ENGINEERING STUDY AND FINANCIAL FORECAST for EXPANSION OF AND IMPROVEMENTS TO THE DARE COUNTY WATER SYSTEM

Board of Commissioners

Robert V. Owens, Chairman

Robert G. Williams	Geneva H. Perry
Joseph M. Midgett	Clarence P. Skinner
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Terry L. Wheeler, County Manager

May, 1994

B&V Project No. 24420.910

TO: Board of Commissioners, Terry Wheeler, Al Cole, Bob Oreskovich

FROM: David Clawson

DATE: June 10, 1994

SUBJECT: Water Revenue Bonds Fesibility Study

We have received the Fiancial Feasibility Study for the Revenue Bonds.

One copy has been placed for the Board's review on the desk in the room containing the Board's mailboxes. If any Commissioner would like to have a copy to keep, please just let me know.

(Wheeler, Cole & Oreskovich have copies.)

BLACK & VEATCH

5540 Centerview Drive, Suite 114, Raleigh, North Carolina 27606, (919) 851-0500, Fax: (919) 859-2326

County of Dare
Water System Expansion and Improvements

B&V Project 24420.910
B&V File B
May 31, 1994

Dare County
P.O. Drawer 1000
Manteo, North Carolina 27954

Subject: Engineering Study and Financial Forecast for Expansion of and Improvements to the Dare County Water System

Gentlemen:

The attached Report reflects our study of the proposed Dare County Water System Expansion and Improvements, and the financing associated with these projects.

The Report describes in detail the water system to be constructed on Hatteras Island to serve the villages of Rodanthe, Waves, and Salvo and their current potential 850 to 900 customers. The purchase of the Colington Water System and the improvements to the Dare County Water System and Reverse Osmosis Plant have been described in less detail as these elements of the Dare County Water System (the "System") have been in operation for a number of years. The projections represented in this Report are based on operating history, an assumed inflation factor, and anticipated growth of the System.

Based upon our analysis of the System, the anticipated use of water, the costs for operations and maintenance, and other related factors, we have assessed the revenue requirements necessary for the County to meet its financial needs (including funds for debt service) during our forecast period extending through fiscal year 1999.

The forecasts in this Report are based upon assumptions developed during our analysis that we consider reasonable as well as discussions with current and potential customers of the System and the County's staff. The forecasts also represent to the best of our knowledge and belief, the expected revenue, expenses, debt service and debt service coverage for the System during Fiscal Years 1995 through 1999. However, there will usually be differences between the forecasted and actual results because events and circumstances frequently do not occur as expected.

Dare County
Water System Expansion and Improvements

B&V Project 24420.910
May 31, 1994

It is our opinion that at rates of charge and projected increases noted in the Report, the service projected to be provided to the customers will generate the revenues to pay current expenses and debt service.

If you have any questions regarding this Report or if we may provide additional information, please do not hesitate to contact me.

Very truly yours,

BLACK & VEATCH

Joseph E. Hardee

Joseph E. Hardee

ddl
Enclosure

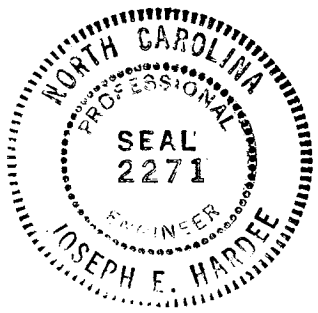
CERTIFICATION

I hereby certify that this Engineering Study and Financial Forecast for Expansion of and Improvements to the Dare County Water System was prepared by me or under my direct supervision.

Signed, sealed, and dated this 31st day of May, 1994.

By: Joseph E. Hardee

JOSEPH E. HARDEE, P.E.
Reg. No. 2271



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1.0 SUMMARY OF PROJECTS TO BE FINANCED

The County is proceeding with three projects that will both expand and improve its water system. These projects include (1) improvements to a water treatment plant, (2) the purchase of a water distribution system currently managed by one of the municipalities in the County, and (3) the construction of a water supply, treatment, storage and distribution system that will serve an area of the County that currently obtains water from individual shallow wells. The total cost of the projects approximates $9,700,000 of which approximately $8,520,000 will be financed. The cost of the projects not financed will be paid by cash contributions from the County and two municipalities (the Towns of Kill Devil Hills and Nags Head) within the County.

Throughout this report, various terms will be used. For clarity, the following definitions apply to these terms:

"Definitions"

"Expenses of Operating and Maintaining the System" shall mean the current expenses, paid or accrued, of operation, maintenance and current repair of the system, as determined in accordance with generally accepted accounting principles, and shall include, without limiting the generality of the foregoing, salaries, wages, employee benefits, cost of materials and supplies, cost of routine repairs, renewals, replacements and alterations occurring in the usual course of business, cost of billings and collections, cost of insurance and cost of audits and taxes, if any. Expenses of Operating and Maintaining the System shall not include any provision for depreciation of capital improvements to the system and amounts deemed to be payments in lieu of taxes or other equity transfers.

"Transfers for Indirect Costs" shall mean transfers made to the County General Fund for a properly allocable share of County administrative and overhead expenses as annually determined by the County's externally prepared Central Services Cost Allocation Plan.

"Net Revenues" shall mean the revenues of the system after deducting the expenses of operating and maintaining the system.

"Revenues" shall mean all receipts, income, revenues, fees and other charges to be levied and collected in connection with, and all other income and receipts of whatever kind or character derived by the County from the operation of the system, including, but not limited to, tap fees, connection charges, impact fees, developer fees, interest earnings (excluding those of the construction fund, the rebate fund, and the debt service reserve fund during the construction period) and other earnings or investments, determined in accordance with generally accepted accounting principles excluding the proceeds of any grants or debt, contributions in aid of construction, gains or losses on extinguishment of debt, extraordinary items, and including fees derived from assessments.

"R-W-S Project Assessments" A $1,500 assessment will be charged for every buildable parcel that will be served by the RWS Water System. This charge will be levied for payment beginning in fiscal year 1995 and may be paid in amounts not less than $215 per year over a maximum 7 year period. Payments that are amortized in this manner will include an interest or carrying charge. If the assessment is not paid, the County is authorized to place a lien on the property for which the assessment is due. The final amount of the assessment and the payment period are currently under review.

1.1 IMPROVEMENTS TO THE REVERSE OSMOSIS (RO) DESALINATION WATER TREATMENT PLANT

The County will construct two deep water production wells, two test wells, and two observation wells; one in the deep and one in the shallow aquifer. A prefab well head will be installed including electrical and telemetry equipment and pumps. A new raw water main will be installed from the well field to the RO plant, in addition to any necessary access roads. Two ocean side monitoring wells will also be designed and constructed. Long-term (6 months) monitoring of the water table aquifer will require that two shallow wells (20 to 30

feet) with automatic level recorders be installed to gather information on changes in the water table surface during winter, spring, and early summer.

The planned improvements to the RO Plant will improve the raw water supply (the water will have fewer dissolved solids and chlorides) to the RO Plant, which will thereby (1) lower the RO Plant's operating costs by reducing the power consumption required for equivalent water production, and also by extending the life of the desalination membranes, and (2) improve conditions for current and future development.

The cost of construction for this project is approximately $1,670,000 of which approximately $540,000 will be financed. Construction of the improvements began in March, 1994 and is scheduled to be completed in September, 1994 (7 months).

