WANCHESE WATER STUDY

Prepared for

Dare County
Board of Commissioners
Manteo, North Carolina 27954

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1.0 SUMMARY & RECOMMENDATIONS

The Dare County Regional Water System, located at Skyco, began operation in 1980 with the belief that a long-term solution to Dare County's water supply demand had been addressed. Heavy growth in the County, in those areas supplied by regional water, caused the necessity for well production to be increased and new wells were added in Southern Roanoke Island. Individual private wells in the Wanchese area of Roanoke Island began to dry up as additional water demand increased during peak summer usage periods. Research indicated the problem to be caused by draw down from the region water well fields affecting the shallow aquifer utilized by private wells in Wanchese. In an effort to accommodate the residents of Wanchese, whose shallow wells were affected, wells were replaced with deeper wells from 1984 to 1987. In 1987, the towns of Kill Devil Hill, Nags Head and Dare County activated the Fresh Pond as a water source to relieve the demand on the Wanchese area aquifer. Basically, that remains the status quo. As Wanchese is predicted to grow and require more water, the question arises as to when would it become feasible to extend a water distribution system to the Wanchese area to prevent the existing private well demands from competing with regional water demands.

A review of the alternatives investigated show that much money has been expended in replacing private wells and these funds cannot be recovered. It is, therefore, not presently deemed feasible to extend water service into the Wanchese area since the water demand required for cost effectiveness has been mitigated with a policy of replacement of private wells rather than a policy to extend regional water service. However, should some event occur to trigger rapid growth in Wanchese (such as a jettied Oregon Inlet), then at that time, a new look should be given toward extending a water distribution system into Wanchese. The alternatives reviewed will remain viable until such time, however costs may well vary upward. Nonetheless, the community, until water distribution lines are installed, will unfortunately remain without adequate fire protection.

2.0 INTRODUCTION

2.1 Authority

The Dare County Board of Commissioners commissioned the engineering firm of Quible & Associates, P.C. to conduct a study to determine the feasibility of extending water lines and services to the unserved areas of Wanchese/Skyco.

2.2 Purpose and Scope of Study

The purpose of this study is to review the feasibility of extending water distribution lines and service into the Wanchese/Skyco area to provide an adequate water supply for consumption and for fire protection. The study consists of an evaluation of the existing water supply for Wanchese, design and cost analysis of several alternative water distribution systems.

2.3 Prior Studies and Reports

Two previous reports have been presented to the Dare County Board of Commissioners concerning the supply of potable water for Dare County:

2.3.1 "Comprehensive Engineering Report on Water System Improvements for County of Dare" by Moore, Gardner and Associates, Inc., March 1984.

2.3.2 "Report on Water Supply and Treatment Alternatives for Dare County, North Carolina" by Black and Veach, Inc., January 1987.

3.0 EXISTING CONDITIONS

3.1 Community Description

3.1.1 Generally

The south end of Roanoke Island is made up of the communities of Skyco and Wanchese.

Skyco, a small residential community, is located adjacent to the Dare County Regional Water Treatment Plant, some four miles north of Wanchese. Its close proximity to the Treatment Facility caused this study to focus on the much larger needs and requirements and more individualized area of Wanchese.

Of the over 5,000 acres of land that make up Wanchese, only 20% of this area is available for development; the remainder has been delineated as wetlands. Only some 25% of the available developable land has been improved in the following manner: 540 residences, 84 mobile homes, 2 restaurants, 10 warehouses, 5 offices, 2 churches, 10 miscellaneous retail businesses, 12 light manufacturing facilities, and an industrial seafood park.

This community of fishermen, churches and fish houses has a history related to the sea and has escaped, to date, the commercialization of Dare County's nearby beach strands.

However, rapid growth in other areas of Dare County and growth predictions for all of Dare County has caused the residents of Wanchese, and other unzoned areas, to begin to voice

concerns about future planning and growth controls to keep unregulated and unanticipated development which makes water supply sources susceptible to contamination by flooding, saltation, or septic discharges.

3.1.2 Wanchese Seafood Industrial Park

In 1981, the Wanchese Seafood Industrial Park, constructed on the north end of Mill Landing, was completed. This 23-acre site was designed to accommodate an ever-growing fleet of modern fishing vessels with processing and canning facilities in an effort to create a North Carolina based seafood operation creating jobs and promoting and developing a traditional North Carolina industry. The Park more than doubled the capacity for seafood processing and packing houses and represents another growth catalyst for the Wanchese community, especially, if a year-round stabilized access to the Atlantic Ocean through Oregon Inlet can be secured.

3.2 WATER SUPPLIES

3.2.1 Community Generally

The area of Roanoke Island, including Skyco and Wanchese, is supplied by private individually-operated shallow and deep well pump systems. The community, in 1980 when the Dare Regional Water System was completed, did not wish to be included, and no distribution system was installed. There are still a

number of residents who remained opposed to the receipt of County supplied water (feasible or not).

3.2.2 Dare County Regional Water Supply System

The Dare County regional water system was completed in 1980. This system was designed primarily to supply raw water to the existing treatment plants and distribution systems at Nags Head, Kill Devil Hills and Manteo. Water for the regional system is supplied by eight (8) deep wells located primarily between Skyco to the north and Wanchese to the south. In addition, a County distribution system was added in the Kitty Hawk, Southern Shores and Duck areas. Very little treated water is consumed on Roanoke Island; of the peak six (6) million gallons per day (gpd) usage, only approximately 500,000 gpd is consumed on the Island.

The system, when brought on line in 1980, was only 40% of design capacity but, by 1987 had reached full capacity averaging around 15% per year growth in demand. Other studies revealed several possible alternatives beginning with the addition of more production wells near Wanchese and treatment plant expansion. A second alternative included production wells on the Mann's Harbor mainland and thirdly, desalinization.

The first alternative was not deemed appropriate because the eight existing production wells near Wanchese

and Skyco had, as production from 1980 to 1987 dramatically increased, caused draw down of such a magnitude that several hundred private wells in Wanchese and Skyco were adversely affected either by salt intrusion or by drying up. In order to combat the private well problems, the County had two (2)choices: provide replacement wells or install a distribution system in Wanchese. Since 1986, all existing private wells affected by loss of water or salinity have been replaced at a cost of near $1 million primarily because of the public sentiment against the receipt of County water. Though the existing private well problems were addressed, future plans for the Wanchese area and the regional system remained to be addressed.

