Proposal for Engineering Services

# WATER SYSTEM IMPROVEMENTS

## Supply and Treatment

*prepared for the*

**Dare County Water Production Department**

*by*

BLACK & VEATCH

PROGRESS BY DESIGN

*September 9, 1992*

BLACK & VEATCH

110 West Walker Avenue, Asheboro, North Carolina 27204-0728, (919) 672-3600, Fax: (919) 672-3640

September 8, 1992

Mr. Bob Oreskovich
Water Production Superintendent
Dare County Regional Water Facility
600 Mustian Street
Kill Devil Hills, North Carolina 27948

Dear Bob:

Black & Veatch is pleased to respond to Dare County's RFP for engineering services for improvements to the Dare regional water supply facilities. This proposal outlines our understanding of the project; provides a project approach and a discussion of our project management approach; and details our experience and qualifications in the field of water treatment systems evaluation and design.

An outstanding project team has been assembled to work on this project under my direction. Black & Veatch's proven expertise in groundwater development, water treatment plant process research and development, and system design will be made available to this project. Our project team is supplemented by hydrogeological expert Ed Andrews. Ed's expertise and understanding of the surficial (groundwater table) aquifer on the Outer Banks will provide a valuable dimension to our team.

Our management and technical approach depends on the critical involvement of Dare County staff as part of the project team. We have long recognized the importance of involving managing and operating staff in the design of facilities such as these. This approach encourages communication and agreement on project components and design criteria. These activities by all members of the project team will result in project design and construction that meet all established project objectives.

As project consultant, Joe Hardee, P.E. will work closely with me and County personnel to develop and implement this project. Joe's more than 25 years involvement in Dare County began in 1966 as project manager for the Cape

Hatteras Water System project. He also served as project manager for the 1986 Regional Water Supply Study. This long-term participation in the development of Dare County's water resources has resulted in his total commitment to Dare County and the continued availability of water to its residents.

Our project team members have a thorough understanding of the services to be provided, based on extensive direct experience with the Regional Water Facility as well as many other projects in North Carolina.

It is our understanding that the County wishes to move forward rapidly with the project. Black & Veatch is prepared to meet with Dare County staff immediately after selection to establish a clear understanding of your requirements and goals. The schedule that appears on page I-7 would then be revised to reflect your requirements.

The outlined approach for studying THM problems at the Skyco WTP will be undertaken step-by-step. Should a management or treatment solution be determined early in the investigative process, the remainder of the proposed work would be terminated.

Black & Veatch is enthusiastic about this opportunity to work on the expansion and upgrade of your water treatment facilities. We appreciate the opportunity to present this information on our collective experience.

Thank you for your consideration of this proposal. Please contact me if you require additional information.

Very truly yours,

BLACK & VEATCH

William P. Bizzell, P.E.
Senior Project Manager

mlp
Enclosures

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# PROJECT APPROACH

## PROJECT BACKGROUND

In 1986, Black & Veatch prepared a report titled *Water Supply and Treatment Alternatives for Dare County, North Carolina* (dated January 1987), consisting of detailed studies for seven water supply alternatives. Based on cost and reliability, desalination of the Yorktown aquifer water by reverse osmosis was the recommended alternative.

The recommendation portion of the report includes the following observation:

> "The behavior of the Yorktown aquifer should be studied as pumping begins and continues. The possibility of salt water intrusion should be assessed through monitoring of water levels and salinities in all production wells and monitoring wells. This data may result in recommendations for changes in groundwater management procedures."

The report also addresses in detail the three primary water supply sources and their limitations - Fresh Pond, brackish water from the Baum Tract, and water from wells on Roanoke Island (Skyco water treatment facility).

The 1987 report also includes (as an appendix) the test well report by Groundwater Management, Inc., a subsidiary of Layne-Atlantic Company. This report presents the results of the extensive test well program and the 40-day pumping test at 450 gpm that were conducted as part of the overall project. Drawdown data was obtained from four observation wells, with one well screened in the surficial lense. The water level in this well varied from 0.41 feet below static level to 0.16 feet above static level (observed at the beginning of the pumping test).

## PROJECT APPROACH

Black & Veatch's project approach for the current project described in Dare County's August 1992 RFP is divided into the following subsections.

- ***Key Issues.*** These issues, which are addressed in the text that follows, include disinfection by-products or trihalomethanes (THMs) in the water supply from Roanoke Island; expansion of the well field to the Nags Head Woods area and the effect of the expansion on groundwater and the local

ecology; financial and risk feasibility of providing partial operation of the R.O. plant on North Carolina Power Company's "A" (high usage) days; overall best management of the three regional water supply sources to minimize capital and O&M costs; project understanding; project scheduling; and project communications.

Auxiliary generation and power usage are also described in this section, which details how the new well facilities will tie in with the existing power system. It also addresses the questions posed in the Request for Proposal regarding auxiliary generators at the wells and the feasibility of standby operation capability.

- ***Project Management Approach.*** This section presents details of our project management including client involvement, project communications; project coordination; project scheduling and internal cost control; quality control; accounting/billing procedures; and resolution of technical issues.

## KEY ISSUES

**Trihalomethane (THM) Formation**

Even though the total THM potential of water from the Skyco plant exceeds the EPA drinking water standard (100 ppb), only five of 18 samples from all distribution systems show THM levels in excess of 100 ppb. The highest levels of total THMs were found in samples that have the greatest residence time in the distribution system, specifically, samples from Collington, Duck, and Oregon Inlet Fishing Center.

Our review of the Trihalomethane Formation Potential (THMFP) data for Dare County's Skyco well numbers 1, 4, 5, and 7 through 13 indicates THMFP levels ranging from 11 to 216 micrograms per liter (ug/L). This data was reported by Oxford Laboratories, May 9, 1991. The THMFP of seven of the 10 wells was less than 40 ug/L. The THMFP for well numbers 1, 11, and 12 were 143, 203, and 216 ug/L, respectively. (The total organic carbon data reported for these wells did not correlate with the THMFP data.)

THMFP data revealed that the principal THM formed is chloroform. Unfortunately, the THM with the second highest formation levels was bromodichloromethane, with levels formed ranging from 1.3 to 64 ug/L. The concern here is that EPA is planning to propose a 14 ug/L limit for this THM.

Based on these data, we would propose the following course of action to develop, evaluate, and recommend solutions to this disinfection byproduct (DBP) limitation problem:

(a) Evaluate the level and speciation of THMs formed when chlorine is added at the dose and for the contact time necessary to satisfy a 2-log enteric virus inactivation, which is the level that EPA is expected to require for disinfection of groundwater supplies.

(b) Evaluate blending of waters from the wells, with the idea to reduce the composite THMFP at the point of chlorination. This could allow compliance in the distribution system using chlorine as the only disinfectant.

(c) Perform bench-scale testing to evaluate the impact of alternative disinfectants on DBP formation rates and levels. For example, could ozone be used as the primary disinfectant? What would be the impact on the biological stability of the finished water (increased biologically degradable dissolved organic carbon)? Would a post-ozone filtration step be required?

(d) Conduct bench-scale flow-through testing of nanofiltration to evaluate THM precursor compound removal effectiveness and achievable flux rates. Any such treatment step could possibly be applied only to those wells having elevated THMFP.

(e) Perform bench-scale testing of activated carbon adsorption on removal of disinfection byproduct precursor.

**Well Field Expansion to Nags Head Woods**

Nags Head Woods is jointly owned and controlled by the Nature Conservancy and the Town of Nags Head. Both parties have expressed concern that pumping brackish water from this area will have a negative impact on the area's ecology. The extent of the impact can be determined through conducting pumping tests similar to those done on the original test well. The original test well was constructed in the same manner as the final production wells, with the only difference being the casing materials. Tentative conclusions may be drawn from the original work; however, an on-site test will be more conclusive. This on-site well should be constructed as a permanent well, with monitoring wells in both the pumped aquifer and the surficial aquifer, and the pumping test should continue over an extended period of time. Also, monitoring wells should be strategically placed in the surficial aquifer to continuously monitor the water table. Rainfall should also be monitored because the water table fluctuates with amount of precipitation, evapotranspiration, and volume of water pumped from Fresh Pond. Both a groundwater hydrologist knowledgeable of the Outer Banks surficial aquifer and the County's hydrologist, Missimer & Associates, will evaluate the results.

**Standby Generation: Modifications and Feasibility**

The standby generator at the R.O. plant was designed to ensure operation of the building facilities and the high service pumping facilities in the event of a power outage, and was sized to eventually accommodate the movement of 12 mgd to the distribution systems. Sizing and design were based on the initial 5 mg of ground-level finished water storage and the statistical power outage time, eventually incorporating more ground-level water storage as the plant capacity and demand increase. Time-of-use currently reduces the R.O. power cost, and capital improvements may be economically justified based upon reducing power costs by an alternative arrangement on the "A" days. The cost versus power savings for both the Skyco and the R.O. plants should be evaluated together. When the R.O. plant is off line, more wells are in operation at Skyco. Various options with North Carolina Power will be evaluated in the feasibility analysis.

**Overall Management of Three Regional Water Supplies**

On an annual basis, the Fresh Pond water supply can provide an average of 1,000,000 gallon per day. The Fresh Pond plant can process 1.5 mgd when needed. Because

the supply is taken from storage that is replenished by rainfall, the plant could operate at the 1.5 mgd capacity for short periods of time, as long as the average withdrawal for June, July, and August does not exceed 700,000 gpd, or 65,000,000 gallons during the three months. (These quantities are based on an average annual rainfall of 44 inches.) As a water resource, the Fresh Pond should be factored into the equation, both from a well management standpoint, as well in consideration of auxiliary power operation of the R.O. plant. Total water pumped from Fresh Pond during June, July, and August of 1991 was 47.4 mg. This resource was not used for months of October through April 1991. Better utilization of this facility can relieve the pumping of wells at the R.O. plant as well as at the Skyco facility, provided there is no negative impact on the Nags Head Woods ecology.

**Project Understanding**

Because of our extensive involvement with Dare County and the Regional Water Supply System over the past nine to ten years, Black & Veatch has the most knowledge of any consulting engineer regarding these water system improvements and their operation. Beginning in 1983, we have worked with the County to develop a water system master plan; determine improvements necessary to meet short-term and long-term system growth and water demands; develop a computer model of distribution system; provide design and construction services for the R.O. facility, Fresh Pond facility improvements, and water line improvements; develop and implement a successful SCADA system to connect existing system components and provide enhanced operational flexibility; and provide contract management and construction observation.

Through this long-term involvement with the County, Black & Veatch engineers have developed a knowledge of the system operation and the characteristics of the existing facilities. We understand the concerns of the three participants in the Regional Water System, and we possess a thorough knowledge of the project and your objectives and expectations regarding the proposed facilities. Project objectives include:

1. A sound technical approach that produces high quality water in the most cost-effective manner.

2. Completion of the works within the project schedule.

3. Enhanced project communication with the County, Nags Head, and Kill Devil Hills, and within the project team.

4. Detailed attention to preparation of drawings and specifications to minimize material and equipment costs.

**Project Scheduling**

The project schedule that appears on the next page will be refined based on input from County staff and officials. Black & Veatch personnel will meet with County staff on a *monthly* basis to review the progress of work, and verify that the project conforms with the schedule at all times.

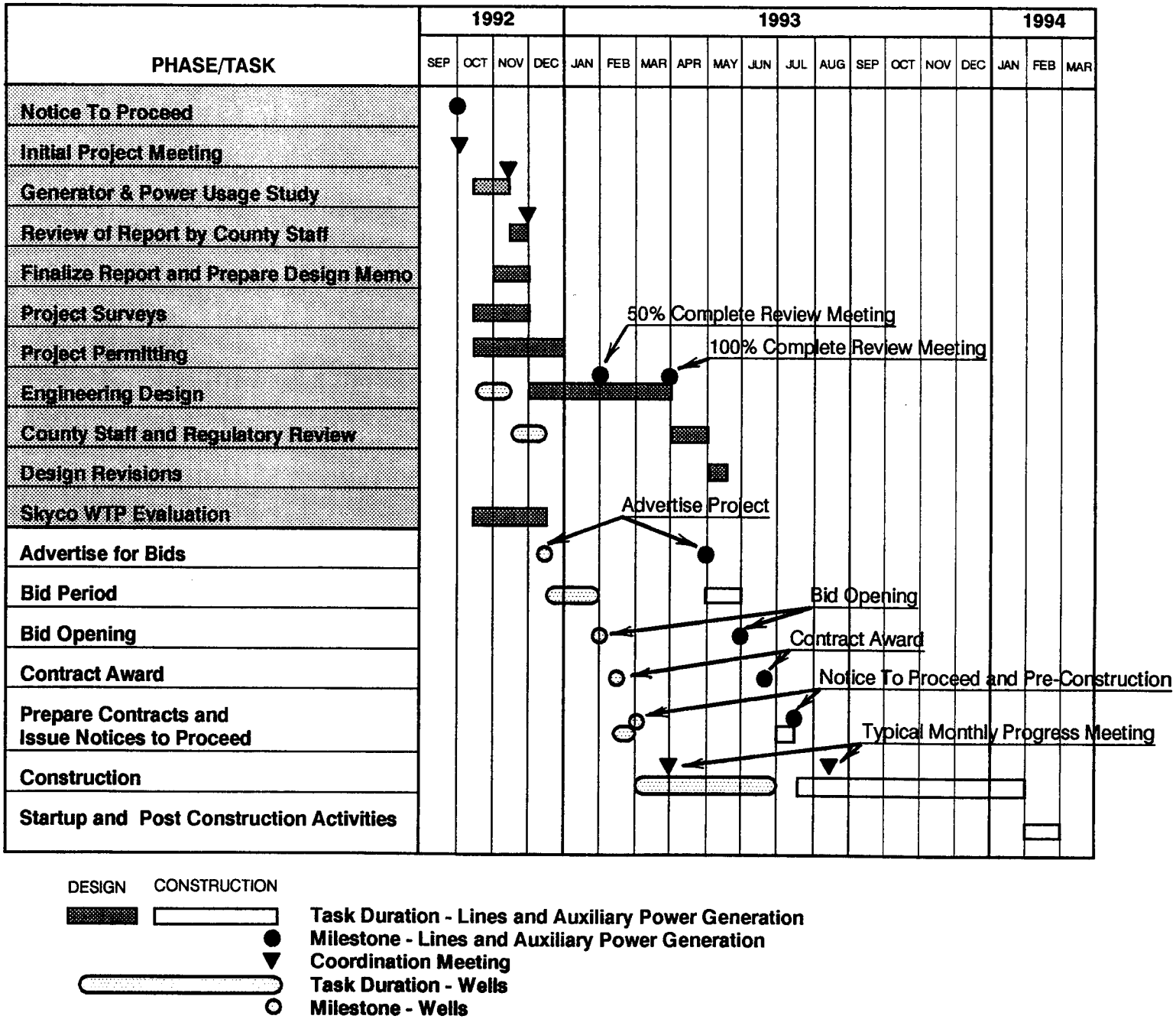
**Project Communications**

Our Project Management Approach (pages I-8 through I-12) outlines the manner in which County staff and Black & Veatch staff will interact. Our approach is summarized as follows:

