DARE COUNTY, NORTH CAROLINA
DESALINATION PROJECT

B&V Project 02976.100

DESIGN REPORT

March 6, 1987

Revised December 30, 1987

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DESIGN REPORT

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

DESIGN REPORT

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B&V Project 02976.100
B&V File B
March 6, 1987
Revised December 31, 1987

To: Distribution

From: D. A. Todd

A. GENERAL

1. Project Description. The project is a nominal 3.0 mgd water supply and treatment system to supplement the existing Dare County regional water system facilities. The project will consist of the following major components.

- o Eight brackish water supply wells, including access roads to three sites.
- o A 3.0 mgd reverse osmosis water treatment plant.
- o Plant auxiliary facilities, such as storage, laboratory, operator facilities, visitor facilities, etc.
- o Transmission pumping and piping to connect to the existing transmission main.
- o A 5.0 mg prestressed ground storage reservoir.
- o A SCADA system for the entire regional water system, including all existing facilities.

2. Location. The project will be located on the Baum-St. Clair tract in Kill Devil Hills, Dare County, North Carolina. The treatment plant site consists of 20 acres of unimproved land bordering Mustian Street. A 10-inch diameter test well was constructed on this site in 1985. The County and the Town of Kill Devil Hills own additional adjacent land, which will be used for well sites and other municipal facilities.

3. Related Report. Black & Veatch prepared a feasibility study that established the need for this project. The final report, Report on Water Supply and Treatment Alternatives for Dare County, North Carolina, is dated January 1987.

4. Future Expansion. The 1987 report indicates that the plant will be expanded in the future to 12.0 mgd. This expansion will be planned for in two stages as follows:

- Size the initial building for 8.0 mgd of RO equipment, install 3.0 mgd of process equipment now, and add 5.0 mgd in modules of 1 mgd as demand increases.

- Layout facilities on the site to allow for addition of 4.0 mgd of RO treatment capacity through building expansion.

Also included will be space for two additional 5.0 mg ground storage reservoirs.

The site may be used in the future for a waste-to-energy plant which will supply electricity. Feasibility studies are yet to be completed for this.

5. Flood Elevation. Typical high water levels due to storm tides in the area are 8 feet. The existing site elevation varies from 8 to 10 feet.

6. Utilities. Power will be supplied by North Carolina Power, a division of VEPCO. Standby power will be as required by the State of North Carolina to keep a minimum amount of facilities operating.

There is no natural gas distribution system in the area.

7. Contracts. The project will be divided into separate construction contracts as follows.

1. Well No. 1 and Observation and Monitoring Wells.
2. RO Equipment Supply and Installation.
3. Ground Storage Reservoir and Transmission Main.
4. General Construction.
5. Plumbing.
6. HVAC Construction.
7. Electrical Construction.
8. Wells 2 through 8.
9. Concentrate Discharge Piping.

A design memorandum dated October 28, 1986, was previously issued covering Contract No. 1 and prequalification of contractors for Contract No. 2.

8. Datum. USGS datum will be used.

9. Standards. Black & Veatch design and drafting standards will apply to this project.

10. Regulatory Review. The following Federal and North Carolina regulatory agencies will review the project.

- o Division of Health Services, all contracts, for compliance with public water supply regulations.
- o Department of Transportation, Contract 3 and 9, for work within DOT rights-of-way.
- o Division of Environmental Management-Groundwater Section, Contracts 1 and 8, for well construction and groundwater regulations. An NPDES permit has been obtained from this agency for the brine discharge.
- o Division of Environmental Management-Land Quality Section, Contracts 3, 4, and 8, for erosion control regulations.
- o Federal Communication Commission, Contract 4, for the radio communications of the SCADA system.
- o Coastal Management Commission, Contract 9 for issuance of a CAMA permit.
- o The site is 3,300 feet from the airstrip at the Wright Brothers National Monument. Depending upon structure height, review by the Federal Aviation Administration may be required.

11. Land and Rights-of-Way. The water treatment plant will be constructed on land owned by Dare County. The wells and raw water pipelines will be located on land owned both by the County and the Town of Kill Devil Hills. The transmission main will be located along Kill Devil Hills municipal streets, and will connect to the existing transmission main within DOT right-of-way.

Figure 7 shows the location of the project facilities and identifies the owner of the property. The location of the wells may be subject to change based upon initial drilling results and final requirements of the North Carolina Division of Health Services.

12. Figures. The following figures providing additional information are attached. All figures are in draft form.

Figure 1 - Process Schematic

Figure 2 - NOT USED

Figure 3 - NOT USED

Figure 4 - Process Computer Block Diagram

Figure 5 - SCADA System Block Diagram

Figure 6 - (not used)

Figure 7 - NOT USED

B. SCHEDULE AND COST

1. Schedule. The project schedule originally called for water production to begin July 1, 1988. The late start being made on the design makes it difficult to complete the project on this schedule. However, water use records from 1986 indicate that the rate of growth in water demand is slowing, and the entire plant will not be needed before July 1, 1989. Therefore, the schedule below calls for the plant to be on-line by April 1989. The schedule revision has been agreed to by Dare County. The dates shown are approximate completion dates, except that dates for completed activities are shown in parenthesis.