3.2.3 Nags Head Fresh Pond Plant

1 million gallons per day (mgpd) added in 1986 to reduce demand on the Roanoke Island aquifers.

3.2.4 Dare County Reverse Osmosis Water Treatment Plant

In 1987, as a result of studies by Black & Veach in an effort to address the draw down problem at Wanchese, and because Mann's Harbor wells presented transmission problems, a joint decision was made by Dare County, Kill Devil Hills & Nags Head to construct a desalination water treatment plant with an 8 mgpd capacity. The plant was authorized and recently began operating in Kill Devil Hills. The desalination plant was preferred pri-

marily because of the reduction in transmission costs, compared to the distance from the Wanchese well fields, and to reduce draw down and extend the life of the Wanchese area well fields which are at capacity. Now with the desalination plant completed, the production necessary from the Skyco regional water plant will be reduced by at least 50% under normal operations (non-tourist season).

3.2.5 Wanchese Seafood Industrial Park

The Wanchese Seafood Industrial Park has an independent central water system consisting of one, 200 gpm pump, a 0.25 mg elevated storage tank and 3400 feet of 8' inch distribution line. Water is supplied from one on-site deep well with a 250 gpm capacity. Once pumped, this water is chlorinated and placed in the storage tank for park use. No major improvements have been made to the Park's system since its opening. .36MGD

Upon request of Dare County, to be made a part of this study, the Wanchese Seafood Industrial Park Authority was contacted and asked whether they wished to be included in our review for possible future connection to the Dare County Regional Water System. The Authority decided not to ask to be included at this time, but asked that consideration be given to the extension of water in the close proximity of the Park but that no connection be made. This study reflects the Seafood Park Authority's wishes.

3.2.6 Existing Fire Protection

Primary fire protection for the community of Wanchese is provided by the Wanchese Volunteer Fire Department. The Department has two (2) pumper trucks, one with a tank capacity of 1000 gallons and the other with a 750 gallon capacity. Both trucks are equipped with 1000-feet of suction hose to be able to utilize a canal, or the Sound as a water source. Pumping capacity is 1000 gpm. In extreme emergencies, the Manteo Fire Department responds with mutual aid with three (3) trucks with tank capacities of 2000, 750, & 500 gallons. Fires not located within pumping distance of a major water source are fought by a shuttle system of refilling pumper truck water tanks.

4.0 PLAN FORMULATION

4.1 Problems and Needs

Operation of the deep wells of the Dare County Regional Water Supply System located between Skyco and Wanchese caused the shallow wells in Wanchese to "dry up." In order to relieve this problem, the County installed deep wells to replace the shallow individual dry wells in Wanchese. These replacement wells supply potable water but do not provide fire protection. Also, there is no provision for future expansion or growth. Four design alternatives have been considered to meet the present and future needs for fire protection and growth as well as a more dependable and greater quantity and quality water supply for individual users. Each alternative has been examined in detail from the standpoint of hydraulics, environmental implications, costs and the appropriate criteria.

4.2 Descriptions of Alternatives Considered

4.2.1 Alternative 1 (Figure 1)

Use existing Skyco elevated storage tank, water treatment plant and existing production wells on Roanoke Island as water supply. The alternative includes running a 16-inch water transmission line from the Skyco tank to Wanchese and connecting to a network of waterlines located in Wanchese. This alternative would also include supplying water to Skyco.

4.2.2 Alternative 2 (Figure 2)

If alternative one does not supply adequate pressure to the waterline network, add a booster station on the main 16-inch transmission line in the vicinity of Baum Town Road.

4.2.3 Alternative 3 (Figure 3)

Construct a new elevated storage tank and water treatment plant in vicinity of Baum Town Road. Use an existing production well on Roanoke Island in the vicinity of this new tank as the water source. This new tank would supply water to a network of waterlines located in Wanchese. This alternative would not include Skyco and would reduce the Skyco system by one well.

4.2.4 Alternative 4

No changes or additions to the Wanchese water supply system at this time.

4.3. Design Criteria

Each alternative was evaluated based on compliance with criteria presented in this section.

The design of the water line network was based on a thirty-year projection of the number of improvements to be expected in Wanchese. Users were divided into four categories: single-family houses, restaurants, boat works and fish houses. The design number used was as follows:

Single-family Housing	871 units
Restaurants	2 each
Fish houses	6 each
Boat Works	4 each

The peak daily flow for each use was determined using North Carolina State Guidelines for water usage. The peak daily flows for each use, according to this criteria, are as follows:

Single-family Housing	400 GPD/unit on 0.27 GPM/unit
Restaurants	40 GPD/seat on 0.03 GPM/seat
* Fish Houses	11,600 GPD/unit or 8.10 GPM/unit
* Boat Works	3,600 GPD/unit or 2.50 GPM/unit

* These values were generated from numbers obtained from existing fish houses and boat works in Wanchese.

Water line layout was designed to be consistent with the Rules Governing Public Water Supplies Sections .0600 through .2600 of the North Carolina Administrative Code, Title 10, Department of Human Resources, Chapter 10, Division of Health Services, along with suggestions from the Dare County Water Department. The criteria used were as follows:

A. Six-inch diameter lines (minimum) for fire protection

B. Fire hydrants at all intersections and every 500 feet between intersections

C. Two gate valves at a tee and three water valves at a cross

D. Blow offs or fire hydrants at end of dead-end lines

E. Looped water lines as much as possible

F. Forty pounds per square inch (PSI) of static pressure at fire hydrants and 20 PSI for residual pressure at fire hydrants

G. One thousand gallons per minute (1,000 gpm) flow at fire hydrants

4.4 Calculations

Each of the three alternatives were analyzed in a computer model using the Hardy-Cross method of establishing water flow and pressure (printouts available). Each alternative was reviewed using different conditions such as fire flows on certain lines, peak hour flows (i.e. 2.5 times peak daily flow) and static pressure on all lines (i.e. no flow-through system). After each alternative was computed, it was reviewed to see if adequate pressure was delivered throughout the entire network.

