Elizabeth City WTP. The discharge point for saline concentrate is assumed to be on the Pasquotank River south of the Coast Guard Station.

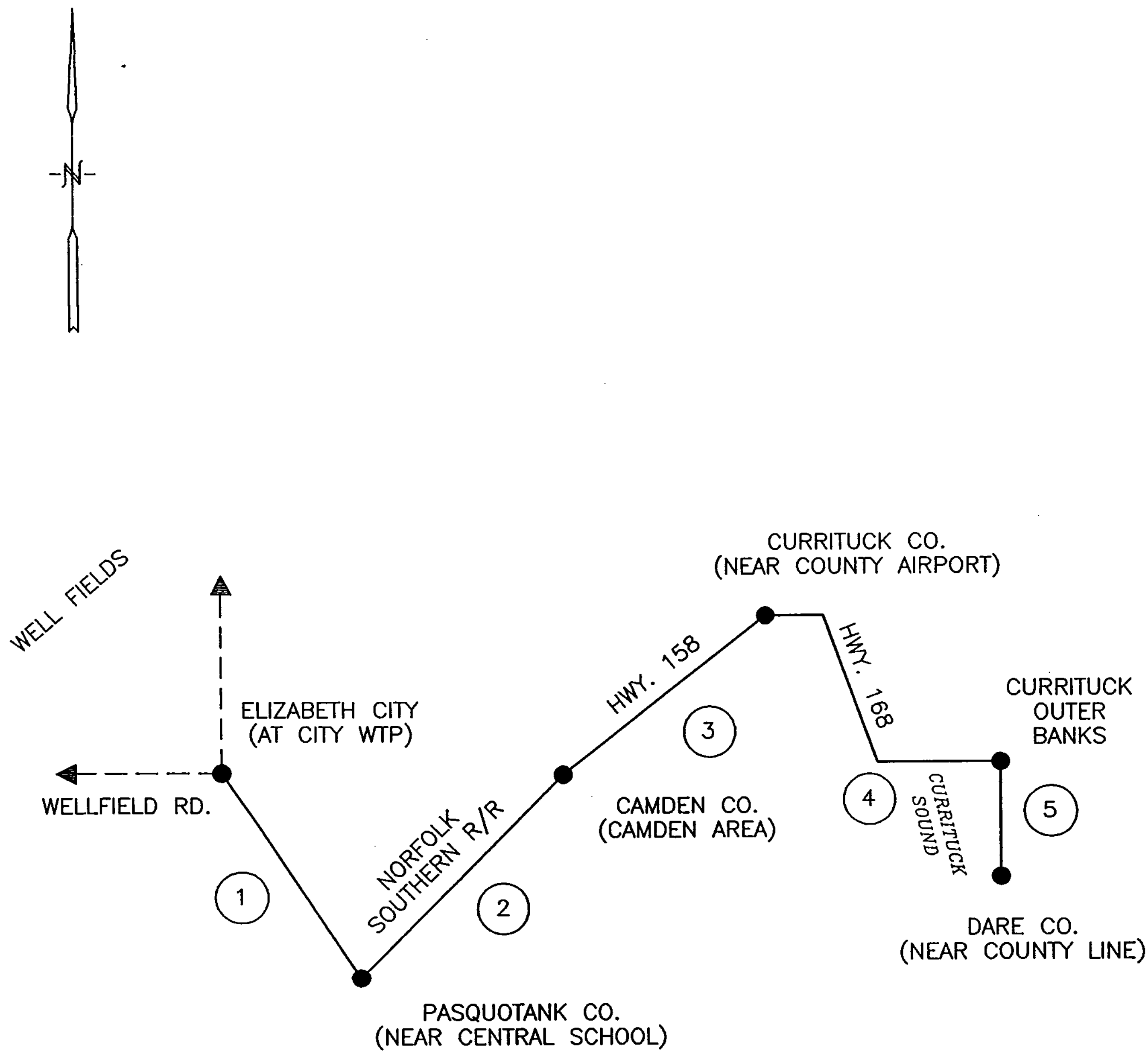
The well field will be installed along roads north and west of the Elizabeth City WTP. Well depths were assumed at 500-550 feet with a well spacing of 2500 feet. Well yield was assumed at 700 gpm each for a total of 35 wells.

Cost of water is presented with 2 phases of construction, providing 50% of demand and then 100% of demand listed above. The well field was broken down with half in the initial phase and the remaining in the final phase. The R.O. treatment facility was sized to 6.5 mgd in the initial phase while the remaining facilities were sized for 13.0 mgd in the initial phase.

NOTE: A hydraulic model for this distribution network is presented at the end of this scenario.

Operation and maintenance costs for Scenario 4 are derived as follows:

Power	
R.O. Process	$0.42
Well Field	0.05
Finished Water	0.10
Chemicals	0.25
Maintenance	0.13
Cartridge Filter Replacement	0.01
Membrane Filter Replacement	0.10
Salary	0.05
Total	$1.11/1000 gallons



NOTE:

(1) PIPELINE SEGMENT.

COST ESTIMATE/SEGMENT
IS PRESENTED IN REPORT.