DESIGN REPORT	
Draft Complete	(January 3, 1987)
Final Complete	(March 6, 1987)
Revisions	As needed (June 9, 1987) (December 30, 1987)
CONTRACT 1 - Well No. 1	
Design and Specifications	(January 1987)
QC/State Review	(February 1987)
Receive Bids	(April 22, 1987)
Complete Construction	(July 31, 1987)
CONTRACT 2 - RO TREATMENT SYSTEM	
Design and Specifications	(September 10, 1987)
QC/State Review	(October 1, 1987)
Receive Bids	(November 18, 1987)
Complete Construction	April 1, 1989

CONTRACT 3 - RESERVOIR AND TRANSMISSION MAIN

Design and Specifications	(October 1, 1987)
QC/State Review	(October 15, 1987)
Receive Bids	(December 2, 1987)
Complete Construction	June 15, 1989

CONTRACT 4-7 - WATER TREATMENT PLANT

Design and Specifications	January 15, 1988
QC/State Review	February 15, 1988
Receive Bids	March 15, 1988
Complete Construction	July 1, 1989

CONTRACT 8 - WELLS 2-8

Design and Specifications	December 31, 1987
Quality Control Review	January 7, 1988
Receive Bids	February 1, 1988
Complete Construction	February 1, 1989

CONTRACT 9 - CONCENTRATE DISCHARGE OUTFALL

Design and Specifications	July 1, 1989
QC/State Review	August 15, 1989
Receive Bids	September 15, 1989
Complete Construction	February 1, 1989

2. Cost Opinion. The preliminary opinion of probable construction cost is as follows.

CONTRACT 1	
Well 1	$ 145,300 (1)
CONTRACT 2	
5.0 mgd RO System	1,890,000 (1)
CONTRACT 3	
5.0 mg Reservoir	1,650,000 (1)
CONTRACT 4,8	
Water Plant Buildings, Site Work SCADA, and Wells 1 through 10 Well Houses and Raw Water Pipelines	2,800,000
CONTRACT 5	
Plumbing	80,000
CONTRACT 6	
HVAC	100,000

CONTRACT 7	
Electrical	385,000
CONTRACT 8	
Wells 2 through 8	820,000
CONTRACT 9	
Concentrate Discharge Piping	300,000
	$ 8,170,300
Construction Contingency 5%	408,515
Power Company Cost	200,000
Construction Total	$ 8,778,815

4,185,000
1,297,760
2,887,000
w/ con
3,032,000

(1) Based upon actual bid amount or final payment amount.

The cost opinion for each contract includes a contingency.

C. WATER QUALITY

1. Raw Water. Raw water will be supplied from 8 wells to be constructed as part of this project. Well field design and well sizing were determined by a subsurface exploration program by Layne Atlantic and further data analysis by Missemer and Associates after construction and testing of production Well 1.

Water will be withdrawn from the Yorktown aquifer. The exploration program has shown that the aquifer salinity varies from top to bottom, with a blended water salinity of approximately 2,100 mg/l TDS. Table 1 shows the anticipated raw water quality, based upon sampling from the first production well. It is assumed that water quality will deteriorate with continued pumping, and that TDS values could increase by a maximum of 20 percent.

Pilot plant work done on water from the test well indicates that iron fouling or scaling is not a problem.

2. Product Water. Table 1 shows the required product water quality.

3. Concentrate. Table 1 shows the anticipated quality of the concentrate. This quality is based upon 75 percent recovery and the maximum possible rejection of dissolved solids.

Table 1

WATER QUALITY

Parameter	Feed	Product	Brine
Barium (mg/l)	0	<1.0	0
Chloride (mg/l)	953	<225	3812
Calcium (mg/l)	19		76
Chromium (mg/l)	0	<0.05	0
Copper (mg/l)	0	<1	0
Fluoride (mg/l)	1.6	<1.8	6.4
Iron (mg/l)	0.185	<0.3	0.75
Lead (mg/l)	0	<0.05	0
Magnesium (mg/l)	24		96
Manganese (mg/l)	0	<0.05	0
Sodium (mg/l)	659	<100	2636
Strontium (mg/l)	0.75		3.0
Alkalinity (mg/l)	318		1272
Sulfate (mg/l)	38	250	152
SiO_2 (mg/l)	14		56
Total Dissolved Solids (mg/l)	2117	450	8468
pH (units)	8.0	6.8-8.0	
Temperature deg C	20		
Silt density index	4.0		
Turbidity	0.6-0.8	1.0	

D. FACILITIES PROVIDED

1. Water Supply Wells. A total of 8 wells will be constructed for the 3 mgd RO plant. Wells will be provided with a well house constructed of concrete block, and have a 100 foot diameter protected area in accordance with state regulations.

Number of Wells	8
Well Capacity, gpm	500
Total Wellfield Capacity, mgd	5.8
Depth of Screen, feet below surface	320-420
Pump type	submersible
HP	varies per well, max 50
Local Instrumentation	
Vortex shedding type flow meter	
Flow indicator	
Control	
Local On-Off-Remote	
Remote On-Off through SCADA	

Wells will be constructed of inert casings (PVC or fiberglass). Well drilling will be without bentonite drilling mud, which can damage RO membranes. Pumps will be of all stainless steel construction. Well head piping and valves will be stainless steel or fiberglass.

Where the required size of the well casing is greater than available PVC or FRP products, a double casing shall be used. The outer casing shall be carbon steel with an inner PVC or FRP casing. The space between inner and outer casings will be grout filled. Well houses will be constructed of concrete block with wood siding finish.

The potential use of a prefabricated well head is being reviewed, with such use depending upon the acceptance of State regulatory agencies and economic analysis.

2. Raw Water Pipelines. Raw water pipelines will be constructed of reinforced fiberglass pipe or high density polyethylene due to the corrosion potential of the brackish water. Piping will be designed to carry water from the well to the pretreatment units without introducing air into the water. Pipe will be designed to use native sand as bedding material. Maximum pipeline velocity will be 5 fps.

3. RO Pretreatment. Pretreatment for proper operation of the RO treatment units will consist of removing suspended solids larger than 5 microns with cartridge filters, addition of acid for pH reduction, and addition of a scale inhibitor chemical. Chemical feed systems are discussed later in this design report.

Cartridge filters will be constructed of 316 stainless steel with wound cloth filter elements which are replaceable. A false bottom will be included.