1.2 PURCHASE OF COLINGTON WATER DISTRIBUTION SYSTEM

The County has purchased the Colington Water Distribution System (CWS) from the Town of Kill Devil Hills. Colington is not within the corporate limits of Kill Devil Hills. The County purchased this distribution system to bring the CWS into the County-wide system. Under the County system, Colington residents will pay lower impact fees and monthly charges.

The County purchased the CWS in March 1994 and will make minor improvements through June 1994. The purchase price of the system was approximately $1,120,000 and the cost of improvements is anticipated to be approximately $315,000. Of these amounts, $1,395,000 will be financed..

1.3 CONSTRUCTION OF RODANTHE, WAVES, AND SALVO (R-W-S) WATER SYSTEM

The County will construct a water system that incorporates supply, treatment, distribution and storage to serve the unincorporated Villages of Rodanthe, Waves, and Salvo. The northern portion of Hatteras Island, which includes these communities, obtains water only through the use of individual shallow wells. By expanding its water system into this area, the County will improve the quality and supply of water for existing residents and will improve conditions for current and ongoing development of the Island. The provision of public water will allow the minimum buildable lot size in the area to drop from 20,000 square feet to 15,000 square feet producing a total of approximately 1925 ultimate buildable lots. Approximately 850 lots are currently occupied.

The project will include the construction of one deep well for the water supply with reverse osmosis treatment to remove the chlorides and dissolved solids. The plant will use this deep well for water production in conjunction with another deep well which was constructed on-site in 1987. The plant will have an initial reverse osmosis capacity of 1,000,000 gallons per day, with the ability to be expanded. Storage will be provided by means of 200,000 gallons in an elevated tank and 1,000,000 gallons in a ground level tank. The distribution system will be comprised of a basis 12-inch diameter line to carry water through the three villages, with other lines being 2 inches through 8 inches in diameter. There will be approximately 20 miles of line. Fire hydrants will be placed along all lines 6 inches and larger in diameter so that each building or building site is within 1,000 feet of a fire hydrant. As proposed, the distribution system can deliver 1,800 gallons per minute of water with a minimum pressure of 35 pounds per square inch. This translates into the ability to meet the peak day demand and deliver 500 gallons per minute fire flow at the same time. Based on certain population projections, the system, as proposed, would be adequate to the year 2010.

The cost of construction, and the amount to be financed, is approximately $6,590,000. Construction, to begin in ~~June~~ August 1994, will be completed in October 1995 (18 months). Bids

will be received on 82 percent of the Rodanthe-Waves-Salvo project on June 8, 1994. The cost opinion that has been developed was based on contractors' estimates. These estimates were made from complete building and site plans for the water plant. Line work estimates were based on the cost of units from final design of the distribution system. Other costs came from suppliers, i.e., ground storage and elevated tanks.

1.3.1 PROJECT FINANCING R-W-S

The initial tap fees for the R-W-S System will be in accordance with present Dare County policy. These funds will be used to defray project costs. The cost of taps for 761 connections ($280,750) is included in the overall initial capital cost budget. Additionally, it has been determined that each buildable lot be assessed $1,500 to cover a part of the cost of the water distribution system. Once the system is operational, new connections will come under the County's policy for payment of the current $2,000 impact fee plus the cost of service tap. The $1,500 assessment per lot will be levied so that the property owner may pay it over a seven-year period at an interest rate of five (5) percent. The above discussion relates to 3/4" residential connections. Service connections requiring larger meters will have a higher rate schedule.

1.3.2 USER COST FOR R-W-S

Revenues have been projected on an average annual daily water usage of 135,000 gallons, while the O&M cost for treatment of water has been based on an average annual daily water usage of 310,000 gallons. This difference in volume is due to the question of just how much water will be used by the tourists and seasonal inhabitants over a twelve month period. This will cover the higher use of O&M and the lower use for revenue. Water rates used in calculating revenues are the same as currently used on the Dare County Water System - $45.00 minimum for 9,000 gallons and $4.00 per 1,000 gallons for all over 9,000 gallons per quarter. Revenues have been projected on a conservative basis. The Dare County Water Distribution System rates are projected to increase 3.83% on July 1, 1995, 5% on July 1,

1998, 5% on June 1, 2000, and 5% on July 1, 2002. The rate increases will be implemented system-wide including the R-W-S System.

The average water bill is approximately $21.00/month for annual revenue projection which includes restaurants, motels, campground, as well as residential.

2.0 GENERAL

Section 2.0 discusses the need for a potable water system to serve the villages of Rodanthe, Waves, and Salvo (R-W-S). It also briefly addresses the improvements to the County's existing RO Plant and the purchase of the Colington water system.

2.1 PURPOSE AND SCOPE FOR R-W-S WATER SYSTEM

In 1982, Dare County initiated a study to investigate the water supply and treatment alternatives available to serve Rodanthe, Waves, and Salvo. This report is based on the alternative Dare County selected to supply the area's water needs beyond the foreseeable future and use new technology for treating the water supply.

The scope of this study includes (1) population projection, (2) water requirements, (3) water facilities needs and cost analysis, and (4) the project financing.

The study period covers the years through 2010.

2.2 NEED FOR POTABLE WATER SYSTEM FOR R-W-S

Presently water is obtained from private wells in what is known as the surficial aquifer which is essentially groundwater that is replenished by rainfall only. This water, being surficial, is subject to various types of pollution such as effluent from septic tank drain lines and ocean or sound over-wash. Recently, these villages had 150-160 private water supplies contaminated with salt water from sound-side flooding during the March 13-14, 1993 storm. It was necessary for the National Guard to provide potable water from March 15, 1993 through June 30, 1993 (three and one-half months).

The water quality is poor due to vegetation decay within this surficial zone. This poor quality is created by color, iron, hydrogen sulfide, and various organics. Pollution from septic tank drains is a real hazard. The porous soil type enables the water to move quickly through the ground, thus making it easier and faster for water to move from septic tank drain fields to well points.

Finally, all of the other villages on Hatteras Island enjoy safe, high quality water from a system operated under the State's requirements as well as those of the Environmental Protection Agency.

A copy of a 1990 memorandum from Harry Johnson, Director, Dare County Health Department to the Hatteras Island Commissioner is attached as APPENDIX A. This memo graphically outlines the potential health risks in the villages of Rodanthe-Waves-Salvo. The memo, in addition to addressing the problems encountered with contamination of private wells by salt water during the March 13-14, 1993 storm, clearly establishes the need for a potable water system to serve residents of these three communities.

2.3. IMPROVEMENTS TO DARE COUNTY RO PLANT

Dare County owns and operates two water plants that provide water to Roanoke Island and the Outer Banks from Oregon Inlet to the Currituck County line. One plant, with a processing capability of 5,000,000 gallons of water daily, is located on Roanoke Island. Treatment of this water consists primarily of softening. The other plant is located at Kill Devil Hills. This is a reverse osmosis (RO) treatment facility with a current capacity to treat 3,000,000 gallons of water per day. Both treatment plants derive their raw water from wells. Wells supplying the RO plant have experienced an increase in chloride levels due to the necessity of having to pump for long periods of time during the peak summer season. The County is constructing two additional wells for north-south expansion of the well field, and a major line from the wells to the RO plant. The Dare County portion of the total project cost for these improvements is approximately $540,000.00.

2.4 ADDITION OF COLINGTON SYSTEM TO THE DARE COUNTY SYSTEM

Dare County recently approved acquiring the water distribution system in Colington from the Town of Kill Devil Hills. The factor that precipitated this action was the very high cost to residents of Colington for water. Customers in Colington will now be charged the same rates as all other retail customers on the Dare County Water System. As an example, the impact fee will be reduced from $6,000 to $2,000.