The main objective of this analysis is not only to provide potable water to Wanchese but to ensure adequate pressure in lines to provide proper fire protection to the entire village of Wanchese. All options were analyzed under different conditions. The conditions were:

A. Peak daily flow

B. Peak hourly flow

C. Peak daily flow with one fire flow, at two different locations on dead-end lines

D. Peak daily flow with two fire flows on loop lines

E. Static pressure test

4.5 Economic Analysis

This section is designed to provide an economic analysis of each alternative. Cost data are developed from talks with local contractors, water system operators and municipalities in Dare County. An 8.5% discount rate is applied for evaluation and a thirty-year project life is assumed. Estimated costs reflect 1989 price levels.

4.5.1 Benefit Analysis

The primary economic benefit to be derived from the first three alternatives would be the reduction in fire insurance rates provided by the improvement in fire protection and elimination of well maintenance cost by individual users. Non-economic benefits to the area coming from a central water distribution system would be an enhancement of the quality of life which follows the acquisition of a dependable water supply. For example, purchase of washing machines, updating of toilet and bathing facilities.

4.5.2 Cost Analysis

Table 1 (attached) gives a detailed breakdown of construction costs for each alternative. These costs are summarized below in Table 2.

TABLE 2

Alternative No.	Construction Cost
1	$ 2,279,600
2	$ 2,582,100
3	$ 3,003,600
4	-0-

Average annual costs are shown in Table 3. These costs are based on a thirty-year project life, 8.5% interest rate and a capital recovery factor (CRF) of 0.09301.

TABLE 3

Alternative Number 1

Construction Costs:	$ 2,279,600 x CRF =	$ 212,018
Maintenance and Operation:	Pipelines	30,000
	Average Annual Cost	$ 242,018

Alternative Number 2

Construction Costs:	$ 2,582,100 x CRF =	$ 240,154
Maintenance and Operation:	Pipelines	30,000
	Booster Station	20,000
	Average Annual Cost	$ 290,154

Alternative Number 3

Construction Costs:	$ 3,003,600 x CRF =	$ 279,358
Maintenance and Operation:		
Pipeline		20,000
Water Treatment Plant		100,000
Elevated Storage Tank		15,000
	Average Annual Cost	$ 414,358

The average annual cost for each alternative shows the cost consisting of the amount required to recover the construction costs over the thirty-year project life. Also included is the annual maintenance and operating cost which must be accounted for each year if the project is to pay for itself.

Cost analyses shown on Figures 4, 5 and 6 show the gains and losses associated with each alternative. This analysis is based on the several assumptions shown. Several points need to be considered when reviewing these analyses. Alternative 1 is the least involved of the first three. Alternatives 2 and 3

present unknowns with regard to replacement and maintenance of the plant, storage tanks and booster station. Alternative 3 calls for the construction of a water treatment plant. This plant should be part of the Dare County Regional Water System, otherwise added development pressure will be placed on the Town of Wanchese to accelerate recovery of the capital costs through additions of users, higher water rates, etc.. One further point is the capital expended initially can be recovered sooner if a grant is obtained from the Regional Water System to reduce the construction cost outlay. At a later time, increased user rates and front-foot assessments are two ways to help recover initial costs sooner.

4.6 Results of Hydraulic Study

Alternative 1 (using existing Skyco elevated water storage tank)

This alternative provided adequate flows and pressures under peak daily flow, peak hourly flow and static pressure test. Fire flow and pressure were adequate when applying two fire flows to lines which were looped. Fire flow and pressure, however, were not adequate when applying a single fire

flow to a dead-end (non-looped) line. Negative pressures were shown in the lines leading to the area of the fire flow. Elimination of dead end lines should improve the flow and pressure conditions. However, this aspect was not included in the hydraulic analysis due to the impracticality of extending water lines through, over or under, existing canals and marshes plus the environmental problems such construction would generate.

Alternative 2 (adding a booster station at Baum Town Road)

This alternative provided adequate flows and pressures under all conditions tested. This system would produce negative pressures if more than two fire flows were applied on dead-end lines at one time.

Alternative 3 (new elevated storage tank and water treatment plant at Baum Town Road)

Results were similar to those in Alternative Number 1 with a slight increase in pressure throughout the system due to the fact that the water tower was closer to the water distribu-

tion system in Wanchese. Fire flow and pressure was still not adequate when applying a single fireload to a dead-end (non-looped) line. Recommendation to eliminate dead-end lines apply to this alternative also.

4.7 Conclusions

The elevated water storage tank at Skyco alone provides adequate flow and pressure to Wanchese under normal non-fire flow conditions. Due to the fact that there are so many dead-end lines, any time a fire flow is applied to one of these lines, negative flows are produced. To solve this problem, the booster station was necessary. However, a better solution might be to try to loop some of these dead-end lines together by means of easements through private property where practical. To eliminate all dead-end lines may be impractical in some areas of Wanchese where existing canals and waterways would prohibit the physical connection of the two dead-end lines. This report does not include an analysis of the situation above as it is believed to be impractical due to environmental complications and high construction costs.

After reviewing the results from Alternatives 1 and 3, neither system delivers adequate flow and pressure to Wanchese under a fire flow condition at the end of a dead-end line. To

solve this lack of pressure, a booster station would be needed in distribution system when the system is under fire flow conditions. Since both alternatives needed a booster station, to provide pressure for fire flow, alternative 3 was not considered because of the expense of constructing a new water tower and water treatment plant.

The fourth alternative, no changes or additions to the existing Wanchese water supply system, was considered from the standpoint of economics. This alternative proposes to wait for five years, at least, before implementing any changes. During this time monitor the growth and water demands in Wanchese and utilize the existing new wells recently developed. If the proposed navigation jetties are constructed in Oregon Inlet, for example, Wanchese could experience an acceleration in growth both commercially and residentially, however, such growth is unlikely to occur within the next five (5) years.