Experience with recent large RO plants indicates that the RO system contractor can best optimize the cartridge filter system through actual quotations from filter manufacturer. The most important design parameter is to limit the flow rate to 5 gpm per 10-inch long filter element, with a 10 percent increase above this allowed with one filter out of service. The contractor can then determine the optimum number of filter elements and filter vessels.

Filters will operate in parallel, with all filters taking suction from and discharging to common headers. This will facilitate continued plant operation when any one filter is out of service.

	Present	Future
Number of filter vessels	*	*
Capacity, max gpm per 10-inch long filter element		
All filters operating	5	5
One filter out of service	5.5	5.5

* To be determined by contractor.

Local instrumentation
Inlet and outlet pressure gages across bank of filters
Differential pressure transmitter across bank of filters, transmit to process computer

Each filter equipped with suction and discharge isolation valves.

Pipe nozzels: stainless steel

Vessel drain from beneath outlet

4. RO Feed Pumps. The RO feed pumps will be a part of the RO equipment supplied under Contract 2. Pumps will be variable speed, vertical turbine can type, taking suction from the cartridge filter discharge header. Each pump will feed directly to an RO unit. The pump will be designed so that stages can be added or deleted. All pump internals will be of 316 stainless steel. An overhead hoist will be provided. Speed control will be automatic through the process computer.

	Present	Future (Total)
Number	4	8
Capacity, each gpm (mgd)	1,000 (1.44)	1,000 (1.44)
Pump Head, feet	650 (approx)	
Motor, hp	250 (approx)	

Local Instrumentation
- Discharge pressure gage
- Suction pressure switch (low pressure cutoff)
- Suction pressure gage

Control
- Local On-Off-Remote
- Remote control through process computer
- Pump start-stop will initiate programmed control sequence for associated train

5. RO Treatment Units. RO treatment units will consist of spiral wound membranes inside pressure vessels, support racks for pressure vessels, interconnecting piping and valves, and associated instrumentation. All wetted parts will be either stainless steel, fiberglass, or PVC. Frames will be coated steel or fiberglass.

RO plant experience indicates that membranes will lose capacity with time, as the flux (gpm/unit membrane area) decreases. Initial operation will be 75 percent recovery. Changes in recovery are possible to account for water quality changes or membrane deterioration.

The contract documents will allow the contractor to optimize the process through selection of the rate of recovery, number of stages, number of elements, operating pressure and amount of water to be bypassed. The specifications will indicate a maximum flux (gal/SF membrane area/day) to avoid overloading of the membranes.

	Present	Future (Total)
No. of RO units	3	8
Estimated No. pressure vessel per unit	30	
Estimated No. membrane per unit	180	
Capacity, mgd per unit at 75% recovery	1.0	
No. stages per unit	2	
Flux, gpd/sf, 1st stage	17	

Controls
One brine flow control valve per train, motor or pneumatic operated with remote control and local manual override; remote control through process computer.

Each RO treatment unit equipped with product water flowmeter, reject flowmeter, pressure gages to measure pressure drop across each stage, product and reject conductivity and pH meters.

6. Clearwell. A separate clearwell is not required, since the ground storage reservoir will provide adequate storage.

Finished water piping will allow future construction of a clearwell. A clearwell would be needed in the future if degassification of the finished water is required to remove hydrogen sulfide or carbon dioxide. Although water analysis does not indicate that hydrogen sulfide will form, experience with coastal groundwater indicates this provision is warranted.

7. Transmission Pumps. Transmission pumps will be installed to pump finished water from the ground storage reservoir to the transmission main. The transmission main will receive input from the pumps at the Roanoke Island and Fresh Pond water treatment plants as well as from these pumps, and will discharge to six separate ground storage reservoirs, including the one at this plant. To allow for more efficient operation of all pumps pumping, these new transmission pumps will be variable speed.

	Present	Future (Total)
Number	~~2~~ 3	4
Capacity, each, gpm (mgd)	2780 (4.0)	2780 (4.0)
Pumping Head, ft	100	100
Motor, hp	100	100
Low Water Cutoff, El.	13.0	13.0

Check valve for each pump

Local Instrumentation
Suction and discharge pressure gages.
Flow tube for total flow.

Control
Local On-Off-Remote.
Remote control through SCADA system.

8. Transmission Main. A transmission main to connect the treatment plant to the existing transmission main will be constructed. Maximum pipe velocity will be 5.9 fps at 12 mgd.

Diameter, inches	30
Pipe to be ductile iron, cement lined	

Transmission piping will be arranged for the following operating conditions.

1. Allow the ground storage reservoir to fill from the transmission main when the transmission pumps are not pumping.

2. Allow the ground storage reservoir to float with the other five reservoirs on the transmission system.

3. Allow the transmission pumps to take suction from the ground storage reservoir and pump to the transmission system.

9. Ground Storage Reservoir. A circular prestressed concrete ground storage reservoir will be constructed.

Capacity, mg	5.0
Diameter, ft	160
Depth, ft	32
Bottom Elevation, ft	10
Overflow Elevation, ft	42
Instrumentation	
Level Gage	
Telltale	
Level signal to SCADA system	

Reservoir will be equipped with an altitude valve, and will hydraulically float with the other reservoirs which receive water from the existing transmission main.

Addition of two future 5 mg reservoirs will be provided for.

10. Concentrate Outfall. An ocean outfall shall be constructed to dispose of RO treatment concentrate to the Atlantic Ocean.