HOBBS, UPCHURCH & ASSOCIATES, P.A. CONSULTING ENGINEERS SOUTHERN PINES, NORTH CAROLINA 28387		DATE: MAY, 1996
		DESIGNED: JNJ
NORTH CAROLINA PROFESSIONAL SEAL 14996 ENGINEER ERIC T. WEATHERLY	REGIONAL WATER STUDY ALBEMARLE COMMISSION HERTFORD, NORTH CAROLINA	DRAWN: DMS
		CHECKED: ETW
		SCALE: NTS
	DISTRIBUTION SCHEMATIC SCENARIO 6	FIGURE NO. 11

Transmission Main Cost Estimate:

Segment 1

7,600 LF 30" Water Main @ $90.00/LF	$ 684,000

Segment 2

32,400 LF 20" Water Main @ $55.00/LF	$ 1,782,000
1,200 LF 20" River Crossings @ $300.00/LF	360,000
	$ 2,142,000

Segment 3

49,000 LF 18" Water Main @ $50.00/LF	$ 2,450,000
3,000 LF 18" River Crossings @ $250.00/LF	750,000
	$ 3,200,000

Segment 4

53,900 LF 16" Water Main @ $45.00/LF	$ 2,425,500
1,000 LF 16" River Crossings @ $200.00/LF	200,000
23,000 LF 12" Mid-County Bridge Attachment @ $125.00/LF x 2 Pipes	5,750,000
3 mgd (150 hp) Booster Pump Station	250,000
	8,625,500

Segment 5

43,300 LF 16" Water Main @ $45.00/LF	$ 1,948,500

SCENARIO 6

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5
Elizabeth City	0.0%	0.00%	0.0%	0.00%	0.00%
Pasquotank Co.	50.0%	000%	0.0%	0.0%	0.00%
Camden Co.	10.0%	20.0%	0.00%	0.00%	0.00%
Currituck Co.	20.0%	40.0%	50.0%	33.0%	0.00%
Dare Co.	20.0%	40.0%	50.0%	67.0%	100.0%
% Elizabeth City	$0	$0	$0	$0	$0
% Pasquotank Co.	$ 342,000	$0	$0	$0	$0
% Camden Co.	$ 68,400	$428,400	$0	$0	$0
% Currituck Co.	$ 136,800	$856,800	$1,600,000	$2,846,415	$0
% Dare Co.	$ 136,800	$856,800	$1,600,000	$5,779,085	$1,948,500
Total Segment $	$ 684,000	$2,142,000	$ 3,200,000	$8,625,500	$1,948,500

Production and Treatment Cost Estimate: at 100% Build-Out

1. 13 MGD RO Water Treatment Plant			
	a. Membranes	$3,000,000	
	b. Skid Assemblies	2,300,000	
	c. Building	4,500,000	
	d. Electrical	2,500,000	
	e. Instrumentation & Controls	1,000,000	
	f. Booster Pumps	2,300,000	
	g. Degasifier	650,000	
	h. Process Piping	1,000,000	
	i. Yard Piping	1,500,000	
	j. Chemical Storage & Feed	800,000	
	k. Cartridge Filter	350,000	
	l. Membrane Cleaning Equipment	800,000	
	m Site Work	800,000	
	n. Generator	500,000	
			22,000,000
2. 5,000,000 Ground Storage			1,000,000
3. 13 MGD Booster Pump Station			600,000
4. Test Wells (4 @ $60,000)			240,000
5. 700 GPM Wells (35 @ $165,000			5,775,000
6. Raw Water Transmission Main			
	13,000 LF 16" @ $45.00/LF	585,000	
	53,000 LF 20" @ $55.00/LF	2,915,000	
	27,000 LF 24" @ $60.00/LF	1,620,000	
			5,120,000
7. Concentrate Discharge Main			
	53,000 LF 30" @ $90.00/LF	4,770,000	
	Header Assembly	250,000	
			5,020,000
		Total Construction	$39,755,000

Cost Distribution

Elizabeth City. (23.1%)	=	$9,183,400
Pasquotank Co. (38.4%)	=	15,265,900
Camden Co. (7.7%)	=	3,061,100
Currituck Co. (15.4%)	=	6,122,300
Dare Co. (15.4%)	=	6,122,300

Total Cost to Participants:

Elizabeth City	
Transmission Main	$ 0
Water Production and Treatment	9,183,400
750,000 Gallon Ground Storage	278,000
3 MGD Booster Pump Station	225,000
Meter Vault	50,000
	$9,736,400
Engineering & Administration (20%)	1,947,300
Contingencies (10%)	973,700
	$12,657,400
Pasquotank Co.	
Transmission Main	$ 342,000
Water Production and Treatment	15,265,900
1,250,000 Gallon Ground Storage	361,000
5 MGD Booster Pump Station	250,000
Meter Vault	50,000
	$16,268,900
Engineering & Administration (20%)	3,253,800
Contingencies (10%)	1,626,900
	$21,149,600
Camden Co.	
Transmission Main	$ 496,800
Water Production and Treatment	3,061,100
300,000 Gallon Ground Storage	167,000
1 MGD Booster Pump Station	125,000
Meter Vault	35,000
	$3,884,900
Engineering & Administration (20%)	776,900
Contingencies (10%)	388,600
	$ 5,050,400