If it is felt that something should be done, i.e., if Alternative 4 is not chosen, then the following course of action is recommended:

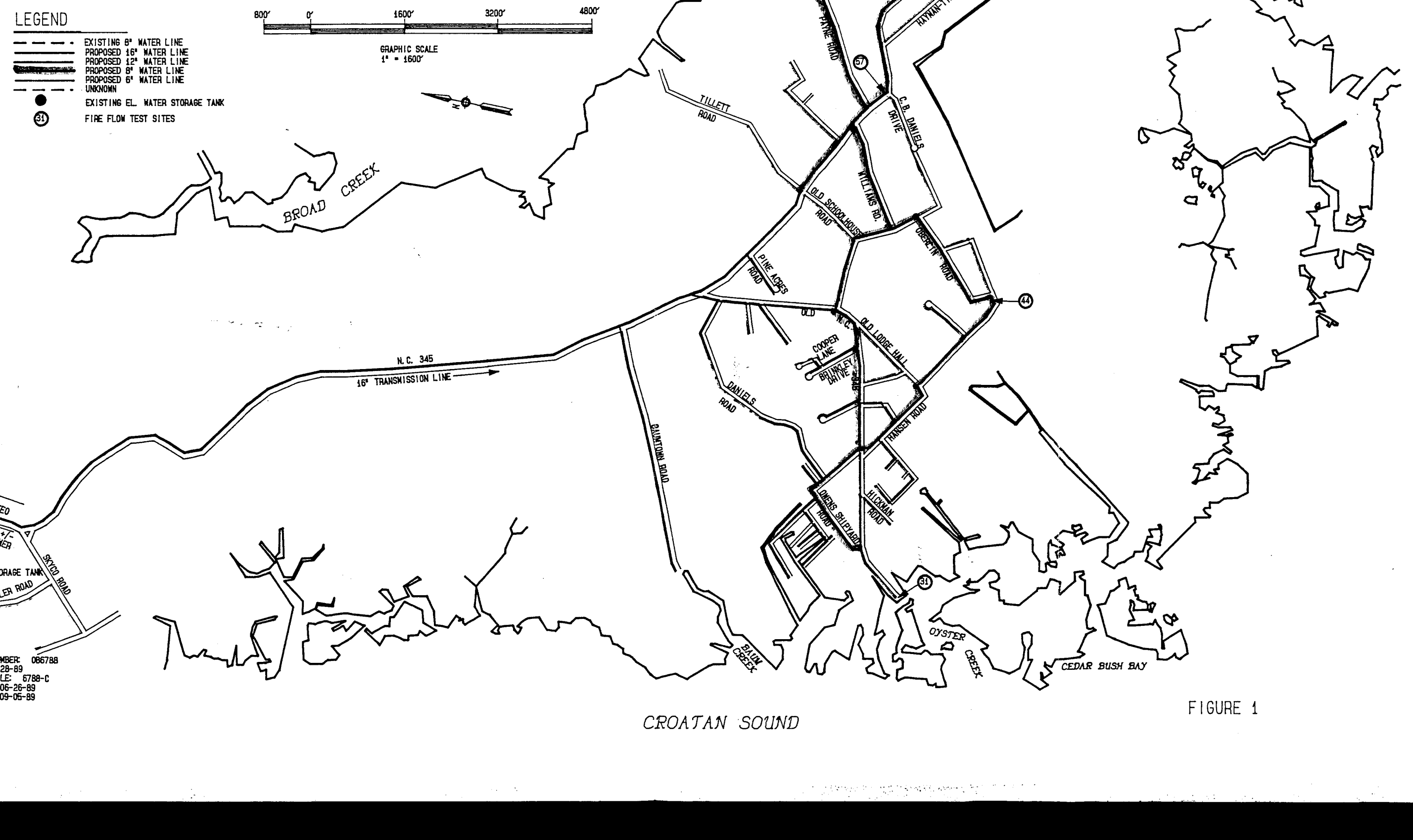
> Choose Alternative 1. Concurrently initiate a study to determine the feasibility of eliminating the dead end lines from the distribution network in Wanchese. Costs

of rights-of-way, environmental problems and construction feasibility, as well as construction costs, must be considered. The cost of this should be compared to the cost of adding a booster station. This evaluation is beyond the scope of this present study.

5.0 CONCLUSIONS & RECOMMENDATIONS

PROPOSED WANCHESE WATER DISTRIBUTION SYSTEM

ALTERNATIVE NUMBER 1
(Using Existing Skyco Elevated Water Tank & 16 Inch Transmission Line)