	Initial (3 mgd plant)	Future (12 mgd plant)
Concentrate flow, mgd (based on 75% recovery, 10 percent blend)	0.9	3.6

max, mgd (based on 70% recovery, no blend)	1.29	5.14

The concentrate will be piped directly from each RO unit to the outfall, which will terminate at a junction box to the east of N.C. Highway 12 at Ocean Street. Also discharging to the junction box will be a 36-inch storm drain. Each pipe will have a backwater valve. The junction box shall isolate each flow, and separate pipes will leave the junction box and discharge to the ocean. Exposed pipe will be reinforced concrete pipe, supported on timber tressels conforming to DOT standards. Buried pipe will be CMP, with stone bedding.

The ocean outfall, including the junction box, will be constructed under Contract 9 as a unit price contract. CONTRACT 2 ?

11. Flowmeters. Flowmeters will be installed at each well, for total raw water flow at the treatment plant, finished water flow, brine flow, and transmission pumping.

Location	No. Req'd	Measured	Meter Type	Range (gpm)
Wellhead	8	Raw water	Vortex shedding	0-700
Pipe Gallery	1	Raw water	Magnetic	800-9,000
RO Unit	3	Product water	Fiberglass insert flow tube	0-1,000
	3	Concentrate	Orifice plate or insert flow tube	0-500
Plant	1	Finished water	Full body flow tube	700-6,000
Yard	1	Transmission Flow	Insert flow tube	700-7,000

12. Chemical Feed and Handling. Chemical feed for RO pretreatment and post-treatment will be constructed as part of Contract 2. The chlorine and fluoride feed systems will be part of Contract 4. It is anticipated that pretreatment chemicals will be acid for pH control and a scale inhibitor. Scale inhibitors typically used are sodium hexametaphosphate, or a proprietary product such as Flocon (manufactured by Pfizer), which is a poly acrylic acid. Post-treatment will consist of caustic soda addition to raise the blended

water pH to 7.0, followed by addition of a corrosion inhibitor such as zincorthophosphate. Additional post-treatment will be the addition of chlorine gas for disinfection and hydrofluorosilicic acid for dental hygiene.

All chemical feed equipment will be sized for 8 mgd, with space to expand to 12 mgd.

Chemical storage facilities will be designed for a minimum of 30 days storage under average conditions (a future plant flow of 4 mgd), or for 1-1/2 times the delivery size.

Sulfuric Acid

a. Application: raw water for pH adjustment.

b. Storage: bulk steel storage tank, horizontal axis; tank car unloading station; level site gage; high and low level indicators; dessicator; and emergency shutoff plug.
Holding tank in feed room (contract 4)

c. Metering pumps: 1/3 hp, number of pumps as required for 8 mgd finished water, local H-O-R and start-stop, remote control through process computer, paced by flow and pH.

Scale Inhibitor

a. Application: raw water for brine scaling control.

b. Storage: drum storage in chemical storage area.

c. Holding tank in feed room.

d. Metering pumps: 1/3 hp, number of pumps as required for 11.5 mgd filtered water (8 mgd finished water).

e. Local H-O-R and start-stop, remote control through process computer paced by flow and rate set.

Chlorine

a. Application: product water for disinfection.

b. Storage: space for 6 1-ton containers off scale; dial scale for two additional containers on-line; hoist and monorail for handling containers.

c. Feed: remote vacuum from the storage container. Two 2,000 lbs/day feeders, fitted for metering 0-1,000 lbs/day. Local control only.

d. Safety features: Forced ventilation, outside entrance. Gas masks. Gas detectors, signal to telemetry system. Separate storage and feed rooms.

Fluoride

a. Application: to blended water for dental hygiene.

b. Storage: drum storage in chemical storage area.

c. Holding tank in feed room.

d. Metering pumps: same as for sulfuric acid.

e. Local H-O-R and start-stop, remote control through process computer, paced by flow.

Sodium Hydroxide

a. Application: product water for pH adjustment.

b. Storage: bulk tank located outdoors with dilution for freeze protection.

c. Day tank.

d. Metering pumps: same as for sulfuric acid.

e. Local H-O-R and start-stop, remote control through process computer paced by flow and rate set.

Corrosion Inhibitor

a. Application: to blended water.

b. Storage: drum storage in chemical storage area.

c. Day tank in feed room.

d. Metering pumps: two pumps of fractional hp, each capable of feeding 1 mg/l in 8 mgd.

e. Local H-O-R and start-stop, remote control through process computer.

13. Cleaning System. A system for cleaning the RO membranes shall be included in Contract 2. Cleaning will be accomplished by running a solution of citric acid (or similar commercially available chemical) through the treatment unit and collecting the waste for disposal. The cleaning system equipment shall consist of a mixing tank for dissolving bagged chemicals, a high pressure pump, flow control valve, 5 micron cartridge filter, flow meters, for input and brine return, pressure control valve, and hoses for connecting to the RO treatment unit feed, product, and brine ports. All equipment will be corrosion resistant.

The cleaning system will be located in the main room.

14. Process Computer. A computer system for monitoring and controlling process variables shall be installed under Contract 2. The computer will be reserved for process work only, and will be separate from the computers provided with the SCADA system.

The computer system will consist of the following.

- o Microprocessor, with spare main memory to accommodate 8 mgd plant.
- o Mass storage, disc drives.
- o Color video display terminal.
- o One printer.
- o Software package designed to process data from all process related instruments, automatically adjust chemical feed, provide reports of process variables, adjust RO system control valves.

15. Plant Building. The plant building will be concrete block bearing wall, with a wood veneer of exterior board and weathering shingles, with insulation between the block and the veneer. The building shall have the following facilities.