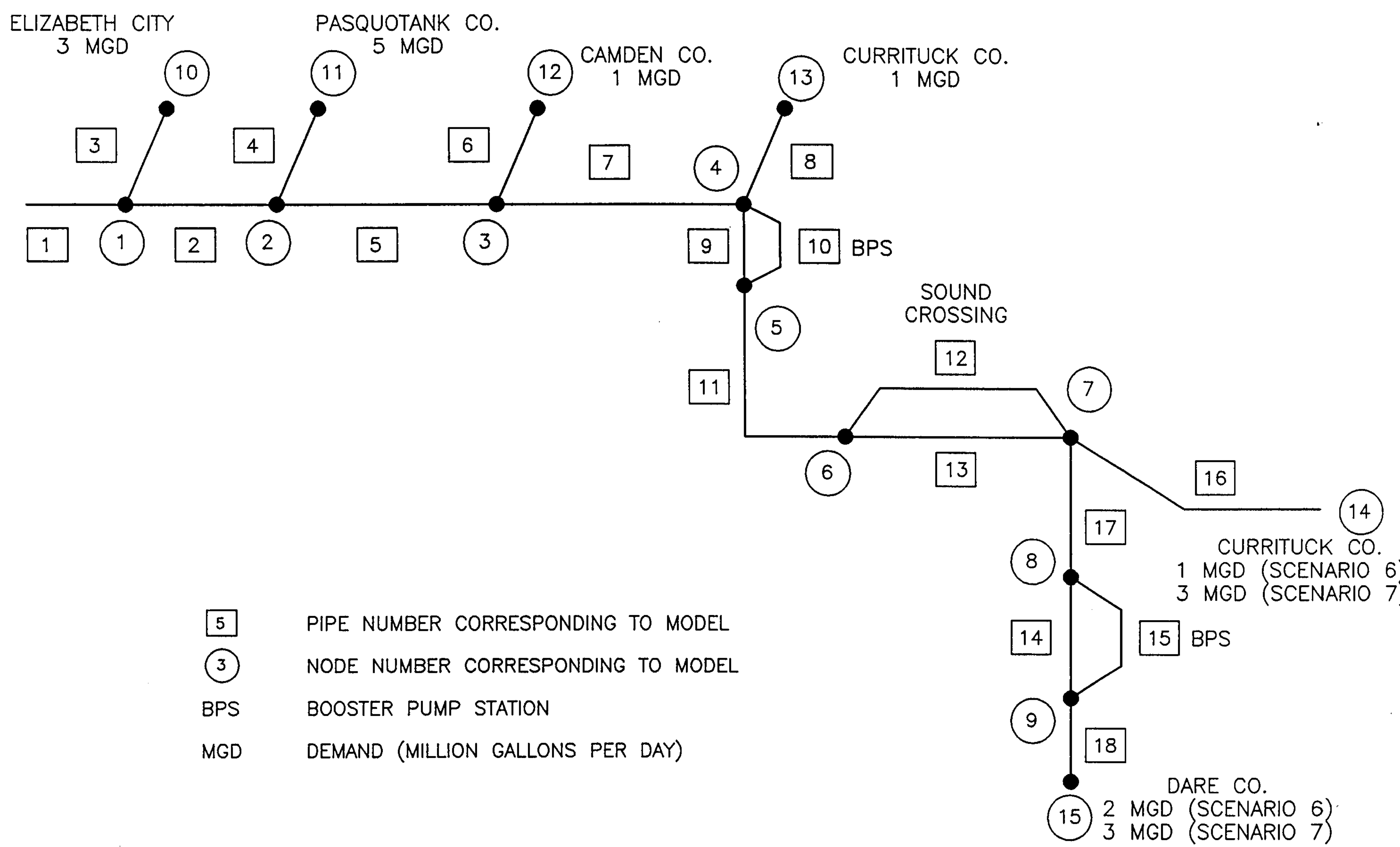
Currituck Co.	
Transmission Main	$ 5,440,000
Water Production and Treatment	6,122,300
2-300,000 Gallon Ground Storage (2 @ $167,000)	334,000
2-1 MGD Booster Pump Station (2 @ $125,000)	250,000
2-Meter Vault (2 @ $35,000)	70,000
	$12,216,300
Engineering & Administration (20%)	2,443,300
Contingencies (10%)	1,221,600
	$ 15,881,200
Dare Co.	
Transmission Main	$ 10,321,200
Water Production and Treatment	6,122,300
2-300,000 Gallon Ground Storage (2 @ $167,000)	229,000
2-1 MGD Booster Pump Station (2 @ $125,000)	250,000
2-Meter Vault (2 @ $35,000)	40,000
	$16,962,500
Engineering & Administration (20%)	3,392,500
Contingencies (10%)	1,696,300
	$ 22,051,300
Total Project Cost	$76,789,900

Debt Service: 20-year loan @ 5.15% interest

Participant	Total Cost		Yearly Debt Service
Elizabeth City	$12,657,400	=	1,029,050/yr
Pasquotank Co.	21,149,600	=	1,719,500/yr
Camden Co.	5,050,400	=	410,600/yr
Currituck Co.:	15,881,200	=	1,291,150/yr
Dare Co.	22,051,300	=	1,792,800/yr

Cost/1000 gallons:

Elizabeth City		
	Debt Service	$0.94
	O& M	1.11
		$2.05
Pasquotank Co.		
	Debt Service	$0.95
	O& M	1.11
		$2.06
Camden Co.		
	Debt Service	$1.13
	O& M	0.11
		$2.24
Currituck Co.		
	Debt Service	$1.77
	O& M	1.11
		$2.88
Dare Co.		
	Debt Service	$2.46
	O& M	1.11
		$3.57



5	PIPE NUMBER CORRESPONDING TO MODEL
(3)	NODE NUMBER CORRESPONDING TO MODEL
BPS	BOOSTER PUMP STATION
MGD	DEMAND (MILLION GALLONS PER DAY)

HOBBS, UPCHURCH & ASSOCIATES, P.A.
CONSULTING ENGINEERS
SOUTHERN PINES, NORTH CAROLINA 28387

REGIONAL WATER STUDY
ALBEMARLE COMMISSION
HERTFORD, NORTH CAROLINA

HYDRAULIC NODE MAP
FOR SCENARIO 6 & 7

DATE: MAY, 1998
DESIGNED: JNJ
DRAWN: DMS
CHECKED: ETW
SCALE: N.T.S.
FIGURE NO. 12

FLOWRATE IS EXPRESSED IN U.S. GPM AND PRESSURE IN PSIG

A SUMMARY OF THE ORIGINAL DATA FOLLOWS

PIPE NO.	NODE NOS.		LENGTH (FEET)	DIAMETER (INCHES)	ROUGHNESS	MINOR LOSS K	FIXED GRADE
1	0	1	1000.0	30.0	140.0	.00	250.00
2	1	2	7600.0	30.0	140.0	.00	
3	1	10	100.0	16.0	140.0	.00	
4	2	11	100.0	20.0	140.0	.00	
5	2	3	33600.0	20.0	140.0	.00	
6	3	12	100.0	12.0	140.0	.00	
7	3	4	52000.0	18.0	140.0	.00	
8	4	13	100.0	12.0	140.0	.00	
9	4	5	100.0	16.0	140.0	.00	