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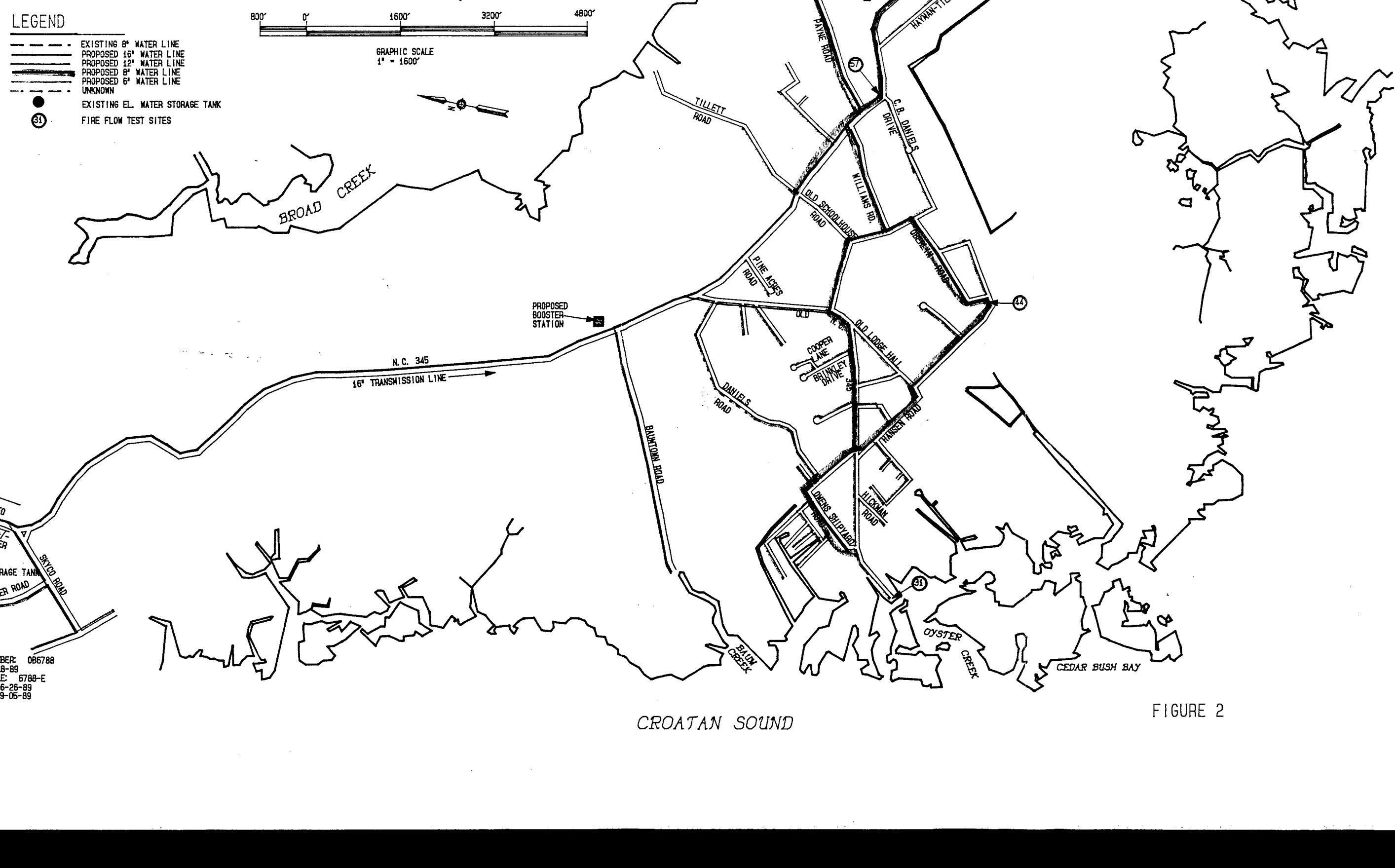
REVISED: 06-26-89
REVISED: 09-05-89

FIGURE 1

PROPOSED WANCHESE WATER DISTRIBUTION SYSTEM

ALTERNATIVE NUMBER 2

(Using Existing Skyco Elevated Water Tank With 16 Inch Transmission Line and Booster Station At Baumtown Road)



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REVISED: 09-05-89

FIGURE 2

PROPOSED WANCHESE WATER DISTRIBUTION SYSTEM

ALTERNATIVE NUMBER 3

(Construct New Elevated Storage Tank And Treatment Plant At Baumtown Road)