Main Room, housing RO treatment units, cartridge filters, cleaning system, RO feed pumps, and transmission pumps

Chemical feed rooms for chlorine, fluoride, acid, scale inhibitor, and post-treatment

Chemical storage areas

Generator room

Electrical room

Mechanical room

Locker rooms (men and women)

Employee room

Receptionist and lobby

Control room

Janitor closet

Laboratory

Electrical closet

Public restrooms (men and women)

Offices

16. SCADA System. Facilities which makeup the existing regional water system are presently served by a telephone line telemetry system. Many problems have been encountered with the reliability of this system. The system has been shut down for over a year due to the inability to make successful repairs to the 90 percent of the lines which were inoperable.

a. Specifications. The specifications will be written to establish a basic system performance against which all bids will be compared. Bidders will be required to prequalify to show that they meet, exceed, or fall short of the intended performance. The items that will be included in this performance evaluation are radio quality, microcomputer capabilities and quality, software capabilities, location of nearest service facilities for all system components, and a list of projects of similar size and complexity completed in the last five years, with references included.

b. SCADA Equipment. The SCADA system will include a base station and remote sending-receiving stations. The base station will be at the new RO water treatment plant and will consist of dual central processing units, input-output interface unit, two operator's terminals, two printers, disc mass storage, streaming tape drive backup storage, and radio receiver. The system will be specified to handle a minimum of 250 remote stations.

Remote stations will be all solid-state circuitry capable of handling status, analog, and control signals as required at the specific remote site. The project will be designed for protection against radio signal interference. The SCADA system supplier will be required to do all work required in obtaining an FCC license.

Table 2 lists all facilities and equipment that must be monitored through the SCADA system. The specifications will allow some options regarding combinations of remote units in close proximity to each other and connection directly by wire of some facilities.

Pump monitoring will consist of status (on-off), run time, and loss of phase.

A paging system will be included as part of the SCADA system that will identify the importance of the alarm, allowing rapid response by operators when required and a more leisurely response where permitted.

All SCADA stations, including the central terminal unit, will be equipped with battery backup.

c. Software. Software specifications will be written to allow several SCADA system manufacturers to submit bids. The specifications will describe, in broad terms, expected software functions and capabilities, and will establish a basis for evaluating proposed software.

The basic software features and capabilities will include the following.

- o High level control language using common English terminology (open, close, position, etc.).
- o Information storage and retrieval.
- o Diagnostic routines for the computer and its associated peripherals.
- o Input scanning and alarm checking routines.
- o Supervisory control and data acquisition (SCADA) routines.
- o Computer-to-computer interconnect by way of a serial communication link.

- o A log/report program providing flexible logging and printing routines.

- o A CRT program compatible with the process and SCADA languages.

- o A display generator to allow modifying or adding new color graphic displays on line from the CRT keyboard.

- o CRT based program source code text editor.

The alarm routine will differentiate between critical and noncritical alarms and shall identify the nature of the alarm through a paging system. Alarms will include change of status, time delay, instrument range violation, high-low limit violation, rate of change limit violation, control time delay, and communication failure.

The color graphics display routine will graphically illustrate the system remote sites. Diagrams will illustrate major system elements such as pumps, meters, and tanks. The color graphic CRT will include software to generate required graphics, including capability to build, delete, or modify graphic screens.

The log/report routine will include the capability to build, delete, or modify reports and logs. Event logs will be generated automatically. Reports will include periodic reports that are at operator selected intervals (daily, weekly, and monthly), operator requested reports, and preventive maintenance reports.

d. Instrumentation. The following instrumentation is required to provide the necessary inputs to the SCADA system.

- o Roanoke Island Raw Water Wells. The ten raw water wells will require modification to provide the following data to the SCADA system.

Monitoring

Pump status.
Pump run time.
Motor phase monitoring.
Flow rate.
Intruder detection (not required for Well No. 12).

Control

Wells to start-stop based upon ground storage level at the Roanoke Island water treatment plant.

Each well has a propeller type flowmeter that will require modification to interface with the SCADA system.

- Venturi Type Flow Meters. Five venturi type flow meters, three at the water treatment plant and two at the Kitty Hawk Pumping Station, will require modification to provide flow rate and flow totalization to the SCADA system. The existing pulse duration type transmitters will be replaced with two-wire, 4 - 20 mA analog transmitters and any other required electronic devices.

- Storage Reservoirs and Tanks. Eight tank and reservoir level monitoring systems will be required. Each system will consist of a static type pressure (level) transmitter connected to either the tank influent or drain line, and any required electronic devices. Ground storage tanks 1-5 levels will control the transmission pumps. The Southern Shores elevated storage tank will control the Kitty Hawk Pumping Station distribution pumps. The Roanoke Island elevated tank level will control the high service pumps. The WTP ground storage reservoir level will control the raw water wells. The turbine type flow meters at each ground storage tank will require retrofitting to interface with the SCADA system.

- Existing Water Plant Equipment. The following existing water plant equipment will require modification to interface with the SCADA system.

    - Booster pumping station - monitor pump status and run time.

    - Softeners - monitor status: on, standby, regeneration.

    - Roanoke Island high service pumps - monitor status, run time, and motor phase. Control based on Roanoke Island elevated tank level.

    - Transmission pumps - monitor status, run time, and motor phase. Control based on ground storage tanks 1-5 levels.

e. Interface with New Facilities. The SCADA system will receive data from certain new facilities as follows.

- o Duck Elevated Tank. A new 1.0 mg elevated tank is being constructed in the Duck area of Dare County. This will require level monitoring, with the tank level being used to control high service pumps at the existing Kitty Hawk Pumping Station.
- o New Ground Storage Reservoir. The new 5.0 mg ground storage reservoir will be monitored for level with the level being used to control transmission pumps.
- o New Transmission Pumps. The new transmission pumps at the RO WTP will be monitored and controlled through the SCADA system. Control of these pumps will be based on the water levels in the 5 existing and one new ground storage reservoirs.

E. HVAC

HVAC design data will be furnished at a later date.