2.5 DARE COUNTY WATER SYSTEM CUSTOMER BASE

Presently, there are 1,272 customers on the Colington system. These are in addition to the existing 4,936 customers on the Dare County Distribution System. For revenue projections and project feasibility, it is assumed that 500 of the 872 potential connections in Rodanthe, Waves, and Salvo will be initial users. Initial users in R-W-S will be charged $1500 assessment plus the cost of tap (approximately $300). Those who choose to hook up after September 1, 1994 will be charged an additional $2,000 impact fee. Thus, there will be a total of 6,708 retail customers on the Dare County system when R-W-S becomes operational.

3.0 POPULATION PROJECTION AND WATER REQUIREMENTS (R-W-S)

3.1 POPULATION PROJECTION

The population of the study area was developed using the Comprehensive Engineering Report, (Black & Veatch, Inc., Engineers-Architects, 1984) and The Carrying Capacity study, (Booz, Allen and Hamilton, 1986) as a resource. Both reports projected the permanent and seasonal population as illustrated in Table 3.0. The population projections are relatively close in both reports.

The area is experiencing moderate growth and this trend is expected to continue. Therefore, the median growth projection in Table 3.0 was used as a reference to determine the water requirement of the area.

3.2 WATER REQUIREMENT

Water usage rates vary during different times of the day and periods of the year. Demand rates are defined by the following terms:

Annual Average Day. Computed by dividing the total annual water production by 365. This value is useful in determining annual operation and maintenance cost, and long-range water resource requirements.

Maximum Day. The maximum amount of water used in any 24-hour period. This number is used to determine treatment plant capacity. A water system should be capable of supplying the maximum day demand without depleting storage. Also, raw water supply facilities must be capable of delivering the maximum day demand.

Maximum Hour. The average amount of water used in a peak period during a maximum day (or near maximum day). Typically, it occurs during late afternoon and early evening for a

TABLE 3-0

POPULATION PROJECTION
(PERMANENT AND SEASONAL)

	1990	1995	2000	2005	2010
Comprehensive Engineering Report (1984)	5,876	6,000	6,160	7,339	8,000
Carrying Capacity Study (1986)					
Low Growth	5,813	6,151	6,514	7,000	8,000
Median Growth	6,116	6,850	7,806	8,500	10,000
Rapid Growth	6,963	9,028	11,942	13,000	15,000

duration of 3 or 4 hours. Although it occurs for only a few hours, this demand is usually expressed in the same units (mgd) as maximum day and annual average day. This number is used to size distribution mains, and pumping and storage, since storage reservoirs are used to supply the difference between maximum day and maximum hour rates.

Average Off-Season Day. Computed by dividing the total water production from October through March by 182 days. This value is used to determine water requirements and the approximate system needs during off-peak periods.

Average Peak-Season Day. Computed by dividing the total water produced from June through Labor Day by 97 days. This value is used to determine sustained peak usage, which is useful in determining staffing, treatment chemical inventories, and preventive maintenance schedules.

Ratios. The ratios of Maximum Day, Maximum Hour, Average off-Season Day, and Average Peak-Season Day to Annual Average Day (MD/ADD, MH/AAD, AOSD/AAD and APSD/AAD) are all useful for projecting future water requirements and for recognizing changes in water use patterns. These ratios will fluctuate from year to year, but, in a stable water system, will remain fairly constant. A consistent change (up or down) in any of these ratios indicates a change in water use patterns, often caused by changing water system socio-economic status or by changes in industrial or commercial water users. Thus, these ratios can be used to improve the accuracy of future water requirement projections.

The projected future water requirement is shown in Table 3-1. The projections for maximum day are based on 105 gallons per capita per day and the median population projection of The Carrying Capacity study of Section 3.0.

TABLE 3-1

WATER REQUIREMENTS (mgd)

	1995	2000	2005	2010
Maximum Day [1]	0.72	0.82	0.92	1.02
Maximum Hour [2]	1.44	1.64	1.84	2.04
Annual Average [3]	0.22	0.25	0.28	0.31

(1) 105 gpcd

(2) 2 times Maximum Day

(3) 0.30 times Maximum Day

4.0 WATER FACILITIES DESIGN (R-W-S)

4.1 WATER SUPPLY

The existing water supply in the Rodanthe, Waves, and Salvo area consists of individual shallow wells of the upper water table aquifer that are mainly captured rainfall. A previous study estimated that approximately 25 percent of the annual rainfall (45 inches) is retained in this aquifer as a potential water supply.

Previous studies have also identified a need in this area for a safe and dependable potable water supply that would serve current and future development.

Within the past several years, Dare County has initiated an extensive study of the groundwater resources in the Outer Banks. The study is currently being conducted on the northern section of the Outer Banks near Kill Devil Hills. The data already collected will be used in this study to determine the needs in the Rodanthe, Waves, and Salvo area. This data would typically represent the general condition of all of the Outer Banks and should be sufficient for the planning purposes described in this report.

4.1.1 Groundwater Exploration

In order to determine whether any groundwater exists which can be treated by desalination, a testing project was undertaken. A test well was drilled in Rodanthe approximately 300 feet south of the Chicamacomico Lifesaving Station. The well drilling anticipated finding the same aquifers that were found in the test well drilled in Kill Devil Hills for the northern Dare County desalination project, although the aquifers were expected to be deeper due to the general slope of the geological plates. The drilling located the following aquifers.

- *Upper Aquifer.* This is a water table aquifer, located approximately 8 to 30 feet deep. This contains fresh water, and is currently used as the primary water source for private wells in the three villages.

- *Lower Aquifer.* This is a confined aquifer of loose sand, located approximately 200 to 250 feet deep. The water, as tested at a depth of 211 to 216 feet, has the same salinity as seawater. Apparently there is a direct connection between this water and the Atlantic Ocean.

- *Yorktown Aquifer.* The Yorktown aquifer was found at elevations 330 to 600 feet, or about the same depths as in Kill Devil Hills. The water is of varying quality, from moderately brackish at the top to half seawater strength at the bottom.

- *Castle Hayne Aquifer.* The Castle Hayne aquifer was not found, although drilling continued to a depth of 1,400 feet. Further drilling was not done since, in all likelihood, the water would be highly saline and deep well drilling costs would be prohibitive.

The Yorktown aquifer at the test well consists mainly of confined sand. Driller's observation of the aquifer indicates that the well could yield in excess of 1,000 gpm, not considering the effect on water quality. Water samples were taken from depths of 332 to 342 feet and 507 to 517 feet deep. These samples were analyzed both at the well head and in the laboratory. The results of these analyses are shown in Tables 4-1 and 4-2.

