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Section 1
Introduction

As the primary water purveyor for the Outer Banks of North Carolina, the Dare County Water Department (the County) operates two water treatment plants (WTPs) to provide public water supply. One of these, the Skyco WTP, is located in central Roanoke Island and has been providing potable water to the Town of Manteo and some unincorporated areas in the central portion of Roanoke Island since 1980. The remaining unincorporated areas of Roanoke Island and the Wanchese area rely on private wells for potable water. The extent of the existing Skyco WTP service area on Roanoke Island is shown on **Figure 1-1**.

Due to poor water quality and insufficient water supply for fire protection from the private wells, the County has undertaken a project to expand their water distribution system from the Skyco WTP to provide high quality water and fire protection for the developed and improved areas on Roanoke Island that are currently not served. An improved area is one that is currently under development or has an approved permit to develop. Water infrastructure will not be extended to undeveloped or unimproved areas in anticipation of growth. However, the recommended tank, pipe, and appurtenance improvements will be sized on projected 2025 demands. Pump improvements will be sized for near-term demands with the ability to be upgraded to meet projected 2025 demands.

In May of 2009 the County retained Camp Dresser & McKee (CDM) to conduct preliminary engineering, design, and permitting services for the expansion of the Skyco WTP distribution system on Roanoke Island, referred to as the Dare County – Roanoke Island Water System Expansion Project (the project). This preliminary engineering report (PER) has been developed to present the preliminary design and summarize the general scope, extent, and character of the project.

This PER includes the following Sections:

Section 1 – Introduction

Section 2 – Description of Project Area

Section 3 – Hydraulic Model Analysis

Section 4 – High Service Pump Station Improvements

Section 5 – Proposed Ground and Elevated Storage Tank

Section 6 – Proposed Transmission/Distribution Pipelines

Section 7 – Permitting Requirements

Section 8 – Preliminary Construction Cost Estimate

Section 9 – Implementation Schedule

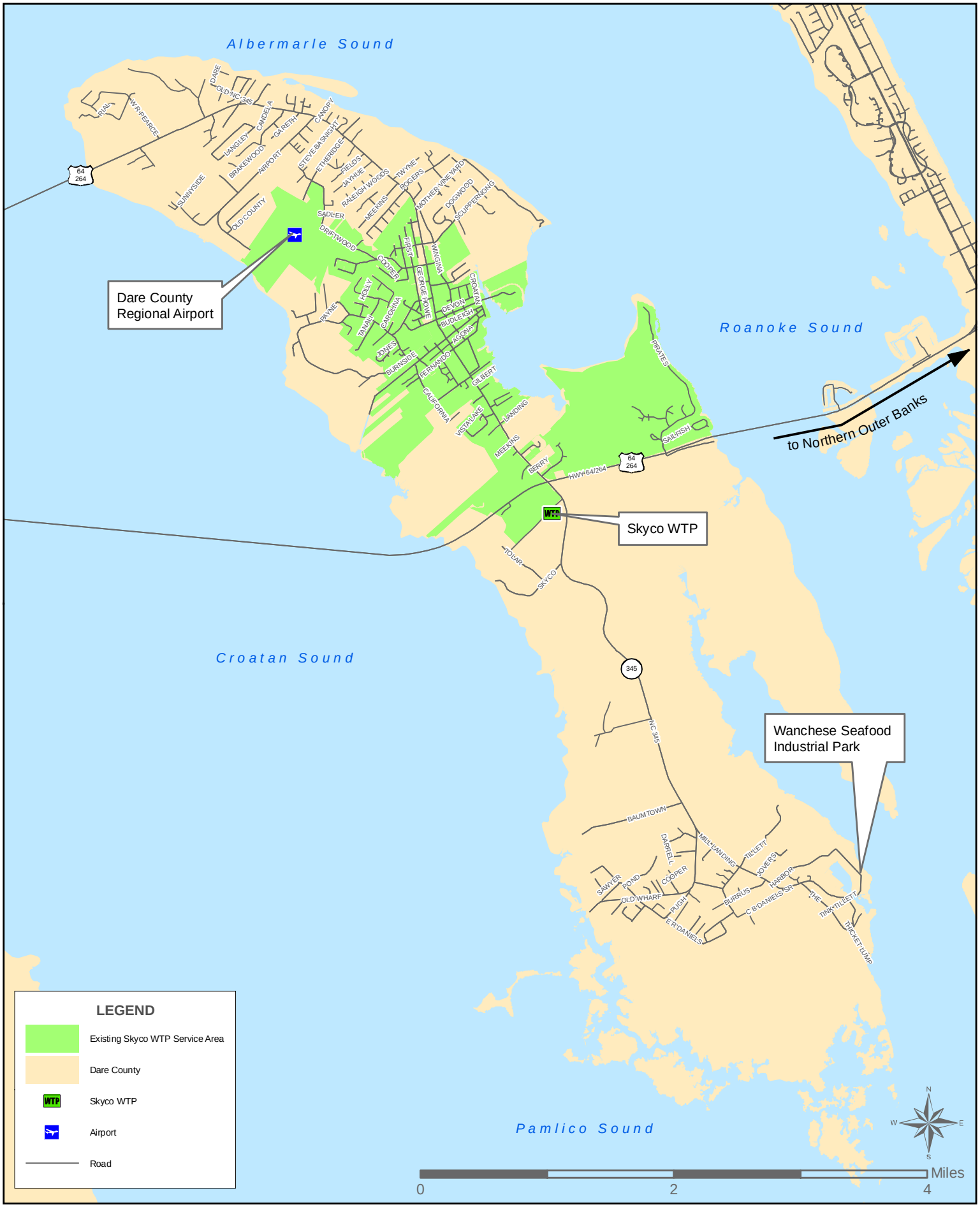

Figure 1-1
Existing Skyco WTP Service Area
On Roanoke Island

CDM

1.1 Project Background

In 2005 the County retained CDM to conduct a water system study to determine the improvements necessary to extend water service on Roanoke Island. As part of the April 2006 *Roanoke Island/Manteo/Wanchese Water System Study* the following tasks were performed:

- Development of 2025 water demand projections
- Development of a computer model of the existing and proposed water distribution system using WaterGemsTM
- Model validation based on available data
- Hydraulic evaluation
- Planning-level cost estimates for recommended system improvements

The results of the study were used as the basis for the preliminary engineering and design analyses presented in this PER.

1.2 Project Description

The April 2006 water system study identified the improvements recommended to provide high-quality water and fire protection from the Skyco WTP to Roanoke Island. This project builds upon those recommended improvements by conducting additional analyses, completing a design, and constructing the improvements necessary to extend water service to existing developed and improved areas within Roanoke Island. **Figure 1-2** details the recommended improvements and is briefly summarized below:

- installation of approximately 56 miles of 6- to 16-inch diameter water transmission/distribution pipe;
- construction of a new 300,000 gallon elevated storage tank within the distribution system;
- construction of a new 2.0 million gallon (MG) ground storage tank at the Skyco WTP; and
- improvements to the finished water pumps and associated equipment at the Skyco WTP.

1.3 Project Schedule

The project will be designed and constructed in phases, with the final design phase estimated for completion by the end of 2010. It is anticipated that construction will begin in early 2010 and last approximately 24 months. A detailed project design schedule is presented in Section 9.