F. ELECTRICAL

A separate electrical design memordandum will be issued for this project.

mlp

Distribution

Dare County
Town of Kill Devil Hills
Town of Nags Head
W.P. Bizzell
A.O. George
J.E. Hardee
G.W. Mullis
Y.E. Spake

TABLE 2
TELEMETRY MONITORING REQUIREMENTS

FACILITY	OWNER	LOCATION	DISTANCE TO BASE (miles)	MONITORING STATUS	ANALOG	CONTROL
Well 1	Dare County	Roanoke Island - remote	15	pump	flow	yes (a)
Well 4	Dare County	Roanoke Island - remote	15	pump	flow	yes (a)
Well 5	Dare County	Roanoke Island - remote	15	pump	flow	yes (a)
Well 7	Dare County	Roanoke Island - remote	15	pump	flow	yes (a)
Well 8	Dare County	Roanoke Island - remote	15	pump	flow	yes (a)
Well 9	Dare County	Roanoke Island - remote	15	pump	flow	yes (a)
Well 10	Dare County	Roanoke Island - remote	15	pump	flow	yes (a)
Well 11	Dare County	Roanoke Island - remote	15	pump	flow	yes (a)
Well 12	Dare County	Roanoke Island - WTP	15	pump	flow	yes (a)
Well 13	Dare County	Roanoke Island - remote	15	pump	flow	yes (a)
Booster Pumping Station	Dare County	Roanoke Island - WTP	15	pump	no	no
Raw Water Meter	Dare County	Roanoke Island - WTP	15(d)	no	flow	no
Water Softeners (4 units)	Dare County	Roanoke Island - WTP	15(d)	yes	no	no
Ground storage reservoir	Dare County	Roanoke Island - WTP	15	no	level	yes (a)

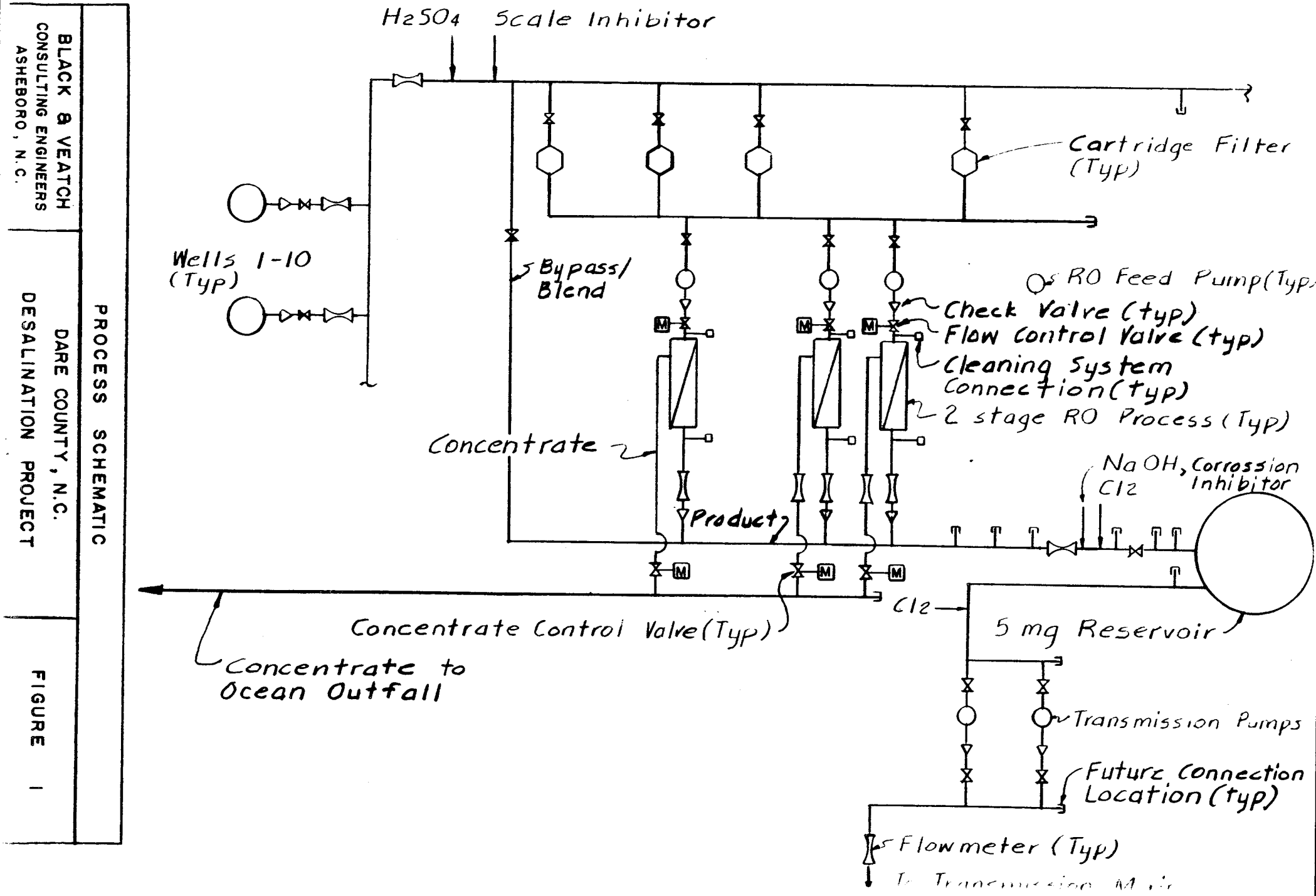
TABLE 2 (continued)
TELEMETRY MONITORING REQUIREMENTS