The characteristics of the aquifer were further studied by setting an 8-inch well screen at a depth of 300 feet to 450 feet, and conducting pump tests. An 8-inch diameter stainless steel casing was increased to 12-inch diameter to accommodate the pump. The pump tests conducted were step drawdown, 24-hour pumping and recovery, and a long-duration pumping test. The latter test was performed to assess the potential for salt water intrusion and hydrologic connections between aquifers. The pumping rate for the 24-hour and long-

TABLE 4-1

YORKTOWN AQUIFER WATER ANALYSIS

	DEPTH OF SAMPLE	
	332-342 ft.	**507-517 ft.**
BOD_5 (mg/l)	<1.5	<1.5
Alkalinity, as C_aCO_3	603	528
Chloride (mg/l)	439	4,920
Color (PCU)	35	10
Conductivity @ 25 C (umhos/cm^2)	2,250	14,000
Fluoride (mg/l)	1.58	1.56
Total Hardness (mg/l)	94	890
Nitrate-Nitrogen (mg/l)	0.055	0.062
Nitrate-Nitrogen (mg/l)	<0.002	<0.002
pH (units)	8.0	7.5
Total Phosphorus (mg/l)	0.074	0.048
Total Solids (mg/l)	1,430	9,480
Total Volatile Solids (mg/l)	177	468
Total Suspended Solids (mg/l)	10	19
Total Dissolved Solid (mg/l)	1,410	9,430
Sulfate (mg/l)	<2	530
Turbidity (NTU)	1.3	7.3
TOC (mg/l)	151	134
Free Chlorine (mg/l)	<0.1	<0.1
Silica (mg/l)	28.8	18.6
Strontium (mg/l)	0.63	0.44
Silver (mg/l)	<0.005	<0.005
Aluminum (mg/l)	<0.5	<0.5
Arsenic (mg/l)	0.0005	0.0077
Barium (mg/l)	0.20	<0.05
Calcium (mg/l)	11.51	93.6
Cadmium (mg/l)	<0.005	<0.005
Total Chromium (mg/l)	<0.005	<0.005
Hexavalent Chromium (mg/l)	<0.01	<0.01
Copper (mg/l)	0.009	<0.005
Iron (mg/l)	0.635	1.236
Mercury (mg/l)	<0.0005	<0.0005
Potassium (mg/l)	33.5	142
Magnesium (mg/l)	36.2	187
Manganese (mg/l)	0.014	0.028
Sodium (mg/l)	540	3,330
Lead (mg/l)	<0.05	0.032
Selenium (mg/l)	<0.0005	<0.001
Zinc (mg/l)	0.03	0.087
SDI (units)	Void	7
Temperature (deg F)	74	72

TABLE 4-2

YORKTOWN AQUIFER WATER ANALYSIS

	DAY OF SAMPLE	
	2	7
BOD_5 (mg/l)	<0.2	<0.3
Alkalinity, as C_aCO_3	597	601
Chloride (mg/l)	435	435
Color (PCU)	30	30
Conductivity @ 25 C (umhos/cm^2)	2,200	2,350
Fluoride (mg/l)	1.96	1.95
Total Hardness (mg/l)	98	100
Nitrate-Nitrogen (mg/l)	0.054	0.025
Nitrate-Nitrogen (mg/l)	<0.002	<0.002
pH (units)	7.8	7.9
Total Phosphorus (mg/l)	0.086	0.05
Total Solids (mg/l)	1,480	1,470
Total Volatile Solids (mg/l)	271	221
Total Suspended Solids (mg/l)	4	7
Total Dissolved Solid (mg/l)	1,460	1,467
Settable Solids (mg/l)	<0.1	<0.1
Sulfate (mg/l)	<2	44
Turbidity (NTU)	0.3	3.0
TOC (mg/l)	115	117
Free Chlorine (mg/l)	<0.1	<0.1
Silica (mg/l)	6.1	27
Strontium (mg/l)	0.75	0.72
Silver (mg/l)	<0.01	<0.01
Aluminum (mg/l)	<0.2	<0.2
Arsenic (mg/l)	<0.002	<0.002
Barium (mg/l)	<0.1	<0.11
Calcium (mg/l)	9.48	9.40
Cadmium (mg/l)	<0.005	<0.005
Total Chromium (mg/l)	<0.02	<0.02
Hexavalent Chromium (mg/l)	<0.02	<0.02
Copper (mg/l)	<0.02	<0.02
Iron (mg/l)	0.052	0.048
Mercury (mg/l)	<0.0005	<0.0005
Potassium (mg/l)	38.5	35.8
Magnesium (mg/l)	20.6	19.9
Manganese (mg/l)	<0.01	<0.01
Sodium (mg/l)	588	527
Lead (mg/l)	<0.05	<0.09
Selenium (mg/l)	0.0023	0.0025
Zinc (mg/l)	0.024	0.026
SDI (units)	0.8	0.6
Temperature (deg F)	70	70

duration tests was 450 gpm, or less than half of the driller's estimates of well capacity. This pumping rate and the screen setting depth were selected to attempt to draw only from the top part of the aquifer and limit the TDS of the potential supply to 2,500 mg/L or less. The long-duration pump test was intended to pump for 15 to 20 days; however, due to equipment problems, the test was terminated after 11 days.

4.1.2 Quality

Table 4-2 shows the results of analyses of water samples from the test well during the long-duration pump test. Analyses consisted of tests at the well head for silt density index, temperature, pH, turbidity, and iron concentration. Tests were conducted each weekday during the specified period. Samples were also collected and sent to the laboratory at approximately weekly intervals, to be analyzed for a broad range of constituents which are factors in desalination process design.

The analyses confirmed that the water is slightly brackish, high in alkalinity and TOC, and relatively high in silica and fluoride. Iron concentration is relatively low, and no problems are anticipated with iron scaling of reverse osmosis membranes. The high level of alkalinity, when combined with the low calcium concentration, does present a problem. The finished water will be corrosive due to the excellent removal by membranes of calcium and alkalinity but not carbon dioxide. To compensate, the treated water will require post treatment of degasification for carbon dioxide reduction, followed by the addition of lime or caustic soda to raise pH to stabilize the water. Blending of raw water with RO permeate will also help to stabilize the treated water.

The evaluation of the water quality of the Yorktown aquifer in Rodanthe shows that treatment of this water by a desalination process is feasible. There are no constituents in the water which would prohibit its use as a feedwater for desalting. However, the plant design should carefully consider all factors listed above to make certain that the plant can successfully treat this water.

10% blend ratio

90 : 10

1 train = 350 gpm

75% recovery = 326
30 blend

315 perm
35 blend
105 conc.
455 gpm raw

Two wells @ 415 gpm each?

4.1.3 Quantity

The quantity of water which can be withdrawn from the Yorktown aquifer for treatment in the area of the three villages, from either a single well or from a well field depends on the geological characteristics of the formation, the amount of water stored in the aquifer, and preservation of water quality. As mentioned previously, the physical characteristics of the formation will allow high yielding wells, in excess of 1,000 gpm, and perhaps as high as 2,000 gpm. This is confirmed by drawdown measurements taken during pump testing.

The apparent specific capacity of the completed well is 20 gpm/foot.
At a well yield of 1,000 gpm, the drawdown is 50 feet. This is within usual well design parameters. A total of two (2) wells will be required as noted in Table 4-3.

Due to the relatively small raw water requirements for this area, a detailed study of overall aquifer characteristics was not made. Comparison of this part of the aquifer with the detailed information about the aquifer obtained from the test well in Kill Devil Hills indicates that the raw water requirements of Rodanthe-Waves-Salvo can be met from the Yorktown aquifer. However, as a part of any well field design associated with implementation of a desalination plant, further evaluation of aquifer yield, well spacing, and well design should be made from data gathered during the well test.

TABLE 4-3

PRODUCTION WELLS REQUIRED

Design Year	Water Demand (mgd)	Well Capacity (mgd)	No of Wells*
1995	0.72	1.29	2.00
2000	0.82	1.29	2.00
2005	0.92	1.29	2.00
2010	1.02	1.29	2.00

* A total of two wells will be required for 1995, as well as 2010.