- Monthly meetings with Dare County personnel to discuss project progress.
- A commitment to respond to *all* client inquiries within the work day.
- Discussions with County personnel to include County, Nags Head, and Kill Devil Hills input in all major decisions or changes in work.
- Formal documentation of all agreed decisions and changes in the project.
- Frequent contact to keep the County, Nags Head, and Kill Devil Hills informed of project development.

# DARE REGIONAL DESALINATION FACILITY
# WELL FIELD EXPANSION, SKYCO WTP STUDY & AUXILLIARY GENERATORS

## PROJECT SCHEDULE



**Auxiliary Generation and Power Usage Study**

Prior to design, Black & Veatch, with the Dare County staff, will perform a study to determine the most cost effective and efficient method of operation for the R.O. plant, Skyco WTP, and the Fresh Pond facility. Below is a listing of items to be specifically addressed.

- Power usage and water demand as related to North Carolina Power rate schedules.
- Standby power generation at the R.O. plant, Skyco facility, and well pumping stations.
- Benefit/cost analysis of probable capital improvements.

Preliminary evaluations of these items, which will be covered in greater depth in the study, are described below.

R.O. plant generator rewiring will provide the capability of producing water under emergency conditions and when North Carolina Power is on a high usage rate schedule ("A" days). Currently, the R.O. plant is taken off-line on these days and the entire water load rests upon the Skyco plant and the Fresh Pond facility. The R.O. plant is on a "daily variable pricing" rate schedule with voluntary power reduction. North Carolina Power determines the daily pricing schedule 24 hours in advance on projected high demand days. Two energy use rates are most feasible, as indicated in the tables that follow.

*1. Daily Variable Pricing (Schedule 10)*

| Day Type | Time | Rate | Max # days/yr |
|---|---|---|---|
| A | 10 am - 10 pm | $.27144/kwh | 32 |
| | Other | $.08/kwh | 32 |
| B | 10 am - 10 pm | $.04115/kwh | unlimited |
| | Other | $.02812 | unlimited |
| C | 10 am - 10 pm | $.03272/kwh | 60 |
| | Other | $.02632/kwh | 60 |

*Note:*

Monthly demand charge of $1.478/kw of largest demand in past year for each month.

2. A second type of rate schedule available from North Carolina Power is the "curtailable pricing schedule." This schedule provides a consistent, reduced rate if the plant agrees to cut demand by a predetermined amount at fixed daily times on a minimum of 30 minutes notice. This rate schedule is summarized below.

***Curtailable Pricing***

| Season | Time | Rate | Max # days/yr |
|---|---|---|---|
| June-Sept. | 2 pm - 9 pm | Penalty | 19 |
| | Other | $.038/kwh | 19 |
| Oct.-May | 6 am - 11 am | Penalty | 13 |
| | Other | $.038/kwh | 13 |

*Note:*
Non-high use days have an energy rate of $.038/kwh.
Penalty of $32/kw for demand over curtailable amount on selected days.
Monthly demand charge of $5.34/kw for non-curtailable load.
Monthly demand charge of $1.478/kw for largest demand in past year.

In addition to these rates, North Carolina Power provides varying schedules for facility type and demand. Obviously, each schedule has advantages and disadvantages. The daily variable pricing schedule provides lower overall cost if the facility can have little or no use on "A" days. However, these high-rate time frames are longer than the time frames under the curtailable pricing. Curtailable rates are attractive because of the limited high-rate times, however, failure to comply carries a stiff penalty. These curtailable rates with the current R.O. plant generator electrical configuration provide an advantage, in that during high-use days, the plant can operate high service pumps and building loads from the generator while producing water at other times of the day. This will help reduce the noncurtailable demand fees and overall cost. The Black & Veatch study will further examine these rate schedules using 1991 demand figures and the County's production capability to determine the most cost-effective alternative.

Another item to be studied is the addition of auxiliary power to the existing and new well sites. Generators can be readily adapted to the existing wells, but would result in some additional cost, as compared to the costs of adding auxiliary power to the new wells. The additional cost is a result of having to abandon the service conductors at

the existing sites to provide new conductors from the transfer switch to the pump station. Well location also impacts auxiliary power considerations. Typically, the closer the well to the plant, the smaller the pump horsepower and the smaller the generator required. Well sites that are closer to the plants could be manually switched, eliminating the need for an automatic transfer switch; however, this arrangement would prevent remote power switchover capabilities. The closer wells will also be easier to access in emergency situations.

Four wells will be required to operate two R.O. trains. Because wells 4, 5, and 6 have water quality problems, wells 1 and 3 should provide the closest usable wells suitable for the addition of generators. To reduce cost, the two new wells could also be used as part of the four-well requirement. In either case, each well would require a separate generator, because the wells are more than 1,000 feet apart, and cabling to connect shared generators is expensive and offers less reliability.

## PROJECT MANAGEMENT APPROACH

The management approach is a key element in merging the talents and capabilities of individual project team members with required activities for control of all technical, administrative, and scheduling issues. It is of paramount importance that, at the project outset, the responsibility and authority of all participants be clearly and concisely delineated, and procedures required to achieve a technically excellent product be outlined and provided to team members.

Key elements of the management approach are *staff organization* and *management control tools*. The proposed management control system to be used by Black & Veatch has been developed in consideration of the administrative and technical aspects of the work effort, and includes an integrated cost/schedule control approach. The control strategy will be tailored to meet all technical, fiscal, and scheduling constraints imposed.

Our Project Management approach includes the following:

- Client Involvement.
- Project Communication.
- Project Coordination.

- Internal Cost Control.
- Quality Control.
- Accounting/Billing Procedures.
- Procedures for Resolution of Technical Issues.

**Client Involvement**

Black & Veatch recognizes that the facilities we study, design, and construct are owned and operated by our clients. Accordingly, client involvement as an integral part of the overall project team is an essential ingredient to the success of the project. *Our project manager and project team will work closely with Dare County to ensure that you receive every opportunity to provide input, that we develop a team approach, and that we keep you fully informed of the project's progress.*

To facilitate and maximize Dare County's input, we will use a concentrated effort that involves *all* members of the project team - your staff *and* Black & Veatch staff - in identifying work items or problems and developing solutions to them. This practice will be applied during the study and concept design phase and during review of the design documents. The input meetings will be held at your facilities. Individual sessions will last anywhere from several hours to a full day. Applying this concept will unite our personnel into a single, efficient project team and will effectively meld the knowledge, expertise, and judgment of the members.

Dare County personnel will be involved in the quality control process through periodic meetings, interim reviews, and review of the final report and drawings and specifications as well as frequent telephone conversations and written correspondence. The overall quality control program will be an ongoing effort throughout the project. Such emphasis on quality will result in the best possible project for Dare County.

**Project Communication**

Prompt and explicit communications are essential to the implementation of any project. It is especially important that the Black & Veatch team and the County staff immediately establish means of effective communication to eliminate all potential for miscommunication. Based on experience with Dare County on previous projects, we feel we have a good understanding of the extent of communications desired by the County, and the degree of involvement the County wishes to take in all design

decisions. These factors are important in undertaking any design project. We feel that with the proposed project team, we will be able to offer highly effective communications between Dare County and Black & Veatch, as well as communications between specific team members.

The project manager will be designated as the individual to provide a focal point for communication with Black & Veatch. Any attempt to use only one individual to make all communications could prove inefficient and cumbersome; however, the project manager will be informed by project team members with respect to any communication they have with the County or other agencies involved with this project.

**Project Coordination**

Successful project coordination involves identifying the function and responsibilities of the various County staff members, as well as individual engineers. It also involves establishing background information needed by the project staff on a day-to-day basis, including items such as data, addresses, phone numbers, contacts at regulatory agencies, utilities, and subcontractors. In addition, names of the various systems/structures to be designed are established.

**Internal Cost Control**

Black & Veatch's cost/schedule control system establishes a disciplined and systematic approach to performance measurement, reporting, and control. The system embodies cost and schedule forecasting for internal control purposes and for reporting to the County.

Our system of cost and schedule control involves the establishment of baseline budgets and schedules. Project performance is based on product (deliverable) milestone achievement. Progress will be assessed and reported via project status reports on a regular basis, comparing actual progress with scheduled progress. With the items of work defined in this manner, an analysis of cost performance can also be developed on a regular basis. This analysis will compare the projected and actual costs to help identify corrective actions that are required.

**Quality Control**

Black & Veatch will use a formalized in-house quality control program to ensure that we provide the highest quality and most practical engineering services to the County. The program has three components: conceptual review, continuous consultation with in-house experts, and final detailed review of the completed design report and drawings and specifications. As stated earlier, Dare County will participate in all such reviews, and will be provided ample time for review prior to submittal of plans and specifications to regulatory agencies.

Conceptual review involves initial reviews of the study concepts and Basis of Design Memorandum, with senior in-house personnel providing project review on a continuing basis. Also, project personnel will be able to draw on the extensive experience and expert knowledge of such specialists and incorporate their knowledge into your project. As a final step, experienced specialists who have not been associated with the project will perform a detailed review of the final report and design documents. This independent review is the keystone of the quality control program.

**Accounting Procedures**

We will establish uniform procedures to be followed for preparing invoices and billings. These procedures will be developed to meet the needs of the County. The project manager will maintain an organized, current file on contracts, invoices, and all contractually-related correspondence.

**Resolution of Technical Issues**

Our management approach will include identification of the procedures to be followed to resolve technical issues. Black & Veatch's experience on similar projects indicates two sides of a single coin: on one side, experience will serve well to avoid or lessen the concerns associated with this type of work. On the other, unanticipated technical problems will arise even under the most extensively detailed level of management care.

Any technical problems which arise during the course of this project will be first addressed at the level at which they are identified. That is, if the design staff unveils a problem, they will first attempt to solve it within the limits of their knowledge and

past experience. If they are unsuccessful, they will immediately contact their direct supervisor and explain the situation. The chain of command established by the project organization diagram will be followed in ascending order in attempts to determine a solution. Frequently, the project manager will also discuss the situation with the County staff. This latter option will come into play on all problems which are determined to impact the project design, budget, or schedule. The project staff will be required to document all problems which arise (except the most trivial) in the form of a memorandum to their supervisors. A complete file of these memoranda will be maintained. The expertise of the project manager will be put to use at the outset of the project on all levels to help minimize difficulties which could arise. This past experience will help the project staff avoid a "trial and error" approach to as great a degree as possible.

Early identification of problems leads to early solutions, regardless of the complexity. Problem identification will be encouraged at every level of the project staff and, with open communications and good project management, the County can be assured of the desired results.

# COST ESTIMATE

## PROJECT A - WELL FIELD EXPANSION

Project A will involve expansion of the reverse osmosis water treatment plant well field through the installation of two additional wells. These wells are proposed to be located on the west side of the Fresh Pond in Nags Head. They will be drilled into the Mid-Yorktown aquifer and will be similar in design to those previously constructed on the Baum Tract.

Two possible ***routes*** should be evaluated for installation of the raw water main. The first route is around the north end of Fresh Pond to Jonas Drive, then along Jonas Drive to U.S. 158 bypass, and along the bypass to the R.O. plant. The second route begins at the north side of Fresh Pond to Burns Avenue, then east toward U.S. 158 bypass to a point, then north across an undeveloped tract to Atlantic Street and Third Avenue, and along Third Avenue to Mustain Street and to the R.O. plant.

The first route will be mostly in existing right-of-way, provided sufficient space is available. We are aware of an existing 16-inch finished water main on the west side of 158 bypass, and there may be other utilities also occupying the limited right-of-way space. The second route is somewhat shorter but will require easements. These two scenarios will be evaluated and discussed with County staff, and a final route will be selected. To estimate costs for this main, we have selected the first routing alternative.