THERE IS A CHECK VALVE IN LINE NUMBER 9

10	4	5	100.0	16.0	140.0	.00	

THERE IS A PUMP IN LINE 10 WITH USEFUL POWER = 110.00

11	5	6	54900.0	16.0	140.0	.00	
12	6	7	24000.0	12.0	140.0	.00	
13	6	7	24000.0	12.0	140.0	.00	
14	8	9	100.0	16.0	140.0	.00	

THERE IS A CHECK VALVE IN LINE NUMBER 14

15	8	9	100.0	16.0	140.0	.00	

THERE IS A PUMP IN LINE 15 WITH USEFUL POWER = 60.00

16	7	14	100.0	12.0	140.0	.00	
17	7	8	43300.0	16.0	140.0	.00	
18	9	15	23500.0	12.0	140.0	.00	

JUNCTION NUMBER	DEMAND	ELEVATION	CONNECTING PIPES			
1	.00	5.00	1	2	3	
2	.00	5.00	2	4	5	
3	.00	3.00	5	6	7	
4	.00	2.00	7	8	9	10
5	.00	2.00	9	10	11	
6	.00	4.00	11	12	13	
7	.00	2.00	12	13	16	17
8	.00	2.00	14	15	17	
9	.00	2.00	14	15	18	
10	2083.00	5.00	3			
11	3472.00	5.00	4			
12	694.00	3.00	6			
13	694.00	2.00	8			
14	694.00	2.00	16			
15	1388.00	138.00	18			

OUTPUT SELECTION: ALL RESULTS ARE OUTPUT EACH PERIOD

THIS SYSTEM HAS 18 PIPES WITH 15 JUNCTIONS , 3 LOOPS AND 1 FGNS

THE RESULTS ARE OBTAINED AFTER 3 TRIALS WITH AN ACCURACY = .00000

PIPE NO.	NODE NOS.		FLOWRATE	HEAD LOSS	PUMP HEAD	MINOR LOSS	VELOCITY	HL/1000
1	0	1	9025.00	1.50	.00	.00	4.10	1.50
2	1	2	6942.00	7.01	.00	.00	3.15	.92
3	1	10	2083.00	.21	.00	.00	3.32	2.12
4	2	11	3472.00	.18	.00	.00	3.55	1.84
5	2	3	3470.00	61.82	.00	.00	3.54	1.84
6	3	12	694.00	.11	.00	.00	1.97	1.12
7	3	4	2776.00	105.72	.00	.00	3.50	2.03
8	4	13	694.00	.11	.00	.00	1.97	1.12
THE CHECK VALVE IN LINE NUMBER 9 IS CLOSED								
10	4	5	2082.00	.21	209.02	.00	3.32	2.12
11	5	6	2082.00	116.27	.00	.00	3.32	2.12
12	6	7	1041.00	57.15	.00	.00	2.95	2.38
13	6	7	1041.00	57.15	.00	.00	2.95	2.38
THE CHECK VALVE IN LINE NUMBER 14 IS CLOSED								
15	8	9	1388.00	.10	171.02	.00	2.21	1.00
16	7	14	694.00	.11	.00	.00	1.97	1.12
17	7	8	1388.00	43.28	.00	.00	2.21	1.00
18	9	15	1388.00	95.34	.00	.00	3.94	4.06

JUNCTION NUMBER	DEMAND	GRADE LINE	ELEVATION	PRESSURE
1	.00	248.50	5.00	105.52
2	.00	241.49	5.00	102.48
3	.00	179.67	3.00	76.56
4	.00	73.94	2.00	31.17
5	.00	282.75	2.00	121.66
6	.00	166.48	4.00	70.41
7	.00	109.33	2.00	46.51
8	.00	66.05	2.00	27.76
9	.00	236.97	2.00	101.82
10	2083.00	248.29	5.00	105.42
11	3472.00	241.30	5.00	102.40
12	694.00	179.55	3.00	76.51
13	694.00	73.83	2.00	31.13
14	694.00	109.22	2.00	46.46
15	1388.00	141.63	138.00	1.57

THE NET SYSTEM DEMAND = 9025.00

SUMMARY OF INFLOWS(+) AND OUTFLOWS(-) FROM FIXED GRADE NODES

PIPE NUMBER	FLOWRATE
1	9025.00

THE NET FLOW INTO THE SYSTEM FROM FIXED GRADE NODES = 9025.00
THE NET FLOW OUT OF THE SYSTEM INTO FIXED GRADE NODES = .00

SCENARIO 6b

Scenario 6b presents water costs at 50% build-out. The distribution network will be built for ultimate capacity but the system will be put on-line with the WTP at one-half capacity. Water delivery is one-half the assigned demand in Scenario 6a.

6.5 MGD Initial Phase

1. 6.5 mgd RO Water Treatment Facility (expandable to 13 MGD)

a.	Membranes	$1,500,000	
b.	Skid Assemblies	1,120,000	
c.	Building	4,000,000	
d.	Electrical	2,000,000	
e.	Instrumentation & Controls	800,000	
f.	Booster Pumps	1,130,000	
g.	Degasifier	650,000	
h.	Process Piping	700,000	
i.	Yard Piping	1,500,000	
j.	Chemical Storage & Feed	600,000	
k.	Cartridge Filter	200,000	
l.	Membrane Cleaning Equipment	500,000	
m	Site Work	800,000	
n.	Generator	500,000	
			17,000,000

2. 5,000,000 Ground Storage		1,000,000
3. 6.5 MGD Booster Pump Station		400,000
4. Test Wells (2 @ $60,000)		120,000
5. 700 GPM Wells (18 @ $165,000		2,970,000
6. Raw Water Transmission Main		
6,500 LF 16" @ $45.00/LF	297,000	
27,000 LF 20" @ $55.00/LF	1,485,000	
14,000 LF 24" @ $60.00/LF	840,000	
		2,622,000
7. Concentrate Discharge Main		
53,000 LF 30" @ $90.00/LF	4,770,000	
Header Assembly	250,000	
		5,020,000
Total Construction		$29,132,000
Engineering & Administration (20%)		5,826 400
Contingencies (10%)		2,913,200
		$ 37,872,000