4.2 WATER TREATMENT

Previous studies have evaluated all alternatives for the area's water supply and treatment. The most effective method to supply the long-range needs is desalination by the reverse osmosis process using the brackish groundwater of the Yorktown aquifer.

Desalination processes are used when water contains dissolved solids that cannot be removed by conventional treatment or when total dissolved solids are present in sufficient quantity to make desalination processes cost effective. Typical dissolved solids which, when present in sufficient quantity, can require the use of a desalination process include sodium, calcium, magnesium, sulfate, chloride, and bicarbonate. Saline water is a term given any water with chloride concentration greater than 250 mg/L and total dissolved solids (TDS) concentrations greater than 500 mg/L. Saline waters include salt water, which is undiluted seawater typically containing 35,000 mg/l TDS, and brackish water, containing up to 10,000 mg/l TDS. Brackish waters include highly mineralized groundwater and diluted seawater.

Dare County has an abundance of saline waters which are potential drinking water supplies if desalination can be economically employed. Sources of saline water near Rodanthe, Waves, and Salvo include:

- The Atlantic Ocean.
- Pamlico Sound.
- Outer Banks groundwater, found in several aquifers of both brackish and salt water at depths exceeding 100 feet.

Water treatment costs, both capital and operating and maintenance, are considerably less for brackish water than for salt water. Since brackish water is available, salt water will not be considered further. Pamlico Sound has TDS concentration of 14,000 to 18,000 near the project area, which would require seawater desalination processes. Therefore, it is not considered further in this report.

11/93
16,940 mg/l. TDS
11,300 mg/l. Cl-

Typical processes used for removing dissolved solids from brackish water are reverse osmosis (RO) electrodialysis (ED), and ion exchange (IE). Distillation can also be used for more concentrated brackish waters although it is more typically used for salt water desalting. Several other desalination processes are being developed, but are not yet commercially feasible and will not be discussed herein.

A brief description of the RO process mentioned above follows.

4.2.1 Reverse Osmosis

Reverse osmosis is a physical process that takes advantage of the natural tendency of water to dilute a concentrated solution. When salt water and fresh water are on opposite sides of a membrane that is permeable to water but not to solids dissolved in the water, dilution of the salt water occurs as water molecules pass through the membrane. When an external pressure is applied to the salt water, the water flow across the membrane can be reversed and pure water is removed from the more concentrated salt solution. This is the process of reverse osmosis.

Pressure is continuously applied to the feed stream by a high pressure pump, while product and brine are continuously flushed from the system in the brine. The brine contains a high level of dissolved solids while the product contains a low level. A flow regulating valve on the brine discharge line controls the percentage of feedwater that is converted to product.

Currently available RO devices are either hollow fiber membrane permeators or spiral wound membrane permeators. The design and manufacture of these device and of process systems incorporating these devices are highly specialized. Performance of the process depends upon feedwater quality, applied pressure, and the pressure of potential fouling or scaling ions which can harm membranes. RO is typically cost-effective at feedwater TDS concentrations of 1,000-6,000 mg/L. The primary operating costs include electric power for the high pressure pumps and membrane replacement.

RO is used mainly for treating groundwater. Surface waters usually require extensive pretreatment for removal of suspended solids and turbidity. Groundwater requires cartridge filtration for removal of fine suspended solids and possibly chemical addition. Other pretreatment requirements are specific to membrane materials and configuration.

RO is a viable process for treating brackish groundwater in the three village area.

4.3 RO FACILITY REQUIREMENTS

4.3.1 RO Process Performance

Previous discussions of reverse osmosis in this report have been brief, without describing performance characteristics or factors affecting performance. Typical measures of performance are salt rejection, membrane flux (flow through the membrane per unit time), percent recovery, and time between membrane cleanings. Factors which affect performance are operating pressure and ionic constituents in the water. Several of these characteristics and factors are discussed below.

4.3.1.1 Feedwater Concentration and Recovery. The concentration of dissolved solids in the feedwater is of prime importance in planning RO systems. The higher the concentration, the higher the feed pressure must be to overcome the feedwater's osmotic pressure. At constant pressure, the percent recovery will decrease as TDS concentration increases. Recovery is the percentage of feedwater which passes through the membranes to become product water. This is a critical parameter in determining RO feasibility since higher recoveries reduce the raw water requirements and the amount of RO membranes to be used, and minimizes pretreatment costs and the amount of brine to be handled. Usual design is intended to utilize as high a recovery as possible without causing damaging scale formation. Probable feedwater analysis is reflected in Table 4-4.

TABLE 4-4

PROBABLE FEEDWATER ANALYSIS FOR COST COMPARISON

PARAMETERS	PRETREATED WATER
Alkalinity (mg/l)	600
Chloride (mg/l)	435
Fluoride (mg/l)	1.96
Hardness, Total (mg/l)	100
pH (units)	7.8
Total Dissolved Solids (mg/l)	1470
Sulfate (mg/l)	44
Turbidity (NTU)	3.0
Calcium (mg/l)	9.5
Iron (mg/l)	0.05
Potassium (mg/l)	38.5
Magnesium (mg/l)	20.6
Manganese (mg/l)	<0.01
Sodium (mg/l)	588
Silica (mg/l)	27

How do we consider TDS increase in the initial R.O. Plant design?

A change in feedwater concentration may adversely affect RO performance. In the Yorktown aquifer in Dare County, there is potential for movement of higher TDS concentration water into the well field. Such movement would gradually increase feedwater TDS, resulting in higher osmotic pressures and lower recovery. With time, the plant capacity would be reduced. Proper well field design and operation can minimize salt water migration in the aquifer, but some increase in feedwater salinity can be anticipated with time. This increase would be considered in the plant design.

4.4 WATER DISTRIBUTION

The distribution system was designed using computer modeling performed by hydraulic analysis. The hydraulic analysis is an analytical method of predicting the hydraulic gradient pattern (pressure) that may occur over a system network based on a given set of water demands.

The distribution mains were sized based on 100 percent participation in the area and the design flow of 400 gallons per residential connection plus a 500 gpm fire flow demand on the system. The distribution system is designed to deliver a maximum flow of 2.6 mgd while maintaining a minimum pressure of 35 psi throughout the system. The system would have sufficient capacity to supply the projected 2010 maximum hour demand of 2.04 mgd.

The water distribution system would consist of a 12-inch diameter transmission main along Highway 12, from the elevated tank at the north side of Rodanthe, to the south side of Salvo. This size main is needed due to the elevated storage tank's location on the edge of the system. If the tank was located nearer the center of the overall distribution system, the transmission main could be reduced in size to an 8 inch diameter. This would reduce the

probable construction cost; however, this cost savings must be weighed against the cost of acquiring a centrally located tank site. With an 8-inch transmission main, pressure would also drop below 20 psi at the north and south ends of the distribution system during the maximum day demand, plus a fire flow of 500 gallons per minute.

4.5 STORAGE

Storage is provided in a distribution system to alleviate heavy demand periods, supplying the difference between maximum day and maximum hour demands, and other emergency flow conditions. Normally, one-half of the total storage volume should satisfy maximum hour demand and the other half should be reserved for emergencies and fire fighting purposes. Using the above criteria and a 4-hour maximum hour duration, the area would need 340,000 gallons of storage to supply the maximum hour condition plus emergency reserve for the design period 2010. State regulations impose the additional requirement that sufficient storage be available to supply the annual average demand for 24 hours.