The ***size*** of the raw water main will depend on the number of wells to be developed on the Fresh Pond tract (or possibly south of this tract). Two wells are proposed at this time and we have assumed that two additional wells may be developed, for a total of four on the Fresh Pond tract. Consultation with Missimer Associates and with County staff regarding future well locations will enable development of the final line size. For cost-estimating purposes, we have based the analysis on a 16-inch main from the well field to the R.O. plant.

Cost figures related to the ***wells*** are based on conversations with Skipper's Well Drilling, who was the contractor for the original wells on the Baum Tract.

## Project A Cost Opinion

### Phase I. Well Field Expansion

| Item | Description | Quantity | Unit | Unit Price ($) | Total ($) |
|---|---|---|---|---|---|
| 1. | Production well to include casing, screen, gravel pack, sampling, prefab well head, pump and testing. | 2 | each | 191,000.00 | 382,000 |
| 2. | Monitoring wells to same depth as production well. Includes casing screen and gravel pack. | 2 | each | 10,000.00 | 20,000 |
| 3. | Monitoring well to approximately 75 ft. deep to monitor surficial aquifer. | 1 | each | 1,875.00 | 1,875 |
| 4. | Extended pumping test. | 336 | hour | 125.00 | 42,000 |
| 5. | Access Road. | 2,000 | lin ft | 25.00 | 50,000 |
| 6. | Electrical. | 1 | each | Lump Sum | 55,000 |
| 7. | Telemetry. | 1 | each | Lump Sum | 30,000 |
| | **Opinion of Construction Cost** | | | | **$ 580,875** |
| 8. | Special permits and environmental issues: Nature Conservancy, wetlands, CAMA. | | | | 10,000 |
| 9. | Allowance for County's hydrogeologist (Missimer). | | | | 20,000 |
| 10. | Allowance for easement surveys, maps, and descriptions. | | | | 15,000 |
| 11. | Engineering design plans and specifications. | | | | 43,700[1] |
| 12. | Construction administration and resident inspection. | | | | 29,000[1] |
| 13. | Project contingency. | | | | 70,000 |
| | **Opinion of Phase I Total Project Cost** | | | | **$ 768,575** |

## Project A Cost Opinion (continued)

### Phase II. Raw Water Main

| Item | Description | Quantity | Unit | Unit Price ($) | Total ($) |
|---|---|---|---|---|---|
| 1. | 16-inch raw water main. | 10,600 | lin ft | 45.00 | 477,000 |
| | | | **Opinion of Construction Cost** | | **$ 477,000** |
| 2. | Allowance for easement surveys, maps, and descriptions. | | | | 5,000 |
| 3. | Engineering design plans and specifications. | | | | 42,000 |
| 4. | Construction administration and resident inspection. | | | | 23,000[2] |
| 5. | Project contingency. | | | | 55,000 |
| | | | **Opinion of Phase II Total Project Cost** | | **$ 602,000** |
| | | | **Opinion of Phase I Total Project Cost** | | 768,575 |
| | | | **Opinion of Total Project Cost for Phase I and II** | | **$ 1,370,575** |

[1]All engineering fees are estimates, based on our understanding of the scope of services. Final fees will depend on the negotiated scope of services and time frame established for design and construction.

[2]If Phase I and Phase II proceed simultaneously, this amount could be reduced.

87,700
70,000
157,700

## PROJECT B - SKYCO WTP EVALUATION

Bruce Long

The cost analysis for Project B (upgrade of the treatment process at Skyco for removal of THMs) is for pilot testing only. Pilot testing will be conducted to determine the most cost-effective manner of correcting the THM potential. Attention will also be given to possible contaminants to be regulated by EPA. Solving the immediate THM problem by major capital expenditures may not be in the best interest of the Regional Water System. However, we do not rule out the possibility of having to make some interim improvements, the type and extent of which will be determined from pilot testing. Once the final EPA rules under the Safe Drinking Water Act are promulgated, additional capital improvements may be required in order to comply.

Preliminary investigations of the THM level within the system on July 8, 1992, indicated that the problem may result from the Skyco water only, and not from mixing of the waters from the two plants.

Because pilot testing is an investigative step, it is difficult to determine exactly what this phase of the work will entail; however, we have developed a cost opinion based upon our scope of effort detailed in the Project Approach to develop, evaluate, and recommend solutions to this disinfection byproduct problem. For budget purposes, the costs of items a through e (as listed in the Project Approach, page I-3) should range from ~~$35,000~~ to $40,000.

40 000

## PROJECT C - ELECTRICAL AND AUXILIARY GENERATOR CONSIDERATIONS

*New Wells*

The electrical design for the new wells should be similar to that of the existing wells. The new wells will be prewired packaged units, suitable for a single power connection and a remote terminal unit (RTU). The power supply should be 480 volt, 3 phase, 60 hertz provided by North Carolina Power. The delivery point should be a pad-mounted transformer served by an underground supply from North Carolina Power. The RTU will provide remote status and control from the RO plant. Auxiliary power generation will be provided if deemed necessary by the generator and power usage study (discussed below).

*Auxiliary Generator - R.O. Facility*

The generator at the R.O. plant can be rewired to serve two RO units if results of the generator and power usage study show that it is most cost-effective. This generator is currently wired to run the high service pumps, the building lighting, and HVAC loads. It is connected through a 1600 ampere automatic transfer switch (ATS) and has a rating of 750 kW. Rewiring the generator would allow water production during emergency and high power rate situations; however, care should be taken not to overload the generator. Two possible options for rewiring the generator are presented below.

*Option 1: Relocate the electrical position of the ATS so that it feeds the main switchgear from the utility service and the generator.*

This would involve upgrading the ATS to 2000 ampere and providing a new 2000 ampere service breaker. Advantages include the capability to run any of the plant loads, up to 750 kW maximum, on the plant generator. It also allows for automatic transfer upon power loss. Disadvantages include cost and the necessity to modify the automatic systems within the plant to prevent overloading the generator and causing plant shutdown.

*Option 2: Remove ATS and feed main switchgear directly from the generator.*

This would involve providing a new 1000 ampere service breaker and a key-interlocking scheme with the existing main breaker. Advantages include the capability to run any of the plant loads from the generator and an operator reminder to reestablish electrical load. The disadvantage is the need to manually transfer to generator power.

Both options may require special construction schedules as well as harmonic filtering due to the large nonlinear loads imposed by the high pressure pump drives. As part of design, Black & Veatch will evaluate these alternatives (and other alternatives, if necessary) to provide an efficient and cost-effective system for the facility.

We have selected Option 1 to develop the cost opinion.

*Auxiliary Generation and Power Usage Study*

Black & Veatch will evaluate operation of the R.O. plant using different electrical rate schedules to assess power savings under each arrangement. Power outages will also be evaluated to determine their frequency and duration in order to further assess the need for standby operation. These evaluations and subsequent recommendations will be based on overall utilization of the three water supplies. Engineering costs for the study should be in the range of $9,000 to $12,000.

## Project C Cost Opinion

**Rewiring R.O. Auxiliary Generator and Providing New Generators at Wells Sites**

| Item | Description | Quantity | Unit | Unit Price ($) | Total ($) |
|---|---|---|---|---|---|
| 1. | Automatic transfer switch upgrade. | 1 | each | 3,000.00 | 3,000 |
| 2. | 2,000 ampere breaker. | 1 | each | 25,000.00 | 25,000 |
| 3. | Cable, conduit, labor. | 1 | each | 85,000.00 | 85,000 |
| | **Subtotal - Rewire R.O. Auxiliary Generator** | | | | **$ 113,000** |
| 4. | Retrofit existing wells for auxiliary generator (includes cable, conduit, generator, ATS, cable). | 2 | each | 40,000.00 | 80,000 |
| 5. | Auxiliary generator at new well sites (includes generator, ATS, cable). | 2 | each | 35,000.00 | 70,000 |
| | **Subtotal - Auxiliary Generators at Well Sites** | | | | **$ 150,000** |
| | **Total Construction Cost Opinion** | | | | **$ 263,000** |
| 6. | Auxiliary generator and power usage study. | | | | 10,000 |
| 7. | Engineering design plans and specifications. | | | | 18,780 |
| 8. | Contract administration and resident inspection. | | | | 11,500 |
| 9. | Project contingency. | | | | 29,000 |
| | **Project C Total Cost Opinion** | | | | **$ 332,280** |

# PROJECT PERSONNEL

This section introduces the members of our proposed project team and describes their assigned responsibilities for the Dare County water system project. Our team is structured to effectively merge the talents and capabilities of the individual members with the required activities necessary to control the technical, administrative, and scheduling aspects of the work.

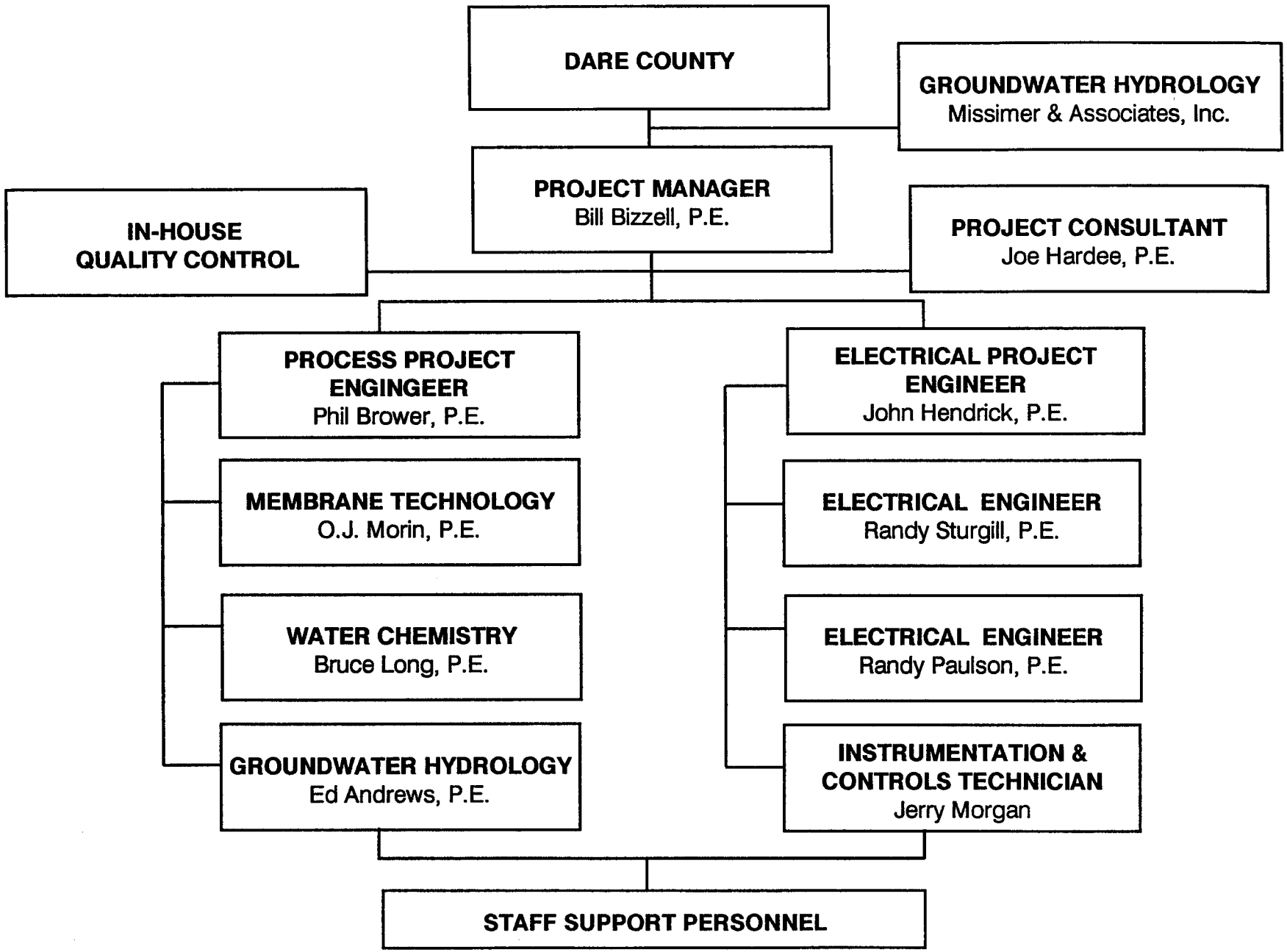
At the project outset, the responsibilities and authority of all participants will be clearly and concisely delineated, and procedures required to achieve a technically sound studies and design will be outlined and provided to team members and the County. Our project team is composed of highly skilled and experienced professional engineers who are dedicated to providing a high standard of engineering quality and service to the Dare County.

## STAFF ORGANIZATION

A project of this type involves individuals with special skills, all of whom are dedicated to meeting the established project objectives. Achieving this objective requires the integration of the expertise of several consulting disciplines, including hydrogeology, water resources management, and treatment technology. To assure that the efforts of all project team members are properly directed, the responsibility of each must be carefully defined. Definitions of the responsibilities for the major project roles and the individuals serving in these roles is provided in this section. A chart depicting project staffing and responsibilities for each major project phase appears on the following page.

The success of a project is tied to the dedication and commitment of a quality project team. Furthermore, it is imperative that the project team members remain on the project from the initiation through completion of all project deliverables. Black & Veatch dedicates this project team to Dare County's comprehensive project.