Debt Service: 20-year loan @ 5.15% interest

Participant	Total Cost		Yearly Debt Service
Elizabeth City	9,458,550	=	$ 769,000/yr
Pasquotank Co.	15,870,100	=	1,290,250/yr
Camden Co.	3,984,150	=	323,950/yr
Currituck Co.:	13,748,700	=	1,117,800/yr
Dare Co.	19,918,800	=	1,619,400/yr

Cost/1000 gallons:

Elizabeth City.		
	Debt Service	$1.41
	O& M	1.11
		$2.52
Pasquotank Co.		
	Debt Service	$1.42
	O& M	1.11
		$2.53
Camden Co.		
	Debt Service	$1.78
	O& M	1.11
		$2.89
Currituck Co.		
	Debt Service	$3.07
	O& M	1.11
		$4.18
Dare Co.		
	Debt Service	$4.44
	O& M	1.11
		$5.55

SCENARIO 6c and 6d

Scenario 6c presents water at 50% and full build-out with the total project cost divided evenly amongst the participants.

50% Initial Phase

Transmission	$25,108,200
Production & Treatment	37,872,000
	$62,980,200

Yearly Debt Service 20-year loan @ 5.15% interest $5,120,300

Cost/1000 gallons:

Debt Service	$2.16
O& M	1.11
	$3.27

100% Build-Out

Transmission	$25,108,200
Production & Treatment	51,681,700
	$76,789,900

Yearly Debt Service 20-year loan @ 5.15% interest $6,243,050

Cost/1000 gallons:

Debt Service	$1.32
O& M	1.11
	$2.43

SCENARIO 6e

Scenario 6e presents water costs if the RO saline concentrate discharge is constructed just south of Knobbs Creek near Roanoke Bible College in Elizabeth City. This would shorten the discharge main by 32,000 LF and would result in a savings in the cost of water.

Saving	=	32,000 LF 30" Water Main @ $90.00/LF	$2,880,000
		Engineering & Administration (20%)	576,000
		Contingencies (10%)	288,000
			$ 3,744,000

Yearly Debt Service (20-year loan @ 5.15% interest) $ 304,400

Savings in Cost/1000 gallons:

at 50% build-out (6.5 mgd):	$0.13
at 100% build-out (13 mgd):	$0.07

Commentary on Scenario 6

- This scenario provides water to meet the total 2020 demand for Elizabeth City, Pasquotank County, Camden County and Currituck mainland. Supplemental amounts of water are provided to the Currituck and Dare County Outer Bank.

- Water is produced from within the area most in need of additional water supply, relieving some of the political pressure and resistance. with the local water source also comes self reliance and independence of water production.

- Water service to the Outer Banks can be provided in conjunction with the proposed Mid-County Bridge, via 2-12" water mains attached to the bridge. This would be less costly than a subaqueous crossing.

- Potential drawbacks to this scenario are the politics of distributing water across county lines and the hydrogeologic unknowns with respect to well construction and well yields. Thorough hydrogeologic investigation must be performed before making final well field designs. If the stated well yields cannot be met or if drawdown cannot be managed in such a large well field, different plans must be made at higher cost, affecting water costs accordingly.

SCENARIO 7a

Scenario 7a presents the same distribution network (see Figure 11, Scenario 6 for schematic) as the previous scenario with the following exceptions:

1. Increased water delivery to Currituck and Dare Outer Banks.
2. Sub-aqueous pipeline (24") across the Currituck Sound..
3. 16 mgd water treatment plant (WTP).

A hydraulic model is provided at the end of this scenario.

Assigned Demands for Year 2020:

Elizabeth City	=	3.0 mgd	
Pasquotank Co.	=	5.0 mgd	
Camden Co.	=	1.0 mgd	
Currituck Co.	=	4.0 mgd	(3.0 mgd to Outer Banks)
Dare	=	3.0 mgd	
		16.0 mgd	

Transmission Main Cost Estimate:

Segment 1	
7,600 LF 30" Water Main @ $90.00/LF	$ 684,000
Segment 2	
32,400 LF 24" Water Main @ $60.00/LF	$ 1,944,000
1,200 LF 24" River Crossings @ $325.00/LF	390,000
	$ 2,334,000
Segment 3	
49,000 LF 24" Water Main @ $60.00/LF	$ 2,940,000
3,000 LF 24" River Crossings @ $325.00/LF	975,000
	$ 3,915,000
Segment 4	
53,900 LF 24" Water Main @ $60.00/LF	$ 3,234,000
24,000 LF 24" Currituck Sound Crossing @ $325.00/LF	7,800,000
5 mgd (200 hp) Booster Pump Station	250,000
	11,284,000
Segment 5	
43,300 LF 18" Water Main @ $50.00/LF	$ 2,165,000

SCENARIO 7

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5
Elizabeth City	0.0%	0.00%	0.0%	0.00%	0.00%
Pasquotank Co.	38.4%	0.0%	0.0%	0.0%	0.00%
Camden Co.	7.7%	12.5%	0.00%	0.00%	0.00%
Currituck Co.	30.8%	50.0%	57.1%	50.0%	0.00%
Dare Co.	23.1%	37.5%	42.9%	50.0%	100.0%
% Elizabeth City	$0	$0	$0	$0	$0
% Pasquotank Co.	$ 262,656	$0	$0	$0	$0
% Camden Co.	$ 52,668	$ 291,750	$0	$0	$0
% Currituck Co.	$ 210,672	$1,167,000	$2,235,465	$ 5,642,000	$0
% Dare Co.	$ 158,004	$ 875,250	$1,679,535	$ 5,642,000	$2,165,000
Total Segment $	$ 684,000	$2,334,000	$3,915,000	$11,284,000	$2,165,000