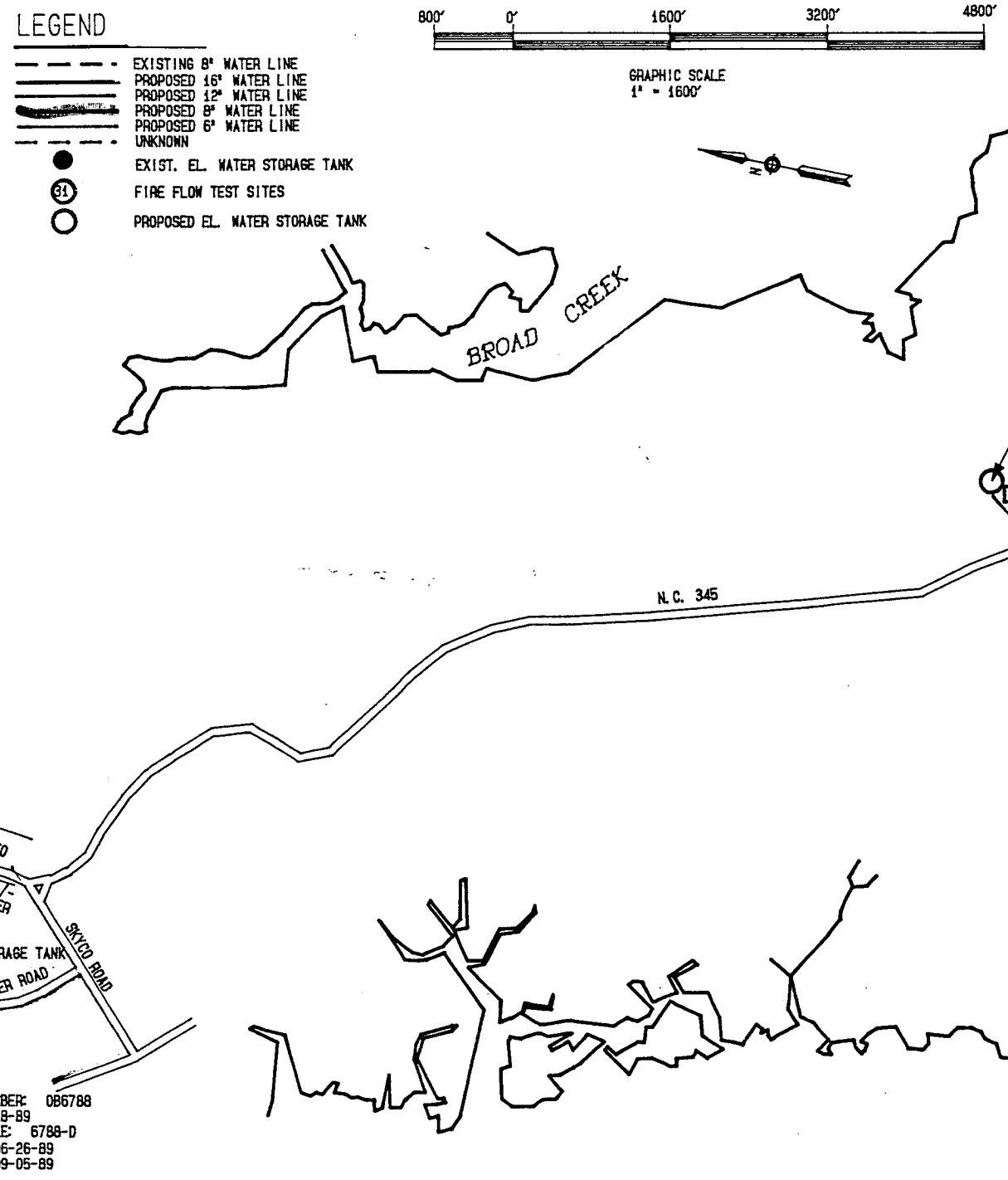

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FIGURE 3

TABLE 1

MATERIALS	UNIT COST	OPTION 1	COST	OPTION 2	COST	OPTION 3	COST
16" Pipeline	$17/ft	17542 ft	298200	17542 ft	298210	2410 ft	40970
12" Pipeline	15/ft	8810 ft	132150	8810 ft	132150	8810 ft	132150
8" Pipeline	13/ft	23260 ft	302380	23260 ft	302380	23260 ft	302380
6" Pipeline	8/ft	41161 ft	329290	41161 ft	329290	35610 ft	284880
2" Pipeline	4/ft	986 ft	4000	986 ft	4000	986 ft	4000
Gate Valves	450 ea	36 ea	16200	36 ea	16200	36 ea	16200
Tap Sleeves							
Hydrants	1400 ea	139 ea	194600	139 ea	194600	139 ea	194600
Tees	200 ea	40 ea	8000	40 ea	8000	40 ea	8000
Elbows	140 ea	18 ea	2520	18 ea	2520	18 ea	2520
Reducers		32 ea		32 ea		32 ea	
Casings 2" bore @30'	30 ft	91x30 ft	82000	91 ea	82000	91 ea	82000
Casings 12"bore @80'	80 ft	128x30 ft	307200	128 ea	307200	128 ea	307200
Meter Deposit/Service	324	556 ea	180140	556 ea	180140	556 ea	180140
SUB TOTAL			1,856680		1856690		1555040
El. Storage Tank (0.20 mg)	400000	0	0		0		400000
Treatment Plant	500000	0	0		0		500000
Booster Station	250000	0	0		250000		0
SUB TOTAL			1,856680		2106690		2455040
Engr/Surveys	10%		185670		210670		245500
Admin. Fees	10000		10000		10000		10000
Rights-of-Ways	20000		20000		20000		20000
Legal Fees							
SUB TOTAL			2,072350		2347360		2730540
Contingency (10%)	10%		207230		234740		273050
TOTAL CONST. COST			2,279580		2582090		3003600
			=========		=======		=======
ANNUAL COST							
30 yr. 8.5% CRF=.09301							
Construction Cost			212018		240154		279358
M&O							
Pipeline			30000		30000		20000
Plant			-		-		100000
Tank			-		-		15000
Booster Station					20000		
TOTAL ANNUAL CHARGES			242,018		290154		414350

Assumptions	
Option 1 Capital Cost	$2,279,580
Initial Users	556
Additional Users per Year	12
Impact Fee for New Users	$2,000
Tap Fee per User	$324
Tap Cost per User	$324
Average Gallons per User	6000
Base Monthly Charge(3000 gal.)	$15
Additional Charge per 1000 gal	$4
Annual Operating Cost per User	$162
Imputed Interest Rate	8.50%

Year	Total Users	Capital Costs	Operating Expenses	Total Costs and Expenses	Tap Fees	Impact Fees	Annual User Charges	Total Fees and Charges	Annual Excess/ (Deficit)	Cumulative Excess/ (Deficit)	Imputed Interest Expense Earnings
0	556	$2,459,724	$0	$2,459,724	$180,144	$0	$0	$180,144	($2,279,580)	($2,279,580)	($193,764)
1	556	$3,888	$90,072	$93,960	$3,888	$24,000	$180,144	$208,032	$114,072	($2,165,508)	($184,068)
2	568	$3,888	$92,016	$95,904	$3,888	$24,000	$184,032	$211,920	$116,016	($2,049,492)	($174,207)
3	580	$3,888	$93,960	$97,848	$3,888	$24,000	$187,920	$215,808	$117,960	($1,931,532)	($164,180)
4	592	$3,888	$95,904	$99,792	$3,888	$24,000	$191,808	$219,696	$119,904	($1,811,628)	($153,988)
5	604	$3,888	$97,848	$101,736	$3,888	$24,000	$195,696	$223,584	$121,848	($1,689,780)	($143,631)
6	616	$3,888	$99,792	$103,680	$3,888	$24,000	$199,584	$227,472	$123,792	($1,565,988)	($133,109)
7	628	$3,888	$101,736	$105,624	$3,888	$24,000	$203,472	$231,360	$125,736	($1,440,252)	($122,421)
8	640	$3,888	$103,680	$107,568	$3,888	$24,000	$207,360	$235,248	$127,680	($1,312,572)	($111,569)
9	652	$3,888	$105,624	$109,512	$3,888	$24,000	$211,248	$239,136	$129,624	($1,182,948)	($100,551)
10	664	$3,888	$107,568	$111,456	$3,888	$24,000	$215,136	$243,024	$131,568	($1,051,380)	($89,367)
11	676	$3,888	$109,512	$113,400	$3,888	$24,000	$219,024	$246,912	$133,512	($917,868)	($78,019)
12	688	$3,888	$111,456	$115,344	$3,888	$24,000	$222,912	$250,800	$135,456	($782,412)	($66,505)
13	700	$3,888	$113,400	$117,288	$3,888	$24,000	$226,800	$254,688	$137,400	($645,012)	($54,826)
14	712	$3,888	$115,344	$119,232	$3,888	$24,000	$230,688	$258,576	$139,344	($505,668)	($42,982)
15	724	$3,888	$117,288	$121,176	$3,888	$24,000	$234,576	$262,464	$141,288	($364,380)	($30,972)
16	736	$3,888	$119,232	$123,120	$3,888	$24,000	$238,464	$266,352	$143,232	($221,148)	($18,798)
17	748	$3,888	$121,176	$125,064	$3,888	$24,000	$242,352	$270,240	$145,176	($75,972)	($6,458)
18	760	$3,888	$123,120	$127,008	$3,888	$24,000	$246,240	$274,128	$147,120	$71,148	$6,048
19	772	$3,888	$125,064	$128,952	$3,888	$24,000	$250,128	$278,016	$149,064	$220,212	$18,718
20	784	$3,888	$127,008	$130,896	$3,888	$24,000	$254,016	$281,904	$151,008	$371,220	$31,554
21	796	$3,888	$128,952	$132,840	$3,888	$24,000	$257,904	$285,792	$152,952	$524,172	$44,555
22	808	$3,888	$130,896	$134,784	$3,888	$24,000	$261,792	$289,680	$154,896	$679,068	$57,721
23	820	$3,888	$132,840	$136,728	$3,888	$24,000	$265,680	$293,568	$156,840	$835,908	$71,052
24	832	$3,888	$134,784	$138,672	$3,888	$24,000	$269,568	$297,456	$158,784	$994,692	$84,549
25	844	$3,888	$136,728	$140,616	$3,888	$24,000	$273,456	$301,344	$160,728	$1,155,420	$98,211
26	856	$3,888	$138,672	$142,560	$3,888	$24,000	$277,344	$305,232	$162,672	$1,318,092	$112,038
27	868	$3,888	$140,616	$144,504	$3,888	$24,000	$281,232	$309,120	$164,616	$1,482,708	$126,030
28	880	$3,888	$142,560	$146,448	$3,888	$24,000	$285,120	$313,008	$166,560	$1,649,268	$140,188
29	892	$3,888	$144,504	$148,392	$3,888	$24,000	$289,008	$316,896	$168,504	$1,817,772	$154,511
30	904	$3,888	$146,448	$150,336	$3,888	$24,000	$292,896	$320,784	$170,448	$1,988,220	$168,999
Totals		$2,576,364	$3,547,800	$6,124,164	$296,784	$720,000	$7,095,600	$8,112,384	$1,988,220		($755,244)