# PROJECT TEAM ORGANIZATION



County representatives offer a wealth of experience regarding the water supply needs for the County, and Black & Veatch considers access to this knowledge to be an integral and essential part of the overall project effort. Consequently, we propose that County personnel be involved on an ongoing basis to ensure that the goals for the project are fully integrated into the work product, where early study efforts must clearly identify and resolve any technical issues. Black & Veatch has assigned a senior and experienced team to accomplish this goal.

## *PROJECT MANAGEMENT*

### *Project Consultant - Joseph E. Hardee, P.E.*

Project Consultant Joe Hardee has more than 40 years of experience in the study and detailed design of environmental engineering projects. For this project, Joe will provide valuable project background input, liaison with the various entities involved in the project, and feasibility/economic analyses.

Joe is recognized by engineering professionals and municipal clients throughout North Carolina for his decades of experience in project feasibility analysis, his expertise in assisting clients in obtaining financing, and project planning and design management. He has more experience in the funding of water and sewer system improvements that any other practicing engineer in the state. A long-term member of state and national professional organizations, Mr. Hardee has held various offices and participated on committees to ensure quality engineering throughout North Carolina. He has been instrumental in obtaining EPA and other government funds for dozens of projects, and has acted as consultant in bond issues and other funding programs for clients.

*Related project experience:*

- Water system development in Dare County, North Carolina has involved 25 years of water supply, treatment, and distribution system's in the county including the popular Outer Banks area. He acted as consultant during the formation of legal bodies and during the development of funding alternatives and plans to finance the County's groundwater supply, a new desalination water treatment plant, and storage and distribution system. He led efforts to design and place into operation Dare County's award-

winning and innovative plant which is the largest desalination plant on the East Coast outside of Florida.

- Feasibility study, bond referendum promotion, and public information meetings advisor during sewer system feasibility for the newly-incorporated Village of Clemmons, North Carolina. Planning tasks included funding analysis and resulted in partial funding of the project by the US EPA and a successful bond referendum in the autumn of 1988.

***Project Manager - William P. Bizzell, P.E.***

Project manager Bill Bizzell has overall responsibility for the technical quality and timely completion of all project tasks, including liaison with the County; project planning and coordination; staff cost and schedule controls; progress reporting; and final product delivery. He will maintain frequent contact with key team members, reviewing the work in progress and ensuring that adequate resources are available to accomplish all project tasks. This individual also conducts primary technical direction of the project, with input from technical experts in several evaluation disciplines. Bill will undertake various tasks to make certain the project is properly administered including:

- Meet with Dare County staff to integrate their technical concerns and input into the contractual scope of services.
- Define the communication methods which ensure ongoing input from the County.
- Identify and evaluate organizational and management alternatives.
- Evaluate financing alternatives.
- Provide continuous scheduling and quality control throughout the project.

As Project Manager, Bill Bizzell will manage this project through the successful blending of previous work by Black & Veatch for Dare County, effective contact with the project consultant and State officials based in Raleigh, and coordination of the project tasks.

The Project Manager has the responsibility to coordinate the development of the various parts and technical disciplines of the project, define criteria for analysis, and provide technical direction throughout project development. Bill has over 25 years of experience in the design and management of water treatment projects. He is currently project manager for the various water system improvements in Dare County.

*Related project experience:*

- Engineering manager during design and construction phase services for the award-winning water desalination to serve Dare County and the Outer Banks area. The design of the 8 million gallon per day water treatment plant included plant and system instrumentation and controls for treatment, distribution, and storage.

- Engineering manager during design and construction phases of a new 24 mgd high service pumping station and office facility for the City of Greensboro. The project required extensive use of existing equipment, working with severe site limitations, and the switch to the new facility without interruption in service.

## *WATER SUPPLY AND SKYCO WTP EVALUATION*

The well field expansion and Skyco treatment facility evaluation plans of the project require an experienced engineering support staff with a diversity of engineering and consulting skills. The resumes of the various water resources, treatment process, and groundwater engineers who will participate in this project are included in this section.

***Process Project Engineer - Philip M. Brower, P.E.***

Phil Brower will serve as Process Project Engineer for the duration of the project. He will remain involved on a continuous basis to coordinate the activities of the water treatment engineers and the findings of the technical specialists, to evaluate the water resources alternatives, and to produce the final evaluation report, design of improvements and others.

Phil brings to the project team an in-depth knowledge of water supply, treatment, and distribution system design. He was the project engineer in the comprehensive Phase I water system for Currituck County that involved preliminary analysis, supply alternatives analysis, and water resources development, the design of the treatment plant, storage, and distribution, and construction phase services.

Phil currently is project engineer for water system improvements for the City of Washington, North Carolina involving water supply development (4.5 mgd well field network) and treatment facility design.

*Related project experience:*

- Planning and design of the City of Havelock's 1.4 mgd water treatment plant including 1,000 gpm production wells, system storage, pumping, and distribution.

- Water system evaluation of Marine Corps Air Station, Cherry Point, including supply, treatment, and distribution.

***Water Chemistry - Bruce W. Long, P.E.***

Bruce Long is Director of Water Treatment Technology for Black & Veatch. His diversified experience includes virtually all facets of conventional and innovative water treatment processes. He will be directly responsible for all pilot and bench scale testing at the Skyco WTP to determine the means and methods of eliminating THM precursors from the water treated at the plant. Mr. Long has designed pilot testing facilities and test programs throughout the Country, including North Carolina projects for High Point (SDWA compliance testing), Asheboro (process design), and the Charlotte-Mecklenburg Utility Department (pilot testing of Lake Norman water for new WTP).

*Related project experience:*

- Pilot plant testing and SDWA assessment of plant disinfection process modifications to minimize distribution system disinfection byproducts levels, Mesa, Arizona.

- SDWA assessment of Lincoln, Nebraska WTP. Project involved design of a permanent pilot testing program to evaluate alternatives for oxidation and removal of atrazine, iron, and manganese.

***Membrane Technology - O.J. Morin, P.E.***

Reverse osmosis specialist O.J. Morin will participate in the evaluation of the Skyco WTP process and the blending of the various waters from the different plants. A nationally-recognized expert in the application of thermal and membrane technologies for the desalination of brackish and sea waters, Mr. Morin has managed the design of major RO facilities throughout the country. He is a member of the International Desalination Association and has served as president and director of the National Water Supply Improvements Association.

*Related project experience:*

- Project manager for a 2.5 mgd RO plant in Indian River County, Florida including construction phase services.

- Lead engineer for design of a 6.5 mgd desalting facility for the Orange County (California) Water District.

***Groundwater Hydrology - Edwin E. Andrews, P.E.***

Ed Andrews will act as technical consultant for hydrogeologic investigations to determine the existing hydrogeologic framework of the study area. Recognized for his broad expertise in the hydrogeology of the coastal regions of North Carolina and Virginia, Mr. Andrews is currently a member of the North Carolina Environmental Management Commission and serves on the Commission's Groundwater and Water Quality committees. Mr. Andrews is based in Raleigh, North Carolina, which will enable Black & Veatch to cost-effectively coordinate his services and the steps required by the state in developing and finalizing the comprehensive evaluation.

*Related project experience:*

- Extensive project experience with all facets of hydrogeology including water supply, environmental audits, underground site assessments, and computer modeling particularly hydrology of the surficial aquifer along the Outer Banks of Dare and Currituck counties.

- North Carolina Board for Licensing of Geologists (1985-1991); Water Resources Committee - Triangle J Council of Governments; Chief Regional Geologist with Virginia State Water Control Board, Tidewater Regional Office, Virginia Beach, Virginia.

*ELECTRICAL SYSTEM AND CONTROLS & INSTRUMENTATION TEAM*

The electrical system analysis and design will require engineers and designers who are familiar with the existing facilities and who have experience in large electrical loads. Black & Veatch's electrical engineering team provides both areas of expertise in addition to a valuable familiarity with pricing structures of power companies.

***Electrical Project Engineer - John R. Hendrick, P.E.***

John Hendrick will direct and coordinate the activities of the electrical project team during analysis of auxiliary power requirements at the new wells and at the R.O. plant. John has managed regional electrical system evaluation and design in the Mid-Atlantic Region since 1988. His extensive background in electrical design for water treatment systems includes plant expansion and rehabilitation, new plant design, SCADA systems, instrumentation and control, and power capacity and load evaluations.

*Related project experience:*

- Evaluation of Glenville Lake WTP existing power capacity and reliability in development of recommendations for electrical system expansion to accommodate planned plant expansion and increase in flow, Public Works Commission of the City of Fayetteville.

- Management of water treatment plant electrical system design for High Point, Washington, Mount Airy, Onslow County, Dare County, Asheboro, and Fayetteville, North Carolina. Design was for systems to serve new plants, plant expansions, ground and surface water supplies, and distribution networks up to 15 mgd in capacity.

*Electrical Engineers - Randall W. Sturgill, P.E. and D. Randall Paulson, P.E.*

Randy Sturgill and Randy Paulson will analyze the feasibility and cost of auxiliary power generation at the new wells and at the R.O. plant. Based on the findings from this analysis, they well develop recommendations regarding optimal rate scheduling with North Carolina Power; equipment and configuration of back-up generators at the well field; and the use of auxiliary power at the R.O. plant.

Both engineers bring solid water system design to the project team. Following his participation on the R.O. plant electrical design, he provided similar service to Onslow County (well field power and controls), High Point (power and instrumentation for pumping station), and Washington, North Carolina (electrical system and control systems for new 4.2 mgd plant and SCADA system connecting wells, storage, and distribution system). Randy has subsequently provided electrical design for Dare County projects, including the recent Kitty Hawk pumping station project.

Randy Paulson, who is based in the Raleigh, NC office of Black & Veatch, has worked on a number of electrical system designs in support of system improvements. For the City of Raleigh, he conducted a detailed load study and utility rate study for the upgrade of the raw water pumping station at the E.M. Johnson water treatment plant. He also provided electrical system design for the upgrade and expansion of the City of Wilmington's Northside wastewater treatment plant. His experience in electrical systems and power generation is extensive, and includes development of design and design criteria of generators for both public and private clients.

*Instrumentation & Controls Design - Jerry D. Morgan*

Jerry Morgan will provide design of all instrumentation and controls required to tie the new wells and auxiliary generators to the existing controls system. He participated on design of the existing SCADA and PLC systems and instrumentation and controls at the R.O. plant, and is highly familiar with the Dare County system. In addition to this experience, Jerry has developed SCADA, instrumentation, and controls for Greensboro, Wilmington, Onslow County, Currituck County, Havelock, and Washington, North Carolina. Several of these projects involved monitoring and control of remote well supplies, storage facilities, and distribution networks.

## WILLIAM P. BIZZELL
## PROJECT MANAGER

Bill Bizzell has managed engineering design, architectural design, and construction management services for major water, wastewater, and site development projects. He coordinates resources and conducts client and regulatory agency contact throughout each project to ensure optimal design and completion that meet budgetary and scheduling objectives.

### RELATED EXPERIENCE

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| Water Supply, Storage, Treatment and Distribution Improvements Dare County, North Carolina | Engineering Manager | Directed the study, pilot plant testing, design, and construction of a 3.0 mgd reverse osmosis regional water treatment facility (winner of 1990 Grand Conceptor Award by the Consulting Engineers Council of North Carolina). Project included regional water storage facilities, water transmission lines, and pumping stations to serve several Outer Banks communities. |
| Resort Development Bald Head Island, North Carolina | Project Engineer | Performed master planning of groundwater supply system, water distribution and storage, wastewater collection and treatment, and street design. |
| Water Improvements Project Seagrove-Ulah Metropolitan Water District Seagrove, North Carolina | Project Manager | Directed study and design of CDBG-funded project. Project consisted of 53,000 LF of water line; 500,000 gallon standpipe; and metering and rechlorination facility. Projects also includes bidding and construction phase services. |
| Northeast Metropolitan Water District Water System, Harnett County, North Carolina | Project Manager | Managed water system design involving 3.2 mgd water treatment facility, 35 miles of distribution line, four elevated storage facilities, and booster pumping stations. |
| Water Treatment Plant Expansions (1970, 1984), Asheboro, North Carolina | Project Manager | Resident engineering services and project management of two WTP expansions for the City of Asheboro. |
| Resort Development Pinehurst, North Carolina | Project Engineer | Prepared master plan development for 5,500-lot resort development, involving surveys, design and construction of 50 miles of streets, 50 miles of water and wastewater lines, pump stations, and storm drainage. |
| Raw Water Supply Design Asheboro, North Carolina | Project Manager | Directed design of 4 billion gallon raw water reservoir, concrete gravity dam, 13 mgd raw water intake and pump station, and 4 miles of 30-inch and 36-inch raw water lines. |

## William P. Bizzell

| | | |
|---|---|---|
| Wastewater Collection System, Clemmons, North Carolina | Project Manager | Managed study, design, and construction of comprehensive wastewater collection system, including more than 48 miles of collection lines and 13 miles of interceptors during phased construction. |
| 1986-87 Annexation Area Wastewater Collection Project Charlotte-Mecklenburg Utility Department, Charlotte, NC | Project Manager | Managed design and construction of more than 25 miles of interceptors. |

**PERSONAL DATA**

1960, B.S., Civil Engineering, North Carolina State University

**Member:** AWWA, PENC

**Professional Registration:** North Carolina, Virginia

**Registered Land Surveyor:** North Carolina

**Joined Black & Veatch:** 1970

**Technical Papers and Presentations:**

Bizzell, W.P. and Wyche, R.J., *Automated Design for Gravity Wastewater Collection Systems*," presented at the 1990 Annual Conference of the Water Pollution Control Federation, October 11, 1990, Washington, D.C.