Production and Treatment Cost Estimate: at 100% Build-Out

1.	16.0 mgd RO Water Treatment Facility			
a.	Membranes	$3,700,000		
b.	Skid Assemblies	2,830,000		
c.	Building	5,408,000		
d.	Electrical	3,080,000		
e.	Instrumentation & Controls	1,240,000		
f.	Booster Pumps	2,840,000		
g.	Degasifier	800,000		
h.	Process Piping	1,240,000		
i.	Yard Piping	1,850,000		
j.	Chemical Storage & Feed	990,000		
k.	Cartridge Filter	432,000		
l.	Membrane Cleaning Equipment	990,000		
m	Site Work	990,000		
n.	Generator	610,000		
				27,000,000
2.	6,000,000 Gallon Ground Storage Tank			1,200,000
3.	16 MGD Booster Pump Station			750,000
4.	4 Test Wells @ $60,000			240,000
5.	43 - 700 GPM Wells @ $165,500			7,095,000
6.	114,200 LF Raw Water Transmission Main			
	16,000 LF 16" @ $45.00/LF		720,000	
	65,000 LF 24" @ $60.00/LF		3,900,000	
	33,200 LF 30" @ $90.00/LF		2,988,000	
				7,608,000
7.	Concentrate Discharge Main			
	53,000 LF 36" @ $130.00/LF		6,890,000	
	Header Assembly		300,000	
				7,190,000
				$51,083,000

Cost Distribution:

Elizabeth City (18.8%)	9,603,600
Pasquotank Co. (31.2%)	15,937,900
Camden Co. (6.2%)	3,167,200
Currituck Co. (25.0%)	12,770,800
Dare Co. (18.8%)	9,603,600

Total Cost to Participants:

Elizabeth City	
Transmission Main	$ 0
Water Production and Treatment	9,603,600
750,000 Gallon Ground Storage	278,000
3 MGD Booster Pump Station	225,000
Meter Vault	50,000
	$10,156,600
Engineering & Administration (20%)	2,031,300
Contingencies (10%)	1,015,700
	$13,203,600
Pasquotank Co.	
Transmission Main	$ 262,700
Water Production and Treatment	15,937,900
1,250,000 Gallon Ground Storage	361,000
5 MGD Booster Pump Station	250,000
Meter Vault	50,000
	$16,861,600
Engineering & Administration (20%)	3,372,300
Contingencies (10%)	1,686,200
	$21,920,100
Camden Co.	
Transmission Main	$ 344,500
Water Production and Treatment	3,167,200
300,000 Gallon Ground Storage	167,000
1 MGD Booster Pump Station	125,000
Meter Vault	35,000
	$3,838,700
Engineering & Administration (20%)	767,700
Contingencies (10%)	383,900
	$ 4,990,300

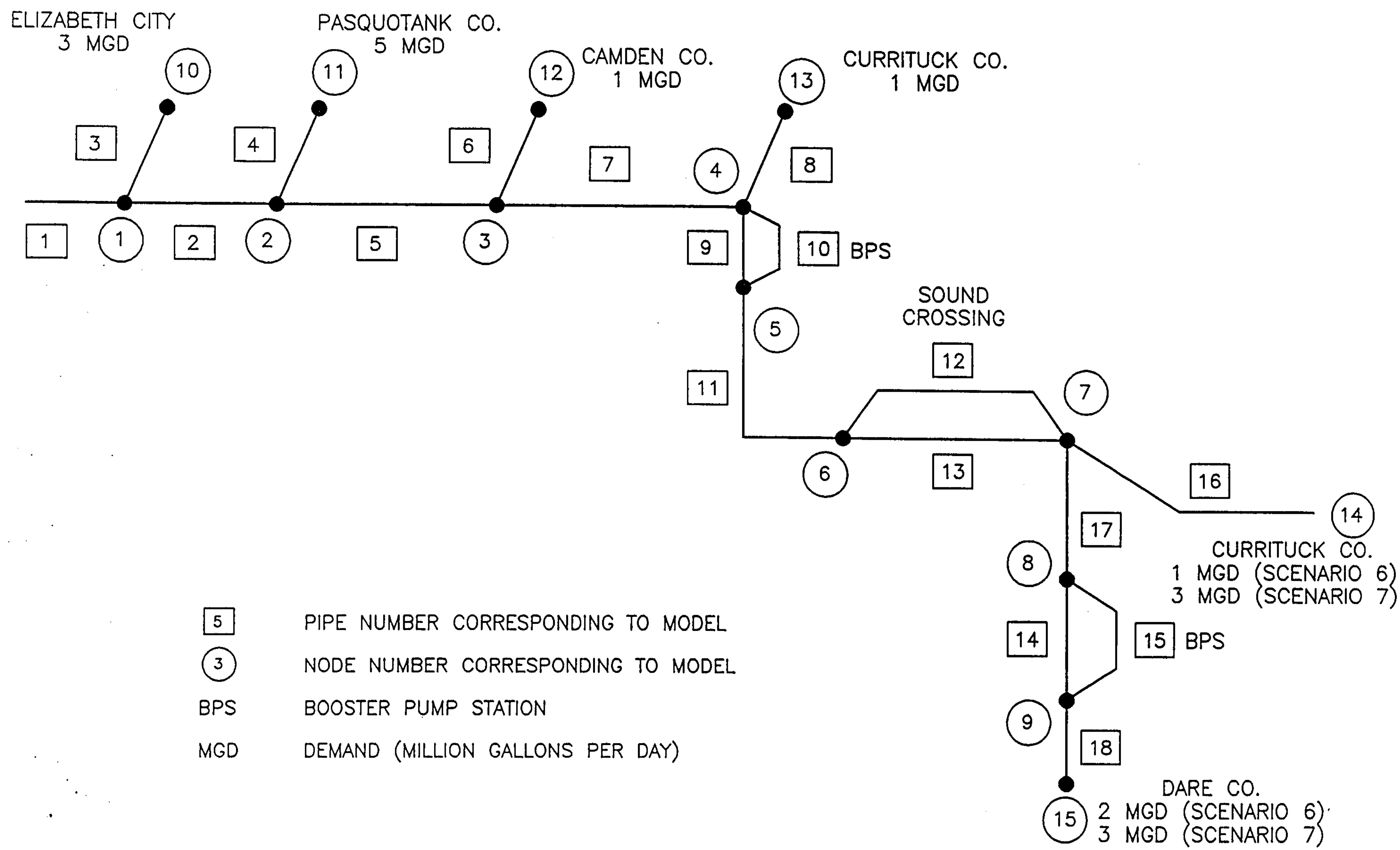
Currituck Co.	
Transmission Main	$ 9,255,200
Water Production and Treatment	12,770,800
1-300,000 Gallon Ground Storage	167,000
1-1 MGD Booster Pump Station	125,000
1-3 MGD Booster Pump Station	225,000
2-Meter Vault (1 @ $35,000 & 1 @ $50,000)	85,000
1 500,000 Gallon Ground Storage	229,000
	$22,857,000
Engineering & Administration (20%)	4,571,400
Contingencies (10%)	2,285,700
	$ 29,714,100
Dare Co.	
Transmission Main	$ 10,519,800
Water Production and Treatment	9,603,600
750,000 Gallon Ground Storage	278,000
3 MGD Booster Pump Station	225,000
Meter Vault	50,000
	$20,676,400
Engineering & Administration (20%)	4,135,300
Contingencies (10%)	2,067,700
	$ 26,879,400
Total Project Cost	$96,707,500