FIGURE 4

Assumptions	
Option 2 Capital Cost	$2,582,090
Initial Users	556
Additional Users per Year	12
Impact Fee for New Users	$2,000
Tap Fee per User	$324
Tap Cost per User	$324
Average Gallons per User	6000
Base Monthly Charge(3000 gal.)	$15
Additional Charge per 1000 gal	$4
Annual Operating Cost per User	$162
Imputed Interest Rate	8.50%

Year	Total Users	Capital Costs	Operating Expenses	Total Costs and Expenses	Tap Fees	Impact Fees	Annual User Charges	Total Fees and Charges	Annual Excess/ (Deficit)	Cumulative Excess/ (Deficit)	Imputed Interest Expense Earnings
0	556	$2,762,234	$0	$2,762,234	$180,144	$0	$0	$180,144	($2,582,090)	($2,582,090)	($219,478)
1	556	$3,888	$90,072	$93,960	$3,888	$24,000	$180,144	$208,032	$114,072	($2,468,018)	($209,782)
2	568	$3,888	$92,016	$95,904	$3,888	$24,000	$184,032	$211,920	$116,016	($2,352,002)	($199,920)
3	580	$3,888	$93,960	$97,848	$3,888	$24,000	$187,920	$215,808	$117,960	($2,234,042)	($189,894)
4	592	$3,888	$95,904	$99,792	$3,888	$24,000	$191,808	$219,696	$119,904	($2,114,138)	($179,702)
5	604	$3,888	$97,848	$101,736	$3,888	$24,000	$195,696	$223,584	$121,848	($1,992,290)	($169,345)
6	616	$3,888	$99,792	$103,680	$3,888	$24,000	$199,584	$227,472	$123,792	($1,868,498)	($158,822)
7	628	$3,888	$101,736	$105,624	$3,888	$24,000	$203,472	$231,360	$125,736	($1,742,762)	($148,135)
8	640	$3,888	$103,680	$107,568	$3,888	$24,000	$207,360	$235,248	$127,680	($1,615,082)	($137,282)
9	652	$3,888	$105,624	$109,512	$3,888	$24,000	$211,248	$239,136	$129,624	($1,485,458)	($126,264)
10	664	$3,888	$107,568	$111,456	$3,888	$24,000	$215,136	$243,024	$131,568	($1,353,890)	($115,081)
11	676	$3,888	$109,512	$113,400	$3,888	$24,000	$219,024	$246,912	$133,512	($1,220,378)	($103,732)
12	688	$3,888	$111,456	$115,344	$3,888	$24,000	$222,912	$250,800	$135,456	($1,084,922)	($92,218)
13	700	$3,888	$113,400	$117,288	$3,888	$24,000	$226,800	$254,688	$137,400	($947,522)	($80,539)
14	712	$3,888	$115,344	$119,232	$3,888	$24,000	$230,688	$258,576	$139,344	($808,178)	($68,695)
15	724	$3,888	$117,288	$121,176	$3,888	$24,000	$234,576	$262,464	$141,288	($666,890)	($56,686)
16	736	$3,888	$119,232	$123,120	$3,888	$24,000	$238,464	$266,352	$143,232	($523,658)	($44,511)
17	748	$3,888	$121,176	$125,064	$3,888	$24,000	$242,352	$270,240	$145,176	($378,482)	($32,171)
18	760	$3,888	$123,120	$127,008	$3,888	$24,000	$246,240	$274,128	$147,120	($231,362)	($19,666)
19	772	$3,888	$125,064	$128,952	$3,888	$24,000	$250,128	$278,016	$149,064	($82,298)	($6,995)
20	784	$3,888	$127,008	$130,896	$3,888	$24,000	$254,016	$281,904	$151,008	$68,710	$5,840
21	796	$3,888	$128,952	$132,840	$3,888	$24,000	$257,904	$285,792	$152,952	$221,662	$18,841
22	808	$3,888	$130,896	$134,784	$3,888	$24,000	$261,792	$289,680	$154,896	$376,558	$32,007
23	820	$3,888	$132,840	$136,728	$3,888	$24,000	$265,680	$293,568	$156,840	$533,398	$45,339
24	832	$3,888	$134,784	$138,672	$3,888	$24,000	$269,568	$297,456	$158,784	$692,182	$58,835
25	844	$3,888	$136,728	$140,616	$3,888	$24,000	$273,456	$301,344	$160,728	$852,910	$72,497
26	856	$3,888	$138,672	$142,560	$3,888	$24,000	$277,344	$305,232	$162,672	$1,015,582	$86,324
27	868	$3,888	$140,616	$144,504	$3,888	$24,000	$281,232	$309,120	$164,616	$1,180,198	$100,317
28	880	$3,888	$142,560	$146,448	$3,888	$24,000	$285,120	$313,008	$166,560	$1,346,758	$114,474
29	892	$3,888	$144,504	$148,392	$3,888	$24,000	$289,008	$316,896	$168,504	$1,515,262	$128,797
30	904	$3,888	$146,448	$150,336	$3,888	$24,000	$292,896	$320,784	$170,448	$1,685,710	$143,285
Totals		$2,878,874	$3,547,800	$6,426,674	$296,784	$720,000	$7,095,600	$8,112,384	$1,685,710		($1,552,358)