The required storage volume based on both of the criteria listed above is shown in Table 4-5.

Based on state regulations, approximately 1.0 MG of storage volume would be needed by 2010. This storage can be provided in any combination, ground storage, and/or elevated storage. The tentative plan is for the wells, treatment plant and storage to be located at the same site which is presently owned by Dare County. Based on the location for these facilities, it would be most feasible to provide the majority of the storage required as ground storage.

It is recommended that 200,000 gallons of elevated storage and 1,000,000 gallons of ground storage be provided for a combined storage of 1,200,000 gallons. This would be sufficient to meet the need of the area through 2010.

TABLE 4-5

REQUIRED STORAGE VOLUME

	1995	2000	2005	2010
Maximum Hour & Emergency	240,000	273,000	306,000	340,000
State Regulation	720,000	820,000	920,000	1,020,000

5.0 ESTIMATED PROJECT COSTS

The construction cost opinion is presented in the following Table 5-0 for work at Rodanthe, Waves, and Salvo. This table also includes the additional cost of the project for Colington and the plant at Kill Devil Hills as well as the overall estimated project cost.

TABLE 5-0
ESTIMATED PROJECT COSTS

RO Equipment	$1,089,000.00
Three HSP's	77,000.00
Lab Furniture	15,000.00
Sitework	270,000.00
Building	530,000.00
HVAC	65,000.00
Plumbing	32,000.00
Bulk Storage Structure & Fuel Tank	44,000.00
Electrical	212,200.00
Subtotal - WIP and Sitework	2,334,200.00
Finished Water Storage (1MG)	265,000.00
Concentrate Outfall	34,000.00
Wells/Pump Chamber (w/electrical)	315,000.00
Raw water lines	58,000.00
Elevated Storage Tank	350,000.00
Distribution System	1,425,000.00
SCADA	50,000.00
Standby Generator	75,000.00
Total Construction Cost	**$4,906,200.00**
Legal and Adminsitrative	35,000.00
Land & Rights-of-Way	202,000.00
Technical Services	933,000.00
Boyle Engineering	90,000.00
Contingency (7%) of construction	345,310.00
Building Furnishings & Power Service to Sites	75,000.00
Subtotal R-W-S	$6,586,510.00
Colington System Purchase	1,435,000.00
R.O. Plant Improvements (Wells & Line)	1,670,000.00
TOTAL PROJECT COST	**$9,691,510.00**

6.0 PROJECT FUNDING

Dare County will fund approximately $8,520,000 of the total approximate $9,700,000 in project costs by issuing Utilities System Revenue Bonds secured by the Net Revenues (as defined on Page 1-2 herein) of the Dare County Water System. The remaining $1,180,000 will be funded by cash contributions of the County and the Towns of Kill Devil Hills and Nags Head.

The general structure of the revenue bond issue contemplates a 20-year term, semi-annual interest and annual principal payments, capitalized interest, a debt service reserve fund, and certain other parameters consistent with this form of financing. The Utilities System Revenue Bonds will be insured by Municipal Bond Investors Assurance Corporation (MBIA). MBIA will also provide a surety policy to fund one-half of the debt service reserve fund requirement.

The estimated par amount for the issue will approximate $9,730,000 resulting in estimated gross average annual debt service of $851,956. Estimated gross annual debt service has been used herein to determine projected debt service coverage ratios for the proposed bond issue. Financing schedules developed to establish these figures incorporated the structure elements described above and an interest rate scenario that produced a true interest cost of 6.17%.

A Sources and Uses of Funds schedule, reflective of the preliminary financing schedules developed in conjunction with this report, is provided in Table 6-0.

TABLE 6-0

Sources and Uses of Funds

County of Dare, North Carolina
Utilities System Revenue Bonds, Series 1994

Dated June 15, 1994
Delivered June 23, 1994

Sources of Funds:

Par Amount	$9,730,000.00
Accrued Interest	12,342.17
Original Issue Discount	(99,242.25)
Total Sources of Funds	$9,643,099.92

Uses of Funds:

Deposit to Construction Fund:	
RWS Project	$6,412,305.10
CWS Project	1,388,565.93
RO Plant Project	536,641.71
	$8,337,512.74
Deposit to Capitalized Interest Fund	564,165.50
Deposit to Debt Service Reserve Fund	434,553.75
Accrued Interest	12,342.17
Costs of Issuance	175,235.96
Underwriters' Discount	119,289.80
Total Uses of Funds	$9,643,099.92

7.0 PROJECTIONS FOR DARE COUNTY WATER SYSTEM WITH RODANTHE-WAVES-SALVO

7.1 SYSTEM OPERATION

There are 852 potential users within the Rodanthe-Waves-Salvo area. The cost is based on making available service to each lot and potential user. These potential users are based on an actual on-the-ground count. Additionally, there are 957 vacant lots for a total of 1,809 lots or properties overall in the three villages. Potentially the estimated build out is 1944 lots.

Revenue estimates have been developed using the existing water rate schedule for the Kitty Hawk-Southern Shores-Duck area of the County. Based on 500 initial users, these schedules will generate in the range of $137,500 annually from water sales in the first year of operation. The basis for the number of services is the result of a survey conducted of potential customers in the three villages.

Dare County currently operates water systems on Roanoke Island, Colington Island, and the Outer Banks area north of Kill Devil Hills to the Currituck County line. These service areas comprise a customer base of approximately 6,208. It is only logical that the County expand its water system operation to include the villages of Rodanthe, Salvo, and Waves. It will be much more economical to add this water service area to those the County already operates, since the added cost of operation would be minimized.

The R-W-S operation and maintenance cost projections are shown in Table 7.0.

TABLE 7-0

WATER SYSTEM OPERATION AND MAINTENANCE COST (R-W-S)

Year	Annual Average gallons/day	Annual O&M Cost* ($)	Cost/1,000 Gallons ($)
1995	220,000	258,000	3.21
2000	259,000	309,000	3.39
2005	280,000	370,000	3.62
2010	310,000	440,000	3.89

* Does not include depreciation.

7.2 REVENUE PROJECTIONS

Revenue derived from operation of the original Dare County Water System has been projected on the basis of historical data, including growth in the number of customers. Likewise, revenue from 1,272 customers on the Colington system has been projected using historical usage and operating data obtained from the Town of Kill Devil Hills. The average water consumption in Colington is approximately 4,500 gallons per month per service.

Even though there are approximately 900 potential water customers in the villages of Rodanthe, Waves, and Salvo initial revenue projections have been made based on 500 customers when the system becomes operational. Revenue per connection is based on 4,500 gallons per month on an annual average, recognizing this will be considerably lower in the winter months and considerably higher in the summer months.

Growth in new connections on the total system is projected to decrease from approximately 4.00% in 1995 to approximately 1.00% in 2015. Since growth in new connections during this period will not keep up with inflation, retail rate increases are proposed as follows: 3.83% on 7/1/95, 5.00% on 7/l/98, 5.00% on 7/1/00 and 5.00% on 7/1/02.

The original Colington system grew from 949 customers to 1,272 customers in seven years. The original Dare County Distribution System grew from 1,722 customers to 4,936 customers in eleven years. Growth in new connections in R-W-S is projected to go from 500 initially to 1,075 in twenty years.

7.3 OPERATION AND MAINTENANCE COST PROJECTIONS

Operating history of the original Dare County Water Distribution System provides a good benchmark for O&M per connection. This information has been used to determine the initial cost of operation of the Colington system. The initial O&M for the R-W-S portion of the overall system was estimated based on operating experience of the existing R.O. plant at Kill Devil Hills. All costs have been escalated based upon increase in the number of connections, increase in water production at Rodanthe, and inflation of approximately 4.00% per year.