# JOSEPH E. HARDEE
# PROJECT CONSULTANT

Joe Hardee is recognized by engineering professionals and municipal clients throughout North Carolina for his 40 years of experience in project feasibility analysis, his expertise in assisting clients in obtaining financing, and project planning and design management. He has more experience in the funding of water and sewer system improvements than any other practicing engineer in the state.

A long-term member of state and national professional organizations, Mr. Hardee has held various offices and participated on committees to ensure quality engineering throughout North Carolina. He has been instrumental in obtaining EPA and other government funds for dozens of projects, and has acted as consultant in bond issues and other funding programs for clients. Additionally, he has been involved in the creation of numerous political entities to provide water and wastewater service to various areas of North Carolina.

## RELATED EXPERIENCE

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| Water System Development, Dare County, North Carolina | Project Manager | Involved for 25 years in the development of water supply, treatment, and distribution system for Dare County including the Outer Banks. Acted as consultant during formation of legal bodies and during development of funding alternatives and plans to finance the County's groundwater supply, a new desalination water treatment plant and storage and distribution system. |
| Water System, Hatteras Island, North Carolina | Project Manager | Directed the functional design of a 1.0 mgd supply, treatment and distribution system using surficial freshwater under the island as supply. |
| Feasibility Studies and Finance Development, Currituck, Pasquotank, Camden, Hertford, Washington counties, North Carolina | Project Manager | Directed feasibility studies of county-wide water and sewer systems. Assisted in financing for water systems in three northeastern North Carolina counties. |

## Joseph E. Hardee

| | | |
|---|---|---|
| Project Feasibility and Funding Alternatives, Bay River Metropolitan Sewerage District, Bayboro, North Carolina | Project Advisor | Participated in preliminary feasibility studies and during project funding phase associated with the District's STEP sewage collection system to serve from 1,100 to 1,200 customers. Funding phase assistance resulted in the client's obtaining FmHA, EPA, DHUD and State funding for the comprehensive project. |
| Feasibility Study, Bond Referendum Promotion, and Public Information Meetings, Village of Clemmons, North Carolina | Project Advisor | Advisor during system feasibility study and extensive participation in promoting bond referendum. Planning tasks included funding analysis and resulted in partial funding the USEPA and a successful bond referendum in autumn of 1988. |
| Water Distribution System, Guilford County, North Carolina | Project Manager | Directed design of system components ranging from 12-inch to 30-inch mains and a pressure-reducing facility. |
| Storm Drainage System Analyses, Whiteville, Enfield, and Cary, North Carolina | Project Manager | Completed studies requiring evaluation of existing systems and projected long-term needs to provide adequate storm water drainage structures. |
| Wastewater System Improvements, Guilford County, North Carolina | Project Manager | Directed design and preparation of plans for 67,000 linear feet of 12-inch to 48-inch Horsepen Creek Interceptor and 3.0 mgd regional pumping station. |
| Field Surveys, Kerr Reservoir, Virginia | Project Manager | Designed and directed surveys of 670-lot residential subdivision. Developed unique adjustments for first order triangulation along the New River in North Carolina and Virginia. |

**PERSONAL DATA**

B.S., Civil Engineering, North Carolina State University, 1951
M.S.C.E., North Carolina State University, 1956

**Member:**

ASCE, NSPE, NC Society of Engineers, NC Society of Surveyors

**Professional Registration:** North Carolina, South Carolina, Virginia

**Joined Black & Veatch:** 1960

## PHILIP M. BROWER
## PROCESS PROJECT ENGINEER

Mr. Brower has participated in a variety of projects requiring detailed and comprehensive knowledge of water and wastewater treatment designs and operations, environmental engineering, state and federal environmental regulations, hydrology, and hydraulics. As project engineer for a number of water treatment system projects, he has conducted preliminary water supply and treatment studies and provided design of well fields, treatment plants, storage structures, and distribution mains.

### RELATED EXPERIENCE

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| County-wide Water System, Currituck County, North Carolina | Project Engineer | Design and construction management of 1.0 mgd pressure filter and softening treatment system, 18 shallow wells, 3 elevated storage tanks, 2 booster pumping stations, and over 100,000 linear feet of distribution main. |
| County-Wide Wastewater System, Harnett County, North Carolina | Project Engineer | Study of a county-wide wastewater collection and treatment system, including development of county and municipal collection and treatment alternatives, cost evaluation of alternatives, preliminary design of selected plan. |
| Water Treatment System, Washington, North Carolina | Project Engineer | Planning and design of new water supply and treatment system consisting of 4.5 mgd well field network, and 4.5 mgd treatment plant including miscellaneous distribution system improvements. |
| Water Treatment Plant, Havelock, North Carolina | Project Engineer | Designed 1.5 mgd water treatment facility that included two 1,000 gpm production wells, aeration, pressure filters and softeners, chemical feed systems, ground storage reservoir, high service pumping, and water treatment plant. |
| Water System Evaluation U.S. Marine Corps Cherry Point, North Carolina | Project Engineer | Water system evaluation of Marine Corps Air Station including supply, treatment, and distribution. |
| Water Treatment Plant Expansion, Greenwood, South Carolina | Project Engineer | Design of 15 mgd expansion of existing 12 mgd surface water plant supplied from Lake Greenwood: 15 mgd high service pumping station; filter backwash; and basin sludge treatment and dewatering facilities. |

| | | |
|---|---|---|
| Water Treatment Plant Upgrade, Mount Airy, North Carolina | Project Engineer | Planning and design of 3 mgd upgrade and refurbishment to existing Lovills Creek supply facilities and Orchard Street treatment plant. Project included: upgrade 3.0 mgd raw water pump station; improvements to 8.0 MG raw water reservoir; new 3.0 filtration/sedimentation complex; new chemical feed complex; convert existing filtration/sedimentation complex to sludge handling facilities. |
| Lake Townsend Water Treatment Plant, Greensboro, North Carolina | Project Engineer | Design of a 10 mgd expansion for the Lake Townsend water treatment plant including new 30 mgd constant speed low lift pump, rapid mix and flow splitting, 10 mgd flocculation/sedimentation basin, three 12.1 x 50' filters, chlorination and hydrated lime facilities, 3 mgd clearwell, and waste handling facilities. |
| Water Treatment Improvements, Richmond County, North Carolina | Project Engineer | Design and construction administration of a 2.0 mgd conventional surface water plant and raw water pumping station. |
| Industrial Water Treatment Plant, Panjapol Paper Industry Ayuthya, Thailand | Project Engineer | Conceptual design of a 6 $M^3$/day water treatment facility to serve 940 metric ton/day pulp and paper mill. |
| Flood Studies National Flood Insurance Program, Washington, D.C. | Project Engineer | Analysis and modeling preparation of hydrologic and hydraulic data using HEC-1 and HEC-2 computer programs. |
| Lake Quality Analysis Federal Clean Lakes Program Raleigh, North Carolina | Project Engineer | Conducted limnological analyses and study of recreational lakes at William B. Umstead State Park; recommended lake rehabilitation measures. |
| Industrial Water & Wastewater System Analysis, Weyerhaeuser Company Moncure, North Carolina | Project Engineer | Conducted water and wastewater systems analysis; recommended recycling treatment measures. |
| Wastewater Treatment Plant Wilmington, North Carolina | Project Engineer | Evaluated interim chemical treatment at Southside Wastewater Treatment Plant. Work included coagulant and polymer screening by bench testing; laboratory testing of bench test results; chemical cost comparisons; sludge handling and treatment modifications; and preliminary design and cost estimate. |

## Philip M. Brower

| | | |
|---|---|---|
| Wastewater Treatment Plant,<br>Liberty, North Carolina | Project Engineer | Design and construction phase services for a new 0.55 mgd land application system. Work consisted of the following major items: triplex influent pump station; facultative lagoon; solid set irrigation system; irrigation pumps; chlorination facilities. |
| Wastewater Treatment Plant,<br>Cramerton, North Carolina | Project Engineer | Design and construction phase services for a new plant using the Schreiber activated sludge process. Design included screens, clarifiers, sludge handling facilities, pumping, chlorination, and outfall. |
| City of Durham,<br>Eno River Wastewater<br>Treatment Plant,<br>Durham, North Carolina | Civil Engineer | Prepared detailed drawings and specifications for this wastewater treatment plant which included biological phosphorus removal. |

### PERSONAL DATA

B.S., Civil Engineering, North Carolina State University, 1975
M.S., Civil Engineering, North Carolina State University, 1977

**Member:** ASCE, AWWA, WPCF

**Professional Registration:** North Carolina

**Joined Black & Veatch:** 1979

# O.M. MORIN
# REVERSE OSMOSIS (RO) SPECIALIST/MEMBRANE TECHNOLOGY

Mr. Morin has more than 29 years of experience in the planning and design of advanced water treatment facilities. He is a nationally recognized expert in the field of thermal and membrane technologies for the desalination of brackish and sea waters. His experience ranges from fractional mgd sized reverse osmosis (RO) plants to the world's largest multi-stage flash (MSF) facility, a 240 mgd plant in Al Jobail, Saudi Arabia.

## RELATED EXPERIENCE

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| Reverse Osmosis (RO) Water Treatment Plant, Indian River County, Florida | Project Manager | Responsible for design of the 2.5 mgd RO WTP and for the continuing operation and maintenance services, the finalization of contracts and initiation of construction work for $1,250,000 plant improvements. |
| Desalting Facility, Orange County Water District, Orange County, CA | Lead Engineer | Duties involved the design and preparation of plans and specifications for the 6.5 mgd desalting facility and all auxiliary equipment. |
| Desalination Facility, San Diego County Water Authority, San Diego, CA | Project Manager | Responsibilities included preparation of all design concepts, cost estimates and evaluation of each of the processes studied which were multi-stage flash (MSF), multiple effect distillation (MED), and reverse osmosis (RO). |
| U.S. Navy, Guantanamo Bay, Cuba | Project Manager | Responsible for design concepts, contract documents, specifications and drawings for the installation of two 1.0 mgd desalination plants. Designs were prepared for multi-stage flash (MSF), multiple effect distillation, sea water reverse osmosis with demineralize system for boiler water makeup. |

## PERSONAL DATA

1961, B.S., Engineering, University of Connecticut
Graduate Studies, Mechanical Engineering, University of Bridgeport

**Member:** AWWA, ASME, International Desalination Association, National Association of Corrosion Engineers, National Water Supply Improvement Association

**Professional Registration:** Florida, Pennsylvania

**Joined Black & Veatch:** 1990

## O.M. Morin

**Selected Publications:**

"Theory of Reverse Osmosis: Part 1," Morin, O.J., NWSIA News, August 1986.

"Theory of Reverse Osmosis: Part 2," Morin, O.J., NWSIA News, September 1986.

"Theory of Reverse Osmosis: Part 3," Morin, O.J., NWSIA News, October 1986.

"Theory of Reverse Osmosis: Part 4," Morin, O.J., NWSIA News, September 1987.

"Operation of the Reverse Osmosis Facility at Indian River County, Florida," Morin, O.J., Pinto, T. and O'Keefe, B., Procedures of the 1988 Biennial Conference, National Water Supply Improvements Association, August 1988.

"Assessing Desalting Needs of South Florida," Morin, O.J., Proceedings of the National Water Supply Improvement Association/South Florida Water Management District Workshop, August 1987.

"Design and Economic Analysis of RO Systems Using Application Software and Microcomputers," Morin, O.J., Proceedings of the First Biannual Conference of the National Water Supply Improvement Association, June 1986.

# BRUCE W. LONG
# PROCESS DESIGN/PILOT TESTING/WATER CHEMISTRY

Mr. Long is the Director of Water Treatment Technology for Black & Veatch. He is responsible for assessing and developing design parameters for water treatment technologies for the firm's water treatment plant design projects. He also designs pilot plant testing facilities and test programs, evaluates the resultant data for upscaling to full-scale treatment processes, and provides process operation optimization and SDWA compliance assessments for our water clients. He has performed several studies on alum sludge dewatering with and without alum recovery.