Debt Service: 20-year loan @ 5.15% interest

Participant	Total Cost		Yearly Debt Service
Elizabeth City (23.1%)	13,203,600	=	$1,073,500/yr
Pasquotank Co. (38.4%)	21,920,100	=	1,782,150/yr
Camden Co. (7.7%)	4,990,300	=	405,750/yr
Currituck Co. (15.4%)	29,714,100	=	2,415,800/yr
Dare Co. (15.4%)	26,879,400	=	2,185,300/yr

Cost/1000 gallons:

Elizabeth City.		
	Debt Service	$0.99
	O& M	1.11
		$2.10
Pasquotank Co.		
	Debt Service	$0.98
	O& M	1.11
		$2.09
Camden Co.		
	Debt Service	$1.12
	O& M	1.11
		$2.23
Currituck Co.		
	Debt Service	$1.66
	O& M	1.11
		$2.77
Dare Co.		
	Debt Service	$2.00
	O& M	1.11
		$3.11



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REGIONAL WATER STUDY
ALBEMARLE COMMISSION
HERTFORD, NORTH CAROLINA

HYDRAULIC NODE MAP
FOR SCENARIO 6 & 7

DATE	MAY, 1998
DESIGNED	JNJ
DRAWN	DWS
CHECKED	ETW
SCALE	N.T.S.
FIGURE NO.	12

FLOWRATE IS EXPRESSED IN U.S. GPM AND PRESSURE IN PSIG

A SUMMARY OF THE ORIGINAL DATA FOLLOWS

PIPE NO.	NODE NOS.		LENGTH (FEET)	DIAMETER (INCHES)	ROUGHNESS	MINOR LOSS K	FIXED GRADE
1	0	1	1000.0	30.0	140.0	.00	250.00
2	1	2	7600.0	30.0	140.0	.00	
3	1	10	100.0	16.0	140.0	.00	
4	2	11	100.0	20.0	140.0	.00	
5	2	3	33600.0	24.0	140.0	.00	
6	3	12	100.0	12.0	140.0	.00	
7	3	4	52000.0	24.0	140.0	.00	
8	4	13	100.0	12.0	140.0	.00	
9	4	5	100.0	24.0	140.0	.00	
THERE IS A CHECK VALVE IN LINE NUMBER 9							
10	4	5	100.0	24.0	140.0	.00	
THERE IS A PUMP IN LINE 10 WITH USEFUL POWER = 100.00							
11	5	6	54900.0	24.0	140.0	.00	
12	6	7	24000.0	24.0	140.0	.00	
LINE 12 IS CLOSED							
13	6	7	24000.0	24.0	140.0	.00	
14	8	9	100.0	16.0	140.0	.00	
THERE IS A CHECK VALVE IN LINE NUMBER 14							
15	8	9	100.0	16.0	140.0	.00	
THERE IS A PUMP IN LINE 15 WITH USEFUL POWER = 75.00							
16	7	14	100.0	16.0	140.0	.00	
17	7	8	43300.0	18.0	140.0	.00	
18	9	15	23500.0	16.0	140.0	.00	

JUNCTION NUMBER	DEMAND	ELEVATION	CONNECTING PIPES			
1	.00	5.00	1	2	3	
2	.00	5.00	2	4	5	
3	.00	3.00	5	6	7	
4	.00	2.00	7	8	9	10
5	.00	2.00	9	10	11	
6	.00	4.00	11	12	13	
7	.00	2.00	12	13	16	17
8	.00	2.00	14	15	17	
9	.00	2.00	14	15	18	
10	2083.00	5.00	3			
11	3472.00	5.00	4			
12	694.00	3.00	6			
13	694.00	2.00	8			
14	2083.00	2.00	16			
15	2083.00	138.00	18			