7.4 OPERATING STATEMENTS

The following operating statement reflects the historical operating data for the Dare County Water System from 1990 through 1994.

7.5 PROJECTED DEBT SERVICE COVERAGE

The following projection is based upon historical data gathered from the operation of the Dare County Water System and a conservative estimate of O&M and revenue for the Colington and Rodanthe-Waves-Salvo segments of the Dare County Water system.

The debt service coverage is shown in the following statement for the fiscal years 1995 through 1999. The per lot assessment for the R-W-S System is projected to generate a total of approximately $2,500,000 between 1995 and 2001.

Dare County
Utilities System Revenue Bonds, Series 1994
Historical Operating Data

	1990	1991	1992	1993	1994
Operating Revenues					
Water Sales	$2,810,565	$2,895,114	$2,839,255	$3,032,987	$3,350,000
Fees	607,114	214,325	351,890	367,225	370,000
Assessments	0	0	0	0	0
Other	179,856	153,498	153,984	157,706	160,000
Total Operating Revenues	3,597,535	3,262,937	3,345,129	3,557,918	3,880,000
Operating Expenses					
Administration and Maintenance	2,208,588	2,043,250	2,078,037	2,158,187	2,400,000
Depreciation	631,725	654,456	713,435	757,299	780,000
Total Operating Expenses	2,840,313	2,697,706	2,791,472	2,915,486	3,180,000
Operating Income	**757,222**	**565,231**	**553,657**	**642,432**	**700,000**
Non-Operating Revenues (Expenses)					
Interest Income	0	83,970	5,300	15,597	25,000
Interest Expense	(54,794)	(56,753)	(30,899)	(13,197)	(8,000)
Transfers for Indirect Costs	0	0	(170,396)	(144,782)	(122,545)
Total Non-Operating Revenues (Expenses)	(54,794)	27,217	(195,995)	(142,382)	(105,545)
Net Income	**702,428**	**592,448**	**357,662**	**500,050**	**594,455**
Add-Back:					
Depreciation Expense	631,725	654,456	713,435	757,299	780,000
Interest Expense	54,794	56,753	30,899	13,197	8,000
Transfers for Indirect Costs	0	0	170,396	144,782	122,545
Total Add-Back	686,519	711,209	914,730	915,278	910,545
Net Revenues, as defined per Bond Ordinance	**1,388,947**	**1,303,657**	**1,272,392**	**1,415,328**	**1,505,000**

Dare County
Utilities System Revenue Bonds, Series 1994
Projected Operating Data

	1995	1996	1997	1998	1999
Operating Revenues					
Water Sales	$3,670,402	$4,075,763	$4,271,474	$4,469,116	$4,804,535
Fees	684,000	553,500	535,500	529,000	499,500
Assessments	350,000	350,000	350,000	350,000	350,000
Other	154,713	154,813	154,913	155,013	155,113
Total Operating Revenues	4,859,115	5,134,076	5,311,887	5,503,129	5,809,148
Operating Expenses					
Administration and Maintenance	2,614,264	3,024,218	3,247,884	3,479,509	3,716,880
Depreciation	862,500	1,012,500	1,020,000	1,020,000	1,020,000
Total Operating Expenses	3,476,764	4,036,718	4,267,884	4,499,509	4,736,880
Operating Income	**1,382,351**	**1,097,358**	**1,044,003**	**1,003,620**	**1,072,268**
Non-Operating Revenues (Expenses)					
Interest Income	26,000	40,510	55,020	56,270	57,020
Interest Expense	0	0	0	0	0
Transfers for Indirect Costs	(124,000)	(150,500)	(152,000)	(153,500)	(155,000)
Total Non-Operating Revenues (Expenses)	(98,000)	(109,990)	(96,980)	(97,230)	(97,980)
Net Income	**1,284,351**	**987,368**	**947,023**	**906,390**	**974,288**
Add-Back:					
Depreciation Expense	862,500	1,012,500	1,020,000	1,020,000	1,020,000
Interest Expense	0	0	0	0	0
Transfers for Indirect Costs	124,000	150,500	152,000	153,500	155,000
Total Add-Back	986,500	1,163,000	1,172,000	1,173,500	1,175,000
Net Revenues, as defined per Bond Ordinance	**2,270,851**	**2,150,368**	**2,119,023**	**2,079,890**	**2,149,288**
Debt Service on 1994 Bonds (1)	108,723	637,421	867,068	867,443	866,463
Debt Service Coverage	20.89	3.37	2.44	2.40	2.48

(1) A portion of the interest on the Series 1994 Bonds in fiscal years 1995 and 1996 is capitalized.

8.0 STATEMENT OF ASSUMPTIONS

1. Production system rate increases are included to match the level of production cost increases.

2. Production system sales are based only upon projected increases in customers and do not make any provision for increases in consumption.

3. Production system costs increases are based upon growth in customers with costs at a historical percentage of sales, (83% for Reverse Osmosis Plant; 96% for Skyco Plant).

4. Projected distribution system cost increases are based upon growth in customers with costs at a historical per connection amount, ($205 per connection for the existing system; $135 per connection for Colington; and $403 per connection, including production costs, for R-W-S) adjusted for inflation at 4% per year.

5. Distribution system retail rate increases of 3.83%, 5.00%, 5.00%, and 5.00% projected to occur on July 1, 1995, July 1, 1998, June 1, 2000, and July 1, 2002 respectively.

6. Rodanthe/Waves/Salvo sales are based upon the design engineer's and County staff's estimates.

7. Rodanthe/Waves/Salvo costs are based upon the design engineer's estimate and similar costs within the County's system.

8. Rodanthe/Waves/Salvo initial users are estimated at 500, which is 58% of existing potential users.

9. Current expense figures for the fiscal year ending June 30, 1994 are based on the County's adopted Fiscal Year 1994 Budget.

9.0 CONCLUSIONS

The Dare County Water System is well maintained and current water rates are sufficient to meet operation, maintenance and debt service costs. As operation and maintenance costs escalate due to inflation (assumed to be 3.5 - 4.0%) and growth in demand, it will be necessary to increase retail water rates approximately 5.0% every two to three years. Wholesale water rates will be increased as necessary to match increased production costs, as is the current practice. Increases in water rates plus growth of the customer base will meet the County's financial requirements.

With the proposed expansion to the water supply at R-W-S, and improvements under construction at the existing Reverse Osmosis Plant, the overall water supply will generate the required revenues.

APPENDIX

APPENDIX "A"

(4 pages)

DARE COUNTY DEPARTMENT OF HEALTH

MANTEO, NORTH CAROLINA 27954

HARRY D. JOHNSON
HEALTH DIRECTOR

May 31, 1990

P. O. BOX 1000
PHONE (919) 473-1101

MEMO

TO: Gack Austin
Commissioner, Hatteras Township

FROM: Harry Johnson, Director
Dare County Health Department

RE: Water Supply- Rodanthe, Waves, Salvo

I have for a number of years become increasingly concerned with the amount of development occurring in the Rodanthe, Waves, Salvo area. I have also from time to time voiced these concerns to the Health Board and to individual commissioners. My most fundamental concern is that the rate of development is exceeding our ability to service the area with a reliable source of potable water, a reliable means of domestic wastewater disposal, and perhaps other county services which are outside my jurisdiction but nonetheless have some impact on public health and the quality of life. My concerns are heavily influenced by the following items:

1. Lot Size: The majority of the developable property in this area was platted many years ago. Regrettably, the lots were plotted in size ranging from 5,000 to approximately 10,000 square feet. Since 1981, of course, we have required the larger lot sizes of 15,000 and 20,000 square feet depending on potable water source but there are relatively few subdivisions currently existing in this area with lot sizes this large. Density therefore, is a major concern. It ranges from 4 to 8 dwelling units per acre, depending upon the size of the lot. Obviously that implies that there are also that many septic tanks and private wells per acre. From the prospective of 20-20 hindsight a density of 2 or 3 dwelling units per acre might be manageable. Greater density, I think, increases public health risk.