## RELATED EXPERIENCE

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| Weyerhauser Paper Company, Water Treatment Consultation, Plymouth, North Carolina | Project Engineer | Performed comprehensive study of potable water system. Evaluated chemical and micorbial quality and developed treatment strategies to ensure finished water quality objectives. |
| City of Raleigh, Raw Water Transmission Main Capacity Restoration, Raleigh, North Carolina | Process Engineer | Provided thorough evaluation of courses for raw water transmission main capacity reduction. Determined the cause and provided process design of remediation alternatives. |
| City of Tucson, Pilot Plant, Tucson, Arizona | Pilot Plant Engineer | Designed and operated pilot plant to evaluate conventional treatment versus direct filtration, filter media design, and possible inclusion of ozone in treatment train for treatment of central Arizona Project water. Pilot plant included full laboratory of performance of THM, THMFP, TOC/DOC, TON testons, particle count and site distribution, and conventional wet chemistry. |
| City of Tucson, Pilot Plant, Tucson, Arizona | Pilot Plant Engineer | Pilot plant lent to design of 225 mgd direct filtration plant incorporating preozonation and deep bed monomedium filtration. |
| City of Mesa, SDWA Assessment, Mesa, Arizona | Project Engineer | Assessed Mesa's water treatment plant. Evaluated disinfection process modifications to minimize distribution system disinfection byproduct levels. |

## Bruce W. Long

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| City of Lincoln,<br>Process Design,<br>SDWA Assessment,<br>Pilot Plant,<br>Lincoln, Nebraska | Process Engineer | Performed SDWA assessment of Lincoln's existing water treatment plant. Designed a permanent pilot plant for Lincoln and directed pilot plant testing program evaluating ozone, potassium permangante and alternative filter designs for oxidation and removal of atrazine, iron, and manganese. Provided process design of 50 mgd plant expansion and participated in public information program. |
| Orlando Utilities Commission,<br>Water Treatment Process Consultation,<br>Orlando, Florida | Process Consultant | Provided process consultation or water treatment and control of taste and odors in the disinfection. Provided consultation on ozone pilot plant testing program. |
| City Utilities of Springfield,<br>Process Consultation, Water Plant Upgrade,<br>Springfield, Missouri | Project Engineer | Evaluated water treatment plant process. Directed process modification designs to reduce residual aluminum in finished waters. Developed process modification designs to implement study findings. |
| City of Martinez,<br>Process Design,<br>Martinez, California | Process Consultant | Provided process design consultation for retrofit of ozonation facilities into existing water treatment plant. Process modifications included design of tube settlers for future sedimentation process enhancement, and the addition of GAC caps existing filters. |
| City of Waukesha,<br>Water Treatment Process Consultation,<br>Waukesha, Wisconsin | Process Engineer | Provided alternative treatment process design for the removal of Radium 226 and 228. Providing ongoing consultation on discussions with regulatory personnel. |
| City of Hannibal,<br>Plant Expansion,<br>Hannibal, Missouri | Process Consultant | Provided process consultation on project to expand and enhance water treatment plant using higher rate processes. Assisted in discussions with regulatory personnel. |
| City of Battle Creek,<br>Water Treatment,<br>Battle Creek, Michigan | Project Engineer | Assessed treatment alternatives for removal of volatile organic chemicals from water supply. |
| City of Lansing,<br>Water Treatment,<br>Lansing, Michigan | Project Manager | Developed softening sludge management, treatment, and disposal procedures. |
| City of Denver,<br>Water Treatment,<br>Denver, Colorado | Project Engineer | Prepared process design of 30 mgd addition to the Marston Water Treatment Plant. |

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| Electric Power Research Institute, Advanced Oxidation Process, Palo Alto, California | Project Engineer | Supervising a pilot plant testing program to assess the effectiveness and cost of ozone, ozone/hydrogen peroxide, and ozone ultraviolet irradiation for the reduction of color from several pulp and paper mill waste streams. The testing program is following a statistical design and is intended to provide data applicable to a multitude of pulp and paper mills. |
| City of San Luis Obispo, Pilot Plant, San Luis Obispo, California | Process Consultant | Provided consultation on pilot plant testing program performance and interpretation of results. Participated in meetings with State regulatory personnel. |
| Board of Public Utilities, Process Assessment, Pilot Plant Design, Kansas City, Kansas | Project Manager | Designed permanent pilot plant facilities to evaluate alternative disinfectants for minimization of finished water disinfection byproducts. Project also included direction and interpretation of pilot plant program and findings, an SDWA assessment of BPU's Quindaro Water Filtration Plant, and design of filter enhancements. Participated in public information programs. |
| City of Fargo, Pilot Plant, Process Design, Fargo, North Dakota | Project Engineer | Provided process performance and SDWA assessment of water treatment plant. Supervised pilot plant testing program for selection of disinfection and taste and odor control process. Pilot program evaluated ozone, powdered activated carbon, potassium permangante, alternative filter designs, and the superpulsator clarifier. |
| City of Decatur, SDWA Assessment, Decatur, Illinois | Process Engineer | Provided SDWA assessment of two water treatment plants. Providing ongoing consultation on regulatory issues. |
| Washington Suburban Sanitary Commission, Process Design, Washington, D.C. | Process Engineer | Designed treatment process alternatives for several raw water supply scenarios. Processes included desalination, ozonation, and GAC in addition to conventional treatment technologies. |
| Fairfax County Water Authority, Process Value Engineering, Merrifield, Virginia | Process Specialist | Performed process value engineering on plant expansion project. |

## Bruce W. Long

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| East Bay Municipal Utilities District, Ozone System Process Design, Oakland, California | Process Engineer | Provided process design for ozonation facilities to be retrofitted into 5 EBMUD water treatment plants. Process design included ozone contactors and dissolved ozone monitoring system. |
| City of Asheboro, Industrial Wastewater Treatment, Asheboro, North Carolina | Project Manager | Designed wastewater treatment system for removal of heavy metals and volatile organic chemicals. |
| Water Pollution Control Department, Industrial Waste Source Control, Kansas City, Missouri | Project Manager | Designed acid and base neutralization systems for source control and developed source volatile organic chemical control measures. |
| City of Roseville, Water Treatment, Roseville, Minnesota | Project Manager | Consulted with Minnesota Pollution Control Agency concerning removal of asbestiform fibers from water supplies. |
| City of Maryville, Industrial Wastewater Treatment, Maryville, Missouri | Project Manager | Designed wastewater treatment system for removal of zinc, mercury, manganese, and trichloroethylene. |
| City of Wichita, Industrial Waste Treatment, Wichita, Kansas | Project Engineer | Designed water recycle/reuse systems. Developed wastewater treatment system alternatives. |
| Various Clients, Industrial Waste Treatment, Cleveland, Ohio; Charlotte, North Carolina; Nashville, Tennessee; and Maybrook, New York | Project Manager | Designed wastewater treatment systems for removal of surfactants, oil and grease, and chemical oxygen demand. Provided operations consultation. |
| City of Independence, Wastewater Treatment, Independence, Missouri | Project Engineer | Performed process design of satellite and centralized wastewater treatment systems and prepared detailed economic analysis of treatment and disposal alternatives. |
| Various Clients, Groundwater Treatment and Hazardous Waste Management, California | Project Manager | Designed facility to remove chromium and copper from groundwater. Chromium and copper are recovered for reuse. |
| City of Saigert, Hazardous Waste Management, Saigert, Illinois | Project Manager | Evaluated scrubber water treatment processes. Designed air pollution control system. |
| Water Pollution Control Department, Hazardous Waste Management, Kansas City, Missouri | Project Manager | Provided chemical engineering consultation to USEPA Region VII on hazardous waste management technologies. |

## Bruce W. Long

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| Water Pollution Control Department, Hazardous Waste Management, Kansas City, Missouri | Project Manager | Designed waste oil handling, treatment, and storage systems. Designed wastewater treatment system. |
| City of Baltimore, Wastewater Sludge Treatment, Baltimore, Maryland | Project Engineer | Prepared process design of dissolved air flotation for thickening waste activated sludge. |
| City of Ellisville, Hazardous Waste Management, Ellisville, Missouri | Project Engineer | Provided chemical engineering consultation to USEPA concerning analytical techniques and development of a hazardous waste generator assignment methodology. |
| City of Chicago, Gas Cleaning, Chicago, Illinois | Project Engineer | Performed detailed assessment of alternative gas cleaning technologies to render anaerobic digester gas suitable for pipeline supply. |
| City of Sullivan, Industrial Wastewater Treatment, Sullivan, Missouri | Project Engineer | Prepared wastewater characterization and designed wastewater treatment system for removal of oil, grease, zinc, and lead. |
| City of Fort Collins, Flocculation Process Performance, Fort Collins, Colorado | Process Consultant | Provided process consultation. Evaluated flocculation process performance leading to modifications from cross-flow paddle wheel to co-axial flow. Provided consultation on pilot plant facility design, data interpretation, and testing programs. |

**PERSONAL DATA**

B.S., Chemical Engineering, Lehigh University, 1968
M.S., Environmental Science, Rutgers University, 1980
Ph.D. Candidate, Environmental Health Engineering, University of Kansas

**Professional Registration:** Missouri

**Joined Black & Veatch:** 1980

**PRESENTATIONS AND PUBLICATIONS:**
"Removal of Priority Pollutants by Conventional Treatment Technologies in the Petrochemical Industry," Presented at 52nd Annual Conference of the Water Pollution Control Federation, Houston, Texas, 1979. Detailed measured organic priority pollutant removal efficiencies for conventional wastewater treatment technologies as a function of design and operating parameters.

"Status of the Local MSD Pretreatment Program," Presented at a Missouri Water Pollution Control Association Seminar entitled "Pretreatment of Industrial Wastes Discharged in Municipal Treatment Facilities," St. Louis, 1981. Described EPA-mandated pretreatment program requirements and presented and detailed how MSD's program was being designed to comply with the requirements.

"Federal Inspiration Enhances Local Industrial Pretreatment Programs," Presented at the 1982 Missouri Water Pollution Control Association's Annual Meeting, Springfield, Missouri. Described the computer-based pretreatment program developed for MSD-St. Louis.

"Site Safety Plant - The First Step in Investigating an Uncontrolled Active Hazardous Waste Disposal Site," Presented at the 184th Annual Conference at the American Chemical Society, Kansas City, Missouri, 1982. Presented factors to be addressed in developing a site safety plan.

"Heavy Metals Removal, More Than Solubility Products," Presented at the 57th Annual Conference of the Water Pollution Control Federation, New Orleans, Louisiana, 1984. Detailed the impact of cheating agents on soluble metal removal efficiencies.

"Alternatives for Groundwater Contamination Cleanup," Presented at ASCE Water Forum, 1986.

"Material Substitution Lowers Industrial Waste Treatment Costs," 41st Purdue Industrial Waste Conference, 1986.

"VOC Control Strategies for Drinking Water Supply and Groundwater Cleanup," 37th Annual Kansas University Environmental Engineering Conference, 1987.

"Tucson Pilot Plant Evaluating Alternatives for Treatment CAP Water," *Water Engineering & Management*, February 1987.

"Use of Ozone in Promoting Microflocculation and Oxidation of Organics in Colorado River Water," 8th Ozone World Congress, Zurich, September 1987.

"Ozone: A Workable Solution to Meeting Tomorrow's Water Standards," *Water Engineering & Management*, May 1988.

"Impacts of Ozone on the Treatment of Colorado River Water," 38th Annual Kansas University Environmental Engineering Conference, 1988.

"Ozone Pretreatment for Microflocculation," Rocky Mountain AWWA JTAC Advance Water Treatment Seminar, 1988.

"Multiple Impacts of Ozone on Water Treatment Processes," 43rd Annual Kansas AWWA Meeting, 1988.
"Tucson Water Treatment Pilot Plant Studies: THM Control," IOA Pan-American Conference, 1988.

"Using Ozone as a Primary Disinfectant for the Tucson CAP Water Treatment Plant," IOA Pan-American Conference, 1988.

"*Cryptosporidium:* A New Water Supply Threat?" *Journal of the New England Water Works Association*, September 1988.

"SDWA Amendments: Small Community Compliance," JAWWA, August 1988.

"SDWA Compliance - Your Distribution System Can Hold the Key," AWWA Distribution System Management Symposium, September 1988.

"The 'How' and 'What' of SDWA Impact Studies," *Water Engineering and Management*, March 1989.

"Ozones' Role in Water Treatment," Nebraska AWWA Annual Conference, November 1988.

"Ozone for Water Treatment," North Carolina AWWA/WPCA Joint Conference, November 1988.

"Disinfection Practices and Consequences," KSAWWA Annual Conference, March 1989.

"Application of an Integrated Oxygen-Ozone System to an Advanced Wastewater Treatment Facility," Ninth Ozone World Congress, New York City, June 1989.

"Disinfection Alternatives for Public Water Supplies: Effectiveness and Byproducts," University of Kansas Sanitary Engineering Conference, 1990.

"An Investigation of Oxidation By-Products from Ozone Treatment of Abrazine," IOA Pan-American Conference, 1990.

"Overview of Disinfection Practices," and "The Use of Ozone and Halogens for Potable Water Disinfection," MOAWWA Annual Conference, April 1990.

"Implementing the New Coliform Rule," NCAWWA/WPCA and NCRWA Seminars, May 1990.

"Ozonation," Joint IOA/Nebraska Water/Wastewater Conference, November 1990.

"Advanced Water Treatment Technologies," North Carolina AWWA/WPCA 70th Annual Convention, November 1990.

"Oxidation of Color and Organics in Pulp and Paper Mill Wastewater by Ozone and Advanced Oxidation Processes," Presented at International Ozone Association, Pan American Conference, Toronto, September 1991.

## EDWIN E. ANDREWS, III
## GROUNDWATER HYDROLOGY

Mr. Andrews is president of Russnow, Kane & Andrews, Inc., a specialty consulting firm providing soils, geology, and groundwater services since 1982.

As President of Russnow, Kane & Andrews, Ed Andrews has provided hydrogeologic services working primarily throughout the coastal area of North Carolina and Virginia. He has extensive project experience with all facets of hydrogeology including water supply, environmental audits, environmental assessments, underground site assessments, wastewater disposals, landfill site assessments, predictive computer modeling, expert testimony, lagoon site analysis, and land application of sludge.

Prior to his association with Russnow, Kane, & Andrews, he was manager and owner of a groundwater development firm which constructed, developed and rehabilitated municipal and industrial wells in North Carolina and Virginia. Hydrogeologic services were provided for several sanitary landfill projects and water supply projects in Virginia, North Carolina, and Maryland.

Mr. Andrews served as a geologist for the Layne Atlantic Company, Norfolk, Virginia on projects involving water supply development in North Carolina, Virginia, and Maryland coastal areas. Duties included well efficiency analysis, regional aquifer analysis, well field planning, and overall water resource planning.

He has also served as the Chief Regional Geologist with the Virginia State Water Control Board, Tidewater Regional Office in Virginia Beach, Virginia.