OUTPUT SELECTION: ALL RESULTS ARE OUTPUT EACH PERIOD

THIS SYSTEM HAS 18 PIPES WITH 15 JUNCTIONS , 3 LOOPS AND 1 FGNS

THE RESULTS ARE OBTAINED AFTER 3 TRIALS WITH AN ACCURACY = .00000

PIPE NO.	NODE NOS.		FLOWRATE	HEAD LOSS	PUMP HEAD	MINOR LOSS	VELOCITY	HL/1000
1	0	1	11109.00	2.20	.00	.00	5.04	2.20
2	1	2	9026.00	11.40	.00	.00	4.10	1.50
3	1	10	2083.00	.21	.00	.00	3.32	2.12
4	2	11	3472.00	.18	.00	.00	3.55	1.84
5	2	3	5554.00	60.79	.00	.00	3.94	1.81
6	3	12	694.00	.11	.00	.00	1.97	1.12
7	3	4	4860.00	73.48	.00	.00	3.45	1.41
8	4	13	694.00	.11	.00	.00	1.97	1.12
THE CHECK VALVE IN LINE NUMBER 9 IS CLOSED								
10	4	5	4166.00	.11	94.97	.00	2.95	1.06
11	5	6	4166.00	58.32	.00	.00	2.95	1.06
LINE 12 IS CLOSED								
13	6	7	4166.00	25.49	.00	.00	2.95	1.06
THE CHECK VALVE IN LINE NUMBER 14 IS CLOSED								
15	8	9	2083.00	.21	142.45	.00	3.32	2.12
16	7	14	2083.00	.21	.00	.00	3.32	2.12
17	7	8	2083.00	51.72	.00	.00	2.63	1.19
18	9	15	2083.00	49.81	.00	.00	3.32	2.12

JUNCTION NUMBER	DEMAND	GRADE LINE	ELEVATION	PRESSURE
1	.00	247.80	5.00	105.21
2	.00	236.40	5.00	100.27
3	.00	175.60	3.00	74.79
4	.00	102.12	2.00	43.39
5	.00	196.98	2.00	84.49
6	.00	138.66	4.00	58.35
7	.00	113.17	2.00	48.17
8	.00	61.45	2.00	25.76
9	.00	203.69	2.00	87.40
10	2083.00	247.58	5.00	105.12
11	3472.00	236.21	5.00	100.19
12	694.00	175.49	3.00	74.75
13	694.00	102.01	2.00	43.34
14	2083.00	112.96	2.00	48.08
15	2083.00	153.87	138.00	6.88

THE NET SYSTEM DEMAND = 11109.00

SUMMARY OF INFLOWS(+) AND OUTFLOWS(-) FROM FIXED GRADE NODES

PIPE NUMBER	FLOWRATE
1	11109.00

THE NET FLOW INTO THE SYSTEM FROM FIXED GRADE NODES = 11109.00

SCENARIO 7b

Scenario 7b presents water costs at 50% build-out. The distribution network will be built for ultimate capacity but the system will be put on-line with the Water Treatment Plant at one-half capacity. Water delivering is one-half the assigned demand in Scenario 7a.

1. 8 MGD RO Water Treatment Plant (expandable to 16 MGD)			
	a. Membranes	$1,850,000	
	b. Skid Assemblies	1,380,000	
	c. Building	4,807,000	
	d. Electrical	2,464,000	
	e. Instrumentation & Controls	992,000	
	f. Booster Pumps	1,396,000	
	g. Degasifier	800,000	
	h. Process Piping	868,000	
	i. Yard Piping	1,850,000	
	j. Chemical Storage & Feed	743,000	
	k. Cartridge Filter	247,000	
	l. Membrane Cleaning Equipment	620,000	
	m Site Work	990,000	
	n. Generator	610,000	
			19,617,000
2. 6,000,000 Ground Storage Tank			1,200,000
3. 8 MGD Booster Pump Station			500,000
4. Test Wells (2 @ $60,000)			120,000
5. 700 GPM Wells (22 @ $165,000)			3,630,000
6. 57,100 LF Raw Water Transmission Main			
	8,000 LF 16" @ $45.00/LF	360,000	
	32,500 LF 24" @ $60.00/LF	1,950,000	
	16,600 LF 30" @ $90.00/LF	1,494,000	
			3,804,000
7. Concentrate Discharge Main			
	53,000 LF 36" @ $130.00/LF	6,890,000	
	Header Assembly	300,000	
			7,190,000
		Total Construction	$36,061,000
		Engineering & Administration (20%)	7,212,200
		Contingencies (10%)	3,606,100
			$46,879,300

Debt Service: (20 Year Loan @ 5.15% interest)

Participant	Total Cost		Yearly Debt Service
Elizabeth City	9,532,250	==>	775,000/yr
Pasquotank Co.	15,827,200	==>	1,286,750/yr
Camden Co.	3,779,500	==>	307,300/yr
Currituck Co.	19,101,450	==>	1,552,950/yr
Dare Co.	17,852,300	==>	1,451,400/yr

Cost/1000 Gallons:

Elizabeth City		
	Debt Service	$1.42
	O& M	1.11
		$2.53
Pasquotank County		
	Debt Service	$1.42
	O& M	1.11
		$2.53
Camden County		
	Debt Service	$1.69
	O& M	1.11
		$2.80
Currituck County		
	Debt Service	$2.13
	O& M	1.11
		$3.24
Dare County		
	Debt Service	$2.66
	O& M	1.11
		$3.77

SCENARIO 7c and 7d

Scenario 7c presents water costs at 50% and full build-out with the total project cost divided evenly amongst participants.

50% Initial Phase

Transmission	$30,299,400
Production & Treatment	46,879,300
	$77,178,700

Yearly Debt Service: (20 Year Loan @ 5.15% interest) $6,274,650

Cost/1000 gallons:

Debt Service	$1.96
O& M	1.11
	$3.07

100% Build-Out

Transmission	$30,299,400
Production & Treatment	66,407,900
	$96,707,300

Yearly Debt Service: (20 Year Loan @ 5.15% interest) $7,862,350

Cost/1000 gallons:

Debt Service	$1.35
O& M	1.11
	$2.46

Commentary on Scenario 7

- Comments on this scenario follow essentially the same line as those for Scenario 6. The differences are:

    1. This scenario provides for the total 2020 demand for Currituck County - mainland and Outer Banks. Dare County still receives a supplemental amount.

    2. The Currituck Sound crossing is a 24" subaqueous installation which will provide significantly greater flow to the Outer Banks than the dual 12" bridge-attached crossing.

    3. Dare County will be required to install a new 16" water main from their point of delivery to fill the Duck elevated water tank at a flow of 4 MGD. Estimated cost for 23,500 LF 16" water main is $1,374,750 or an additional debt service of $0.11/1000 gallons.