FIGURE 5

Assumptions	
Option 3 Capital Cost	$3,003,600
Initial Users	556
Additional Users per Year	12
Impact Fee for New Users	$2,000
Tap Fee per User	$324
Tap Cost per User	$324
Average Gallons per User	6000
Base Monthly Charge(3000 gal.)	$15
Additional Charge per 1000 gal	$4
Annual Operating Cost per User	$162
Imputed Interest Rate	8.50%

Year	Total Users	Capital Costs	Operating Expenses	Total Costs and Expenses	Tap Fees	Impact Fees	Annual User Charges	Total Fees and Charges	Annual Excess/ (Deficit)	Cumulative Excess/ (Deficit)	Imputed Interest Expense Earnings
0	556	$3,183,744	$0	$3,183,744	$180,144	$0	$0	$180,144	($3,003,600)	($3,003,600)	($255,306)
1	556	$3,888	$90,072	$93,960	$3,888	$24,000	$180,144	$208,032	$114,072	($2,889,528)	($245,610)
2	568	$3,888	$92,016	$95,904	$3,888	$24,000	$184,032	$211,920	$116,016	($2,773,512)	($235,749)
3	580	$3,888	$93,960	$97,848	$3,888	$24,000	$187,920	$215,808	$117,960	($2,655,552)	($225,722)
4	592	$3,888	$95,904	$99,792	$3,888	$24,000	$191,808	$219,696	$119,904	($2,535,648)	($215,530)
5	604	$3,888	$97,848	$101,736	$3,888	$24,000	$195,696	$223,584	$121,848	($2,413,800)	($205,173)
6	616	$3,888	$99,792	$103,680	$3,888	$24,000	$199,584	$227,472	$123,792	($2,290,008)	($194,651)
7	628	$3,888	$101,736	$105,624	$3,888	$24,000	$203,472	$231,360	$125,736	($2,164,272)	($183,963)
8	640	$3,888	$103,680	$107,568	$3,888	$24,000	$207,360	$235,248	$127,680	($2,036,592)	($173,110)
9	652	$3,888	$105,624	$109,512	$3,888	$24,000	$211,248	$239,136	$129,624	($1,906,968)	($162,092)
10	664	$3,888	$107,568	$111,456	$3,888	$24,000	$215,136	$243,024	$131,568	($1,775,400)	($150,909)
11	676	$3,888	$109,512	$113,400	$3,888	$24,000	$219,024	$246,912	$133,512	($1,641,888)	($139,560)
12	688	$3,888	$111,456	$115,344	$3,888	$24,000	$222,912	$250,800	$135,456	($1,506,432)	($128,047)
13	700	$3,888	$113,400	$117,288	$3,888	$24,000	$226,800	$254,688	$137,400	($1,369,032)	($116,368)
14	712	$3,888	$115,344	$119,232	$3,888	$24,000	$230,688	$258,576	$139,344	($1,229,688)	($104,523)
15	724	$3,888	$117,288	$121,176	$3,888	$24,000	$234,576	$262,464	$141,288	($1,088,400)	($92,514)
16	736	$3,888	$119,232	$123,120	$3,888	$24,000	$238,464	$266,352	$143,232	($945,168)	($80,339)
17	748	$3,888	$121,176	$125,064	$3,888	$24,000	$242,352	$270,240	$145,176	($799,992)	($67,999)
18	760	$3,888	$123,120	$127,008	$3,888	$24,000	$246,240	$274,128	$147,120	($652,872)	($55,494)
19	772	$3,888	$125,064	$128,952	$3,888	$24,000	$250,128	$278,016	$149,064	($503,808)	($42,824)
20	784	$3,888	$127,008	$130,896	$3,888	$24,000	$254,016	$281,904	$151,008	($352,800)	($29,988)
21	796	$3,888	$128,952	$132,840	$3,888	$24,000	$257,904	$285,792	$152,952	($199,848)	($16,987)
22	808	$3,888	$130,896	$134,784	$3,888	$24,000	$261,792	$289,680	$154,896	($44,952)	($3,821)
23	820	$3,888	$132,840	$136,728	$3,888	$24,000	$265,680	$293,568	$156,840	$111,888	$9,510
24	832	$3,888	$134,784	$138,672	$3,888	$24,000	$269,568	$297,456	$158,784	$270,672	$23,007
25	844	$3,888	$136,728	$140,616	$3,888	$24,000	$273,456	$301,344	$160,728	$431,400	$36,669
26	856	$3,888	$138,672	$142,560	$3,888	$24,000	$277,344	$305,232	$162,672	$594,072	$50,496
27	868	$3,888	$140,616	$144,504	$3,888	$24,000	$281,232	$309,120	$164,616	$758,688	$64,488
28	880	$3,888	$142,560	$146,448	$3,888	$24,000	$285,120	$313,008	$166,560	$925,248	$78,646
29	892	$3,888	$144,504	$148,392	$3,888	$24,000	$289,008	$316,896	$168,504	$1,093,752	$92,969
30	904	$3,888	$146,448	$150,336	$3,888	$24,000	$292,896	$320,784	$170,448	$1,264,200	$107,457
Totals		$3,300,384	$3,547,800	$6,848,184	$296,784	$720,000	$7,095,600	$8,112,384	$1,264,200		($2,663,036)

FIGURE 6