2. Soil Conditions: The soils in this area are generally unsuitable for septic systems in a very technical sense. Sand, with a very high infiltration rate, combined with a very high ground water table, make a very bad combination for septic system efficiency. The proximity of miscellaneous bodies of water simply compound the problem. Developmental pressures exerted by real estate interests as well as private property owners, coupled with occasional political pressure, have tended to create a situation wherein we are allowing the installation of septic systems on increasingly marginal property. As you are well aware, the health department creates considerable agitation when we deny a septic permit. Although no elected official has ever given me explicit instructions to issue a permit that I felt was unwarranted, I have sensed a general feeling that elected officials prefer that we try to find a way to modify the property in order to make it acceptable rather than denying the permit. Notwithstanding the fact that there are a large number of lots in the Rodanthe, Waves and Salvo area that have, in fact, been denied permits, we have been as lenient in issuing permits as we possibly can be in keeping with the spirit and intent of the State sewage rules.

3. Potable Water: One requirement for a septic permit as well as healthy living is a source of potable water. There are no public water sources available in this area, and although there are a few community systems, most all potable water must be obtained through private wells. The standard minimum separation distance between a septic system and a private well is 100 feet. There is, however, an exemption paragraph in the sewage rules that allows for lots platted prior to 1977 a discretionary reduction of this distance to as little as 50 feet. On the small lots, as indicated in item one above, it is physically impossible to obtain a 100 foot separation. Consequently, if we did not allow the reduction in separation distances the lots would have to be declared non-buildable, to the distress of many property owners. The only potable water source is a fresh water lens which lies approximately 10 to 25 feet below the surface of the ground. There is frequent salt water intrusion into this lens under natural circumstances. This fresh water lens is recharged exclusively via rainfall. In order to reach the fresh water aquifer the rainwater has to filter through the same soils

that also have to filter our septic system wastewater. Waste effluents enter the soil and move into the groundwater system as easily as rainfall. I am not a hydrologist but I expect that the high porosity of our soils allows all infiltration to infiltrate too quickly. In other words, I cannot be sure that the existing soils properly purify septic effluent before it gets to the fresh water lens. Increasing the number of septic systems, as well as all other pollutants created by human habitation, tends to increase the risk of pollution. The fresh water lens is highly variable, dependant entirely on adequate rainfall to recharge it and heavily influenced by user demand (discharge) placed upon it. It also is influenced frequently by ocean or sound overwash.

Our recent conversation generated a review of some old studies. There was a groundwater resources study done by the United States Geological Unit of the Department of the Interior in 1975. It depicts the groundwater resources for the entire Outer Banks from Whalebone Junction to Hatteras Inlet. I believe that this study is still very accurate. It substantuates the fact that in the Rodanthe, Waves, Salvo area there is very little in the way of groundwater resources that could be considered potable... There was a study on water supply and treatment entitled, "Alternatives for Villages of Rodanthe, Waves, Salvo", which was done in April 1982. It studied five alternatives for provision of water to this area and concluded that the most feasible method was connecting Rodanthe, Waves and Salvo to the Cape Hatteras Water Association Distribution System at Avon. Reverse Osmosis was a consideration, however it was ruled out at that time due primarily to the cost, particularly the operation and maintenance cost. This study was a fairly superficial study and is much outdated now. I am not even certain who authored it. Even so, there are a few tidbits of information in it that would still be applicable today. I also have a copy of the final Environmental Impact Statement done for the Avon Water Project in order to connect to the Cape Hatteras Water Association System. It was done by the Farmers Home Administration to discuss the environmental impact of tying in Avon to the Cape Hatteras Water Association water supply system. It was performed in 1977 and it too is obviously outdated now. Nonetheless, it still is interesting reading and much of what is contained in this study might still be applicable today, particularly in regard to ecological and environmental concerns. The Dare County Carrying Capacity Study done in 1985 addresses a great number of issues for all of Dare County, but in particular it addresses these issues by geographic district, one of which is the Rodanthe, Waves and Salvo area. I thought this was a very well done study but I am afraid that few people bother to read it anymore and that much of what is contained therein goes largely unheeded.

I have not been privy to any of the subsequent studies pertaining specifically to the Reverse Osmosis proposal for this area other than a general

awareness gleaned through newspaper accounts and informal discussions with various county officials. It is therefore risky for me to make assumptions based on a limited knowledge of what is contained in these studies. I believe, however, that there is not much argument in terms of the need for and the desirability of a reliable source of potable water for this area. I also suspect that Bob Slade and the current County Commissioners have a legitimate concern about the economic viability and feasibility of a reverse osmosis plant for this area. I have absolutely no quarrel with Mr. Slade's recommendation to update the existing studies involving this project. I would be very pleased to contribute to and be a part of these studies in any way that I can. I am afraid that if we don't do something fairly quickly about the water supply system that the Health Department may be put in a position of having to cease issuing septic system permits. As you know, I do not have the inhouse expertise to conduct a full blown study but our local intuitive knowledge about this area leads me to believe that the quality of water currently being consumed is exceedingly poor. It comes through the faucets looking like iced tea, smells like rotten eggs, and tastes like medicine. We know for a fact that it is easily infiltrated by salt water and although I cannot prove it, there may be reason to suspect eventual, if not present, contamination by septic effluent. Even though our permits precisely indicate where the wellpoints are located relative to the septic systems at the time of final inspections, I cannot verify that they remain in that location after the inspector has departed. Also, we do not inspect the quality or quantity of water produced by these wellpoints. If the county were to institute a formal testing program and if those samples proved to be contaminated to any degree, I might have no choice but to cease issuing permits.

If development is to continue in this area, it is absolutely essential that a potable water supply be developed. Whereas it may not resolve every public health problem or even other problems such as increased demand for municipal services, it would at least remove one variable in that we would not have to be concerned about contamination of wells. The overall issue of how much development should be allowed and what type development should be allowed are more appropriately issues for the Planning Board and the County Commissioners to resolve. At the present time, due largely to the lack of zoning for this area, the burden of whether or not a piece of property is developable and what type of use might be applied to that property falls squarely on the shoulders of the Health Department. If we can authorize a septic permit then there generally is no problem obtaining a building permit. Whether or not we should continue to be relatively lenient in issuing permits or whether or not we should be coming more restrictive is a legitimate concern. Lastly, as a counterpoint, I would hope that you and the other commissioners would realize that whereas provision of a reliable potable water source by a reverse osmosis treatment plant or any other means would solve one problem, in a broader prospective it may create even greater problems by creating more intense pressure to develop the land without regard to lack of an effective methodology of wastewater disposal or increased risk of pollution of our estaurine via septic seepage and surface water runoff, and by generation of greater demand for all other county services.