FACILITY	OWNER	LOCATION	DISTANCE TO BASE (miles)	MONITORING STATUS	ANALOG	CONTROL
Roanoke Island High Service Pumps (2)	Dare County	Roanoke Island - WTP	15(d)	pump	no	yes[b]
Roanoke Island flowmeter	Dare County	Roanoke Island - WTP	15(d)	no	flow	no
Transmission Pumps (4)	Dare County	Roanoke Island - WTP	15(d)	pump	no	yes[c]
Transmission flowmeter	Dare County	Roanoke Island - WTP	15(d)	no	flow	no
Roanoke Island Elevated Tank	Dare County	Roanoke Island - WTP	15	no	level	yes[b]
Ground Storage Tank No. 1	Nags Head	Gull St., Nags Head	10	no	level	yes[c]
Flowmeter	Nags Head	Gull St., Nags Head	10	no	flow	no
Ground Storage Tank No. 2	Nags Head	Fresh Pond WTP, Nags Head	5	no	level	yes[b]
Flowmeter	Nags Head	Fresh Pond WTP, Nags Head	5	no	flow	no
Ground Storage Tank No. 3	Kill Devil Hills	8th St., Kill Devil Hills	5	no	level	yes[c]
Flowmeter	Kill Devil Hills	8th St., Kill Devil Hills	5	no	flow	no

TABLE 2 (continued)
TELEMETRY MONITORING REQUIREMENTS

FACILITY	OWNER	LOCATION	DISTANCE TO BASE (miles)	MONITORING STATUS	ANALOG	CONTROL
Ground Storage Tank No. 4	Kill Devil Hills	Municipal Complex, KDH	2	no	level	yes[c]
Flowmeter	Kill Devil Hills	Municipal Complex, KDH	2	no	flow	no
Ground Storage Tank No. 5	Dare County	Kitty Hawk[e]	4	no	level	yes[c]
Flowmeter	Dare County	Kitty Hawk[e]		no	flow	no
Distribution Pumps (3)	Dare County	Kitty Hawk[e]	4	pump	no	yes[f]
Distribution flowmeter	Dare County	Kitty Hawk[e]	4	no	flow	no
Elevated Storage Tank	Dare County	Southern Shores	8	no	level	yes[f]

(a) Wells to be controlled from level of ground storage reservoir at the water plant.
(b) High service pumps to be controlled from level of Roanoke Island elevated storage tank.
(c) Transmission pumps to be controlled from levels of Ground Storage Tank No. 1-5.
(d) Equipment is located within the existing water plant building.
(e) Equipment all located at the Kitty Hawk pumping station site.
(f) Distribution pumps to be controlled from the level of the elevated storage tank at Southern Shores.



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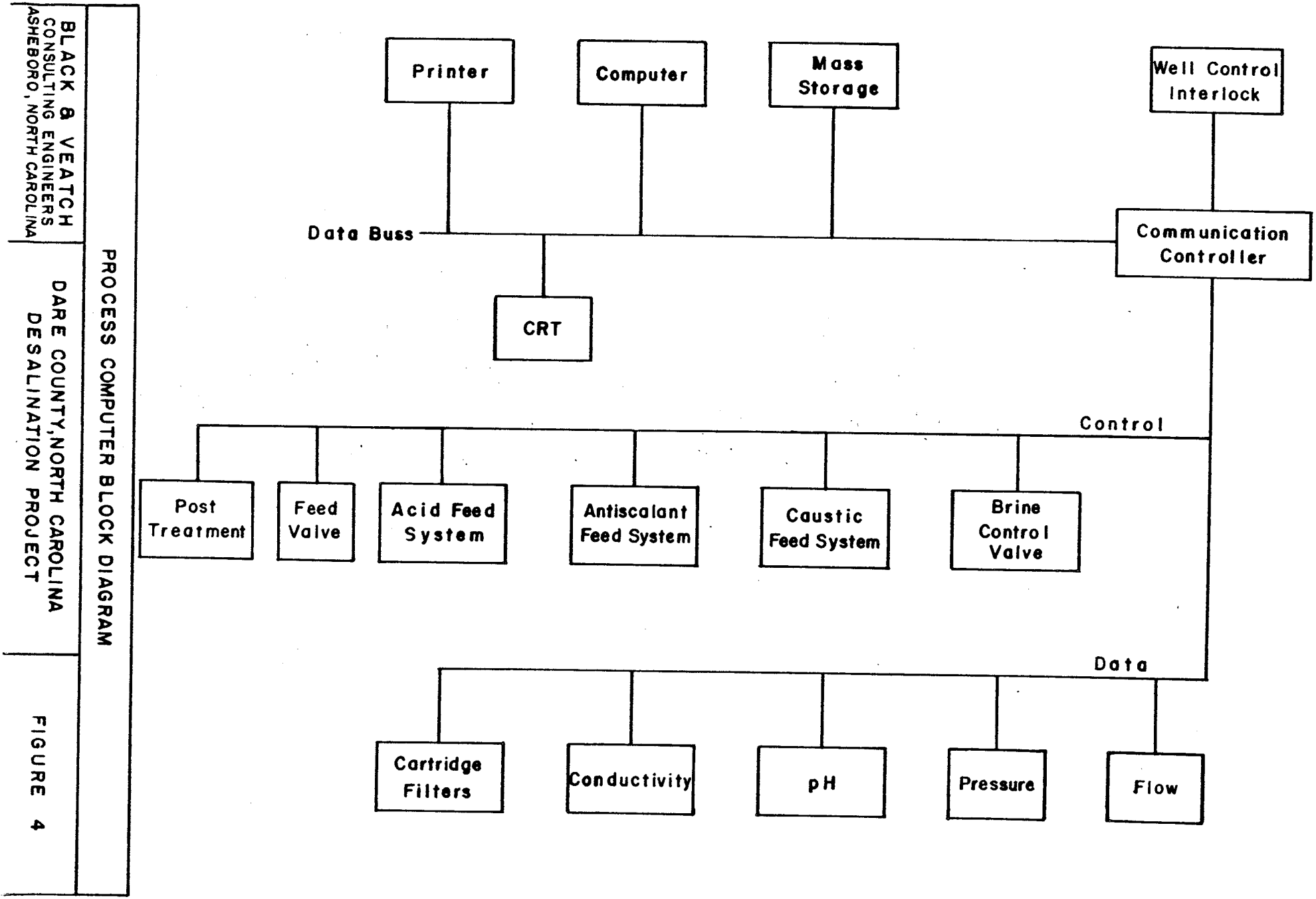
PROCESS SCHEMATIC