**PERSONAL DATA**

B.A., History, Virginia Military Institute
M.S., Geology, University of South Carolina

**Member:** American Institute of Professional Geologists

**Professional Registration:** North Carolina, Virginia, South Carolina, Florida, Indiana

# JOHN R. HENDRICK
# ELECTRICAL PROJECT ENGINEER

John Hendrick is responsible for electrical and instrumentation planning and design, including specification writing, estimating, and equipment submittal review. He also oversees all personnel assignments, provides quality control review, and assists project managers in meeting project schedules and budgets.

## RELATED EXPERIENCE

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| SCADA Design<br>County-wide Water System<br>Dare County, North Carolina | Design Manager | Directed planning and design of county-wide SCADA system to include all water supply wells on the system, three elevated water storage tanks, and six ground-level storage tanks. |
| Water Treatment Plant Expansion,<br>Danville, Virginia | Electrical Design Manager | Managed design of electrical system and controls rehabilitation during plant expansion/upgrade; design also included laboratory upgrade and architectural improvements. |
| Water Treatment Plant Expansion,<br>Asheboro, North Carolina | Electrical Design Manager | Managed design of electrical system and controls rehabilitation during plant expansion/upgrade; design also included laboratory upgrade and architectural improvements. |
| Water Treatment Plant/ Rehabilitation,<br>Mount Airy, North Carolina | Electrical Design Manager | Managed design of electrical system and controls rehabilitation during plant expansion/upgrade; design also included laboratory upgrade and architectural improvements. |
| North Texas Municipal Water District,<br>Wylie, Texas | Electrical Design Manager | Managed electrical and instrumentation design during expansion of Plant No. 2 by 70 mgd and the filter rehabilitation project to the existing 75 mgd Water Treatment Plant No. 1. Design included architectural improvements. |
| Public Works Commission,<br>P.O. Hoffer Water Treatment Plant Electrical System Upgrade,<br>Fayetteville, North Carolina | Electrical Design Manager | Directed evaluation and design of electrical system expansion to improve system reliability for water treatment facility. |
| City of High Point,<br>Oak Hollow Raw Water Pumping Station,<br>High Point, North Carolina | Electrical Design Manager | Directed design of electrical system, controls and instrumentation, and SCADA interface for 12 mgd raw water pumping station. |

## John R. Hendrick

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| City of High Point, Water Treatment Plant Electrical Design, High Point, North Carolina | Electrical Designer | Design of electrical system for 16 mgd water treatment facility, expandable to 32 mgd. |
| Public Works Commission, Glenville Lake Water Treatment Plant Upgrade Report, Fayetteville, North Carolina | Electrical Design Manager | Managed evaluation of plant's existing power capacity and reliability to develop recommendations for electrical system expansion to accommodate planned expansion and increase in flow. |
| Water Treatment Plant Expansion, Greenwood, South Carolina | Electrical Design Manager | Managed design of electrical system and controls in support of 15 mgd upgrade of water treatment facility. |

**PERSONAL DATA**

B.S., Southern Illinois University, Electrical Engineering Technology

**Member:** IEEE, NSPE, AWWA

**Professional Registration:** North Carolina, Texas, Louisiana, Arkansas, Oklahoma, Mississippi

**Joined Black & Veatch:** 1974

# RANDALL W. STURGILL
# ELECTRICAL ENGINEER

Randall Sturgill is an electrical engineer responsible for providing electrical engineering support for civil-environmental projects. His design experience includes power systems, lighting systems, fire alarm systems, SCADA systems, instrumentation and control systems, installation details, and field inspections.

## RELATED PROJECT EXPERIENCE

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| Water System Improvements, Onslow County, North Carolina | Project Electrical Engineer | Designed power and control systems for two water supply wells and three booster pumping stations. |
| Water Treatment Plant Expansion Danville, Virginia | Project Electrical Engineer | Designed power and instrumentation systems for plant expansion, including power and instrumentation, standby generator, analytical instrumentation (pH meters, conductivity meters, turbidimeters, and chlorine residual meters). |
| Raw Water Pumping Station High Point, North Carolina | Project Electrical Engineer | Designed power and instrumentation for the 12 mgd Oak Hollow raw water pump station. Design included multi-speed 4,160 volt motors, 4,160 volt distribution, and SCADA control. |
| High Service Water Pumping Station Greenville, North Carolina | Project Electrical Engineer | Upgraded existing power and control of high service pumping station to incorporate new 4,160 volt high service motors. Designed power and telemetry systems for two new elevated tanks. |
| Wastewater Pumping Station Durham, North Carolina | Project Electrical Engineer | Designed a 20 mgd wastewater pumping station. Ultimate design included six 700 hp motors driven by adjustable frequency drives, a programmable logic controller system for wetwell level control, a bubbler system for level measurement, and a lighting and gas detection system. |
| Water Desalination Plant Dare County, North Carolina | Project Electrical Engineer | Electrical and control system design of an 8 mgd desalination water treatment plant, including adjustable frequency drives, HID lighting, architectural lighting and a total connected load of 3,500 amps at 480 volts. |
| Electrical System Design, Water Treatment Plant, Washington, North Carolina | Electrical Engineer | Design of electrical and control systems for a 4.2 mgd pressure filter water treatment plant. Included 30 remote site SCADA system connecting wells, storage, and distribution system to a central location. |

## Randall W. Sturgill

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| Electrical System<br>Farmer Elementary School,<br>Randolph County,<br>North Carolina | Project Electrical Engineer | Design of electrical systems for 62,200 square-foot elementary school. Design included security, fire alarm, lighting, and intercom systems. |
| Electrical System<br>Seagrove Elementary School,<br>Randolph County,<br>North Carolina | Project Electrical Engineer | Design of electrical systems for 62,200 square-foot elementary school. Design included security, fire alarm, lighting, and intercom systems. |
| Fire Alarm System Study,<br>North Carolina<br>Zoological Park,<br>Asheboro, North Carolina | Project Engineer | Conducted comprehensive fire alarm system study and prepared documents for system improvements to comply with state fire alarm requirements. Evaluation included study of several connected systems of various types, equipment, and installation gages. |
| Pumping Station<br>Electrical Systems,<br>Greenville Water System<br>Greenville, South Carolina | Project Electrical Engineer | Designed electrical design and controls for 1.0 mgd finished water booster pumping station. |
| Construction Inspection,<br>Rockfish Creek WWTP,<br>Fayetteville (NC) Public Works Commission | Electrical Engineer | Provided construction Phase services for installation of electrical system, lighting, and controls for WWTP expansion. |
| Electrical System Design,<br>Pressurized Sewer and Lagoon System,<br>Bay River Metropolitan Sewerage District<br>Pamlico County,<br>North Carolina | Project Electrical Engineer | Designed electrical and control systems for 1,200-connection pressurized sewer and lagoon wastewater treatment system. |
| Electrical System Design,<br>Wastewater Lift Stations,<br>Elkin, North Carolina | Project Electrical Engineer | Electrical and control system design for four wastewater lift stations as part of WWTP plant expansion project. |

**PERSONAL DATA**

B.S., Virginia Polytechnic Institute and State University, Electrical Engineering

**Member:** IEEE

**Professional Registration:** North Carolina

**Joined Black & Veatch:** 1987

# D. RANDALL PAULSON
# ELECTRICAL ENGINEER

Randy Paulson is an electrical engineer based in the Raleigh, North Carolina office of Black & Veatch. He has provided preliminary study and design of electrical systems for a wide range of industrial and private clients including several North Carolina municipalities, pulp and paper companies throughout the Southeast, and other industrial entities.

## RELATED EXPERIENCE

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| City of Raleigh<br>Raleigh, North Carolina | Project Engineer | Detailed load study and a brief utility rate study for the upgrade of the existing raw water pump station for the E.M. Johnson Water Treatment Plant to 100 MGD. |
| City of Wilmington<br>Wilmington, North Carolina | Project Engineer | Electrical design for expansion of the existing Northside Wastewater Treatment Plant. |
| Shepherd Electric/<br>G.E. Company<br>Raleigh, North Carolina | Project Manager/<br>Engineer | Detailed short-circuit calculation and relay coordination for a WWTP upgrade. The system consisted of 5 utility ties, 1 medium voltage bus and 4 low-voltage busses. The largest motor was 800 hp. |
| AES/Stone Container<br>Jacksonville, Florida | Project Engineer | Conceptual study for a 4.1 million pound per day recovery boiler installation and a 43 MW turbine generator. Developed design criteria for boiler, generator, and auxiliaries. |
| Union Camp Corporation<br>Franklin, Virginia | Project Engineer | Modification of the generator tripping schemes to enable sequential generator/breaker trips in addition to simultaneous generator/breaker trips. |

## PERSONAL DATA

B.S., Electrical Engineering, North Carolina State University, 1983

**Member:** IEEE, Past Chairman for the joint Industry Applications Society/Power Engineering Society - Eastern North Carolina Section, and currently serving on the Pulp and Paper Power Distribution Committee of IEEE Industry Applications Society.

**Professional Registration:** North Carolina, Virginia, Georgia

**Joined Black & Veatch:** 1988

## JERRY D. MORGAN
## INSTRUMENTATION & CONTROLS SPECIALIST

Mr. Morgan is responsible for the design of control systems for water treatment plants and expansions and water distribution systems. He coordinates the design of process metering, equipment control, and telemetry and SCADA systems for various municipal water and wastewater treatment systems. He also designs equipment power distribution systems and support facilities design for SCADA systems and provides field inspection services for the installation of electrical, and control and instrumentation systems.

### RELATED PROJECT EXPERIENCE

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| Charlotte-Mecklenburg Utility Department, Mallard Creek Wastewater Treatment Plant Expansion, Charlotte, North Carolina | Instrumentation and Controls Design Technician | Design of a programmable logic control (PLC) system for control of the influent pumping station, based on wetwell level; design allowed for interface with adjustable frequency drive controls for the pumps. |
| SCADA, Instrumentation and Controls, Townsend Water Treatment Plant Expansion, Greensboro, North Carolina | Instrumentation and Controls Design Technician | Preliminary evaluation and design for new plant instrumentation and controls system for plant expansion, which went into design in mid-1991. |
| Instrumentation and Controls, Water Treatment Plant Upgrade, Mount Airy, North Carolina | Instrumentation and Controls Design Technician | Rehabilitation of instrumentation and controls related to water treatment plant upgrade. |
| Instrumentation and Controls Water Treatment Plant Upgrade/Expansion Danville, Virginia | Instrumentation and Controls Design Technician | Rehabilitation of instrumentation and controls related to water treatment plant upgrade. |
| Instrumentation and Controls, Water Treatment Plant Expansion Asheboro, North Carolina | Instrumentation and Controls Design Technician | Designed new instrumentation and controls system during major plant expansion. |
| Regional Reverse Osmosis Water Treatment Plant, Dare County, North Carolina | Instrumentation and Controls Design Technician | Design of a programmable logic control (PLC) system using a host computer for the reverse osmosis process. Extensive construction observation and on-site inspection of the facilities and installation of equipment. |
| Water System Improvements, Dare County, North Carolina | Instrumentation and Controls Design Technician | Design of county-wide Supervisory Control and Data Acquisition (SCADA) system to monitor and control all water supply wells on the system, three elevated water storage tanks, and six ground-level storage tanks. |

## Jerry D. Morgan

| Client, Project, and Location | Position | Responsibilities |
|---|---|---|
| City of Wilmington, Northside Wastewater Treatment Plant Upgrade/Expansion, Wilmington, North Carolina | Instrumentation and Controls Design Technician | Design of electrical and instrumentation and control systems improvements for the Northside plant upgrade/expansion. Design, construction administration, and onsite inspection of the new systems. |
| Water System Improvements, Onslow County, North Carolina | Instrumentation and Controls Design Technician | Design of instrumentation and controls for the addition of two new water supply wells and the upgrade of three booster pumping stations. |
| SCADA System Design, Water System Improvements Onslow County, North Carolina | Instrumentation and Controls Design Technician | Design of a county-wide SCADA system. Construction administration. |
| SCADA System Design, County Water System, Currituck County, North Carolina | Instrumentation and Controls Design Technician | Design of SCADA system for water supply and distribution systems monitoring and control. New county wide water supply, treatment, storage, and distribution system. |
| Instrumentation and Controls, Water Treatment Plant, Havelock, North Carolina | Instrumentation and Controls Design Technician | Design of instrumentation and control systems for a pressure filter and softening water treatment plant. Extensive construction administration and follow up. |
| Water Pumping Station Instrumentation and Controls, Greensboro, North Carolina | Instrumentation and Controls Design Technician | Designed instrumentation and controls system for new 24 mgd high service finished water pumping station. |

**PERSONAL DATA**

DuPont Control Technology
DeVry Institute of Technology

**Certification:** NICET Certification Senior Engineering Technician

**Joined Black & Veatch:** 1974

# RELATED EXPERIENCE

This section includes an overview of Black & Veatch's regional experience in the planning and design of water supply systems, treatment facilities, and distribution systems.

One of the largest and oldest civil engineering firms in the state of North Carolina, Black & Veatch has provided design and construction administration services for water treatment facilities for North Carolina municipalities since 1939. Many of these facilities are located in Eastern North Carolina including Havelock, Washington, Dare County, Currituck County, and Pasquotank County.

Working closely with municipalities and county governments of all sizes to plan, finance, design, and construct water facilities, Black & Veatch has spearheaded environmental responsibility through sound engineering principals and participation in professional organizations that establish goals and back legislation to ensure clean water for North Carolina's citizens.