FIGURE 1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DARE COUNTY, NORTH CAROLINA
DESALINATION PROJECT
PROCESS COMPUTER BLOCK DIAGRAM
FIGURE 4
Printer
Computer
Mass Storage
Well Control Interlock
Data Buss
Communication Controller
CRT
Control
Post Treatment
Feed Valve
Acid Feed System
Antiscalant Feed System
Caustic Feed System
Brine Control Valve
Data
Cartridge Filters
Conductivity
pH
Pressure
Flow

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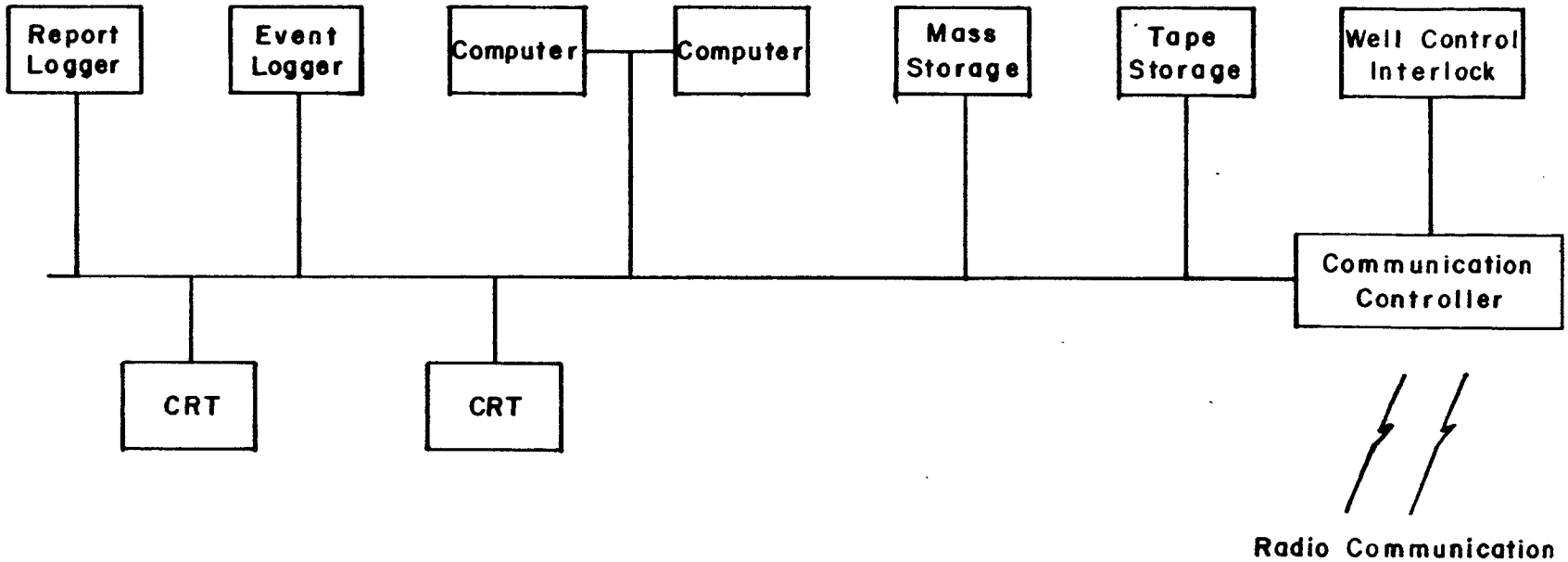
DESALINATION PROJECT

SCADA SYSTEM BLOCK DIAGRAM



RTU's with Radios

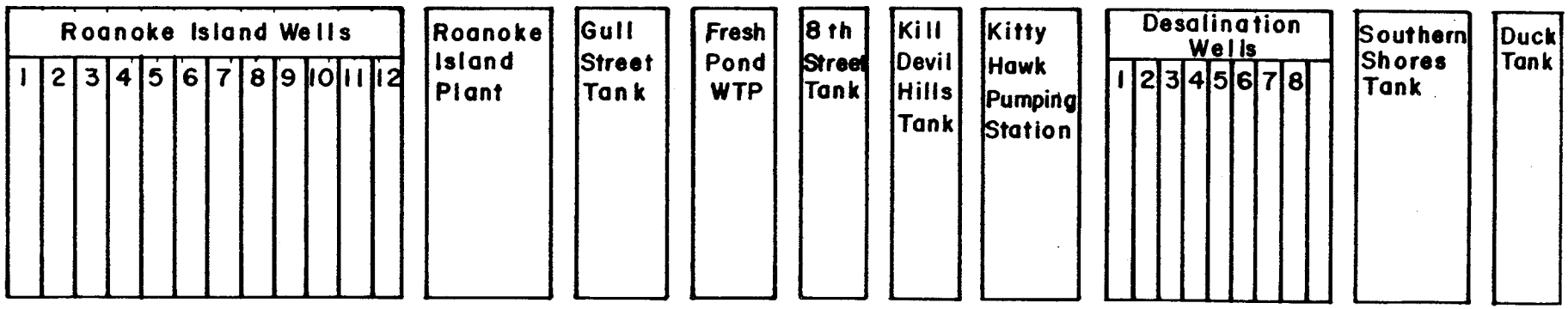


FIGURE 5