Such activity has resulted in Black & Veatch's unparalleled involvement throughout the years in major regional water treatment projects, numerous repeat engagement to expand on previous work, and a total familiarity with design procedures most suited to the region's water treatment needs.

In addition, Black & Veatch's familiarity with the requirements of State and Federal regulatory agencies has been gained through hundreds of projects involving agency approval. We are highly familiar with the procedures and requirements of the North Carolina Department of Environmental Health and Natural Resources who will review all phases of the design.

Black & Veatch has been very successful in obtaining approval from EH&NR for recent projects. Furthermore, our full-service North Carolina offices enable us to quickly resolve (in person, if necessary) questions regarding project design, applications, testing, or other aspects of State or Federal regulatory compliance.

Black & Veatch regularly prepares cost opinions for all recommended improvements and activities. We maintain historical cost information on a nationwide basis, and in preparing cost opinions, we use this data, factoring into

the cost such items as local labor markets, availability of materials and equipment, and other factors that influence costs. We also develop detailed schedules for implementation of recommended improvements. Timetables are prepared in consultation with client staff to ensure workable and realistic schedules and to prioritize the tasks in light of factors such as cost and importance. For example, if the cost of a certain recommendation exceeds scheduled funding allocations, implementation may need to be either accelerated or delayed to coincide with available funding. Other factors that determine recommended scheduling are included and, with the client's input, are incorporated into a workable and effective plan.

Because of the crucial role of budgeting, the success of any system project depends greatly on the ability of the engineer to accurately ***estimate the costs*** of the recommended improvements. Black & Veatch maintains several cost estimating specialists who track current construction costs in *all areas* of the country, enabling us to accurately estimate project costs, as shown by the regional project table below.

| Project | Preliminary Study Estimate | Final Cost Opinion | Bid |
|---|---|---|---|
| Asheboro WTP Expansion | $ 3,700,200 | $ 3,950,000 | $ 3,699,221 |
| Mesquite Regional WWTP Expansion | $15,452,000 | $ 14,343,227 | $ 14,509,974 |
| Greensboro Mitchell Pumping Station | $ 4,038,000 | $ 4,421,000 | $ 4,094,215 |
| Fayetteville PWC Cape Fear Raw Water Pumping Station | $ 4,950,000 | $ 4,740,000 | $ 4,259,000 |
| Fayetteville PWC Rockfish Creek WWTP Expansion | $ 13,960,000 | $ 15,740,000 | $ 12,443,000 |
| Greenwood, SC WTP Expansion | $ 16,000,000 | $ 15,500,000 | $ 15,727,000 |
| Danville, VA WTP Expansion | $ 4,750,000 | $ 4,593,120 | $ 3,795,979 |
| Washington, NC WTP & Supply | $ 10,600,000 | $ 11,000,000 | $ 9,487,620 |

In summary, because of our extensive, long-term participation in similar system analyses, we thoroughly understand the processes involved, including the timing of all phases from planning to construction finalization, legal deadlines, agency approval, and public notification. Backing up this experience are:

- Repeat engagements with other clients for master planning projects; for example, multiple system projects for Dare County, the Town of Cary, Harnett County, the City of Havelock, and Onslow County, North Carolina.
- Experience in assisting local governments in planning for and obtaining project financing.
- Comprehensive computer modeling, design, and drafting capabilities for both water and wastewater systems.

**Water System Supply and Treatment**
**Dare County, North Carolina**

Black & Veatch was retained by Dare County to design a 3 mgd reverse osmosis water treatment plant, expandable to 12 mgd in the future. Feedwater to the desalination process is brackish groundwater from a well field also designed by Black & Veatch. Pretreatment consists of acidification, injection of scale inhibitor, and cartridge filtration. The main treatment units are 1 mgd RO trains utilizing thin film composite spiral wound membranes. Design recovery is 75 percent, and blending of a maximum of 10 percent raw water with RO permeate is included. Feedwater TDS is approximately 3,500 mg/L. Brine disposal is by ocean outfall.

Part of the design included conducting a pilot plant study to determine if iron in the feedwater would cause problems for the RO process. Well field design included the early construction of one well to provide additional information for process design. The project also includes a 5,000,000 gallon ground storage reservoir, transmission pumps, transmission mains, and administrative facilities.

The project followed a feasibility study for additional water supplies for the main water system in Dare County, North Carolina. The project involved evaluating three fresh groundwater supplies, a fresh surface water supply, two brackish surface water supplies, two saline (brackish and salt) groundwater aquifers, and

pipelines to two other utilities. The requirements were an increase in water supply of 5 mgd by 1995 and 12 mgd by 2005. The study indicated desalination of brackish groundwater located in the heart of the water use area to be the most feasible alternative. As part of the study, two test wells were constructed, and aquifer testing was conducted for over 40 days. The selected desalination process was reverse osmosis utilizing spiral wound membranes.

***REFERENCE:***

*Mr. Terry Wheeler, Manager*
*Dare County*
*(919) 473-1101*

**Cape Hatteras Water System**

Water system study, development of financing, and implementation of a new water supply and distribution system to serve the villages of Buxton, Frisco and Hatteras. Water supply consisted of 35 shallow wells drawing water from the fresh water lenses in Buxton woods. The initial system consisted of a 1.0 mgd treatment plant, a 200,000 gallon finished water ground storage tank, and two 100,000 gallon elevated water tanks, and served 582 households and businesses.

***REFERENCE:***

*Mr. Raney Jennette, Retired Manager*
*Cape Hatteras Water System*
*(919) 995-5689*

**Currituck County, North Carolina**

Following completion of a county-wide water study that included recommendations for supply and distribution, Black & Veatch was retained to design the recommended improvements and assist in arranging financing of the 1.0 mgd system using groundwater supply. The project was completed in April 1990.

Following the design portion of the Phase I improvements, Black & Veatch conducted a comprehensive study of the water source alternatives and improvements required for Phase II/III developments. The report titled *Mainland Water Facilities, Phase II/III Study,* was finalized in December 1989.

Black & Veatch conducted a feasibility study for desalting both groundwater and brackish surface water for the Outer Banks region of the county. The study included sampling of surface water in Currituck Sound, evaluation and analysis of geophysical logs and other information from exploratory wells in the area, preliminary reverse osmosis evaluation, and preparation of cost opinions.

In conjunction with Ed Andrews, Black & Veatch investigated deep aquifer water resources on the Outer Banks in 1991. This investigation resulted in a June 1991 report titled *Hydrogeologic Investigation Water Resources of a 1500 Foot Deep Test Well Ocean Sands Subdivision.*

***REFERENCE:***

*Mr. Bill Richardson, Manager*
*Currituck County, North Carolina*
*(919) 232-2075*

**Havelock, North Carolina**

Over the past 20 years, Black & Veatch has provided both water and wastewater system design services to the City of Havelock, including a comprehensive water supply, treatment, storage, and distribution study and analysis of financial alternatives; wastewater treatment plant design; and subsequent expansion of the WWTP to include nitrification and expanded clarifier capacity. Black & Veatch recently completed contract administration of a new 1.4 mgd filter softening plant at the City's water treatment facilities.

***REFERENCE:***

*Mr. Ralph Kennedy, Manager*
*Havelock, North Carolina*
*(919) 444-6401*

**City of Wilmington, North Carolina**

The City of Wilmington contracted with Black & Veatch to prepare a comprehensive, long-term master plan for the future development of the City's water system. Services included the following major work items.

- Projection of future water demands.
- Evaluation of the City's existing water system facilities.

- Assessment of current and projected future water treatment alternatives.
- Evaluation of water supply and treatment alternatives.
- Computer modeling and analysis of the City's water distribution system.
- Recommendation of a 15-year master plan for expansion of the City's water system.

This work was conducted for the City's existing water service area as well as for areas designated by the City beyond the present service area. Seven different water supply alternatives and 13 water treatment alternatives were analyzed for the years 1993, 1998, 2003, 2028, and build-out. Thirteen alternatives were analyzed for the 20-year present worth analysis of the feasible combinations of water supply and treatment. Proven project approach and cost estimating approaches were used to result in thorough, objective, and comparable alternative evaluations.

***REFERENCE:***

*Mr. Tom Frederick, Management Analyst*
*City of Wilmington*
*(919) 341-7810*

**Asheville-Buncombe Water Authority**

**Asheville, North Carolina**

Black & Veatch prepared a comprehensive water master plan for the Asheville-Buncombe Water Authority. The plan, which was finalized in 1988, included:

- Future population and wastewater requirement projections.
- Hydraulic analyses to determine the capability of the distribution system to meet existing and future water demands.
- Evaluation of distribution system control and data gathering requirements and development of a control and monitoring program.
- Development of a master plan for recommended water system improvements including a phased capital improvements program and opinions of probable costs for budgeting purposes.

***REFERENCE:***

*Mr. Harold Huff, Director*
*Asheville-Buncombe Water Authority*
*(704) 259-5955*

**Washington, North Carolina**

Project consisted of 3.0 mgd iron removal and softening plant, operations center, groundwater supply from Castle Hayne aquifer, waste disposal into Pamlico River, 1.5 million gallon ground storage tank, SCADA system, and major transmission water main from plant to city.

***REFERENCE:***

*Mr. Ed Burchins, Manager*
*City of Washington*
*(919) 946-1033*

**Harnett County, North Carolina**

Black & Veatch has provided comprehensive water system planning and design to several districts within Harnett County including:

- Northeast Metropolitan Water District - Planning and design of a county-wide system including a 3.3 mgd raw water pump station; raw water mains; 3.3 mgd water treatment plant; 1.5 MG elevated storage; booster pump stations; and 35 miles of distribution system.
- South Central Water & Sewer District - Creation of district, financing assistance for distribution system; and distribution system design to serve 2,500 customers.
- Northwest Water & Sewer District - Creation of district; financing assistance for distribution system; and distribution system designed to serve 1,200 customers.

***REFERENCE:***

*Mr. Rodney Tart, Director of Public Utilities*
*Harnett County, North Carolina*
*(919) 893-7555*

## NATIONAL SYSTEM PLANNING/DESIGN EXPERIENCE

**Metropolitan Water District of Southern California, Assessment of Desalination Technologies**

In planning for its long-term needs, MWD retained Black & Veatch to conduct a comprehensive assessment of desalination technologies for production of drinking water supplies from seawater and brackish water sources. This study included site visits to 22 desalination plants to document actual construction and operating costs as well as operating performance. This report is now considered a reference standard, and presents actual operating and maintenance costs, and capital costs adjusted for ENR indices to 1988 California market dollars.

*REFERENCE:*

*Dr. Wylie Horne*
*Director of Planning*
*Metropolitan Water District*
*Los Angeles, California 90054*
*(213) 250-6217*

**San Diego, California**

Black & Veatch designed, managed construction, and continues to oversee operation of a 50,000 gpd capacity advanced reverse osmosis water treatment facility for the City of San Diego. This demonstration facility is part of a Total Resource Recovery Program to develop technology for purifying wastewater to meet potable water standards and study energy conservation. Effluent from the San Diego Aquatic Wastewater Treatment Plant is pretreated by chemical addition, coagulation, sedimentation, filtration, and ultraviolet disinfection. Demineralization consists of spiral wound reverse osmosis units. Post-treatment includes aeration, carbon adsorption, and chemical addition. Black & Veatch continues to assist the City with operation and testing at this unique facility.

*REFERENCE:*

*Mr. Kenneth Thompson*
*City of San Diego*
*San Diego, California 92103*
*(619) 463-0327*

**6.5 MGD Desalting Facility**
**Orange County, California**

Black & Veatch was retained by the Orange County Water District to design a 6.5 mgd desalter to furnish drinking water to the Irvine Ranch Water District, Irvine, California. The project consists of a demineralization water treatment plant for the reduction of minerals contained in the source water supply, to potable water quality. Also, treatment equipment is furnished to remove Volatile Organic Contaminants (VOC) in the supply including Trichloroethylene (TCE). The project consists of:

- Wellfield facilities including telemetry equipment.
- Membrane type treatment equipment to reduce the source water total dissolved solids (TDS) to less than 500 mg/L. The desalination equipment is arranged to maximize plant recovery, thereby minimizing concentrate disposal volume and consequent costs.
- Packed tower strippers to remove the VOCs in the supply.
- Building to house the membrane treatment equipment, control room, offices, chemical treatment equipment, etc.
- Product water storage and pumping facilities.

***REFERENCE:***
*Mr. Nereus L. Richardson*
*Orange County Water District*
*Fountain Valley, California*
*(714) 963-5661*

**San Diego County Water Authority,**
**Combined Power/Seawater**
**Desalination Facility Feasibility Study**

This feasibility study is intended to identify the most appropriate desalting technology to incorporate into either of two coastal power plant locations. These are at Encina, north of the City and at South Bay. Power plant size being considered for each site is on the order of 490 MW. Water production from the desalination facility is set at 50,000 acre feet per year (i.e., water plant capacity of 44.5 mgd).

This work will include a technical and economic review of each of the following desalination processes:

- Multi-stage Flash (MSF).
- Low Temperature Multiple Effect (LTMED).
- High Temperature Multiple Effect (HTMED).
- Reverse Osmosis (RO).

Each of these proven designs will be investigated to determine which process offers the most cost-effective approach to providing the necessary potable water.

***REFERENCE:***

*Mr. Byron Buck*
*San Diego County Water Authority*
*San Diego, California 92103*
*(619)297-3218*