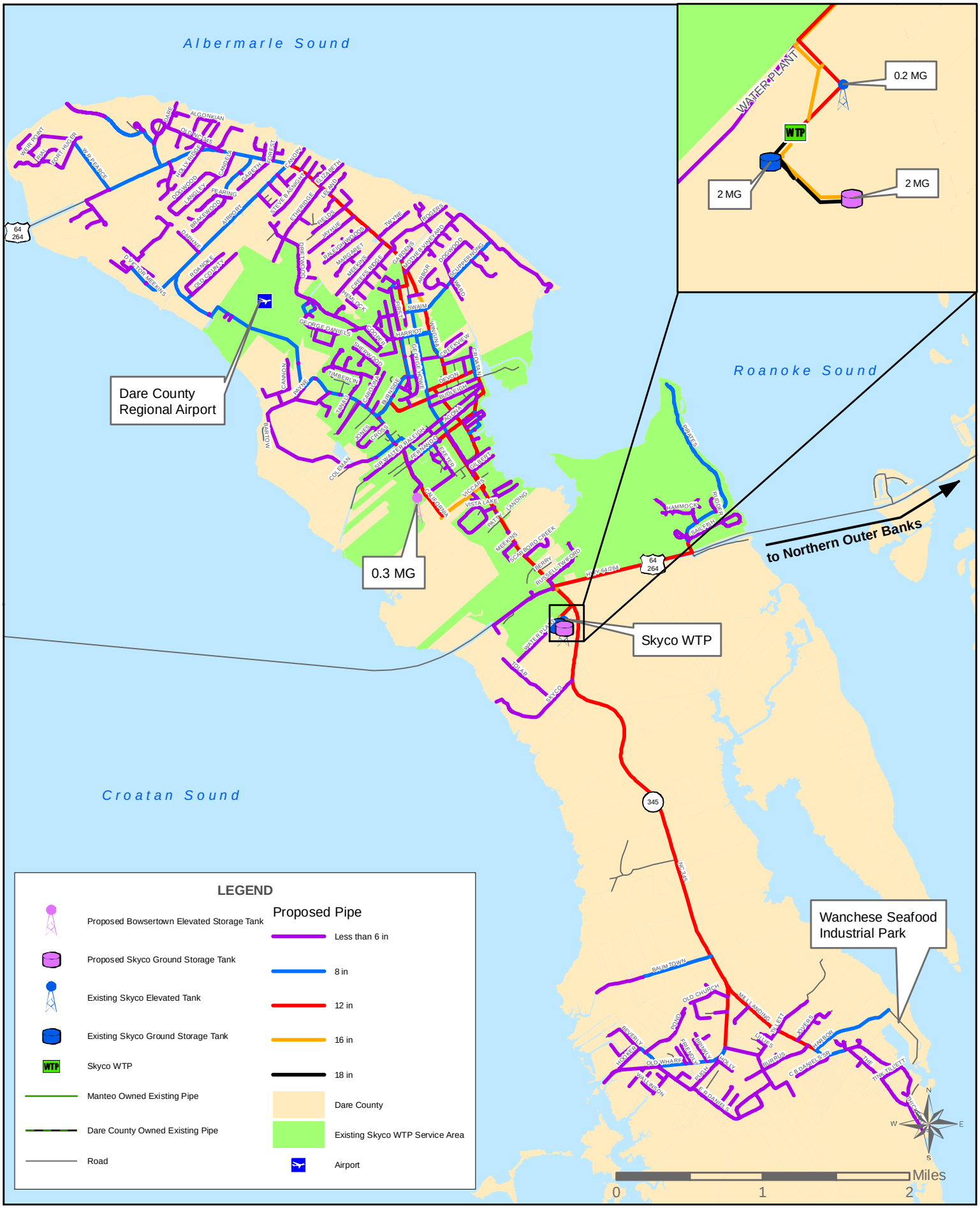

Figure 1-2
Recommended Water System
Infrastructure Improvements

Section 2
Description of Project Area

2.1 Introduction

This section provides a description of the project area, the existing water distribution service areas and facilities, and additional survey and geotechnical investigations to be performed as part of final design.

2.2 Project Area Description

Roanoke Island is approximately 11 miles long and 2 miles wide and is located between the mainland and the northern beaches in Dare County, North Carolina, as shown on **Figure 2-1**. The island is surrounded by the Albemarle Sound to the north, the Croatan Sound to the west, the Roanoke Sound to the east, and the Pamlico Sound to the south. The island can be accessed from the mainland by the US-64/264 William B. Umstead Memorial Bridge at the north end of the island or the US-64/264 Virginia Dare Memorial Bridge at the central portion of the island.

Roanoke Island is made up of the Town of Manteo and the remaining unincorporated areas of Dare County, which includes the community of Wanchese. The Town of Manteo is located near central Roanoke Island, immediately north of where US-64/264 crosses the island. Wanchese is located in the southern portion of Roanoke Island and is considered a census-designated place, which means it resembles a City, Town, or Village with its centralized community, but does not have a municipal government. This area will be referred to as "Wanchese" throughout this report.

2.3 Existing Service Areas and Facilities

The Skyco WTP is located on central Roanoke Island, immediately south of the US-64/264 and NC-345 intersection. Two transmission mains exit the Skyco WTP, one to serve the Town of Manteo and a limited area of unincorporated Dare County and the second supplies water to Dare County's northern beaches. The following is a summary of the existing facilities and infrastructure at the Skyco WTP, within the Town of Manteo and some unincorporated portions of Roanoke Island, and a state-owned water supply and distribution system in Wanchese.

2.3.1 Skyco WTP

The Skyco WTP was constructed in 1979 and is owned and operated by Dare County. The WTP is located in central Roanoke Island, near the intersection of US-64/264 and NC-345, as shown on Figure 1-1. The WTP is supplied by 10 production wells tapping the Upper Yorktown Aquifer and utilizes a combination anion/ion exchange for treatment, with a capacity of 6.0 million gallons per day (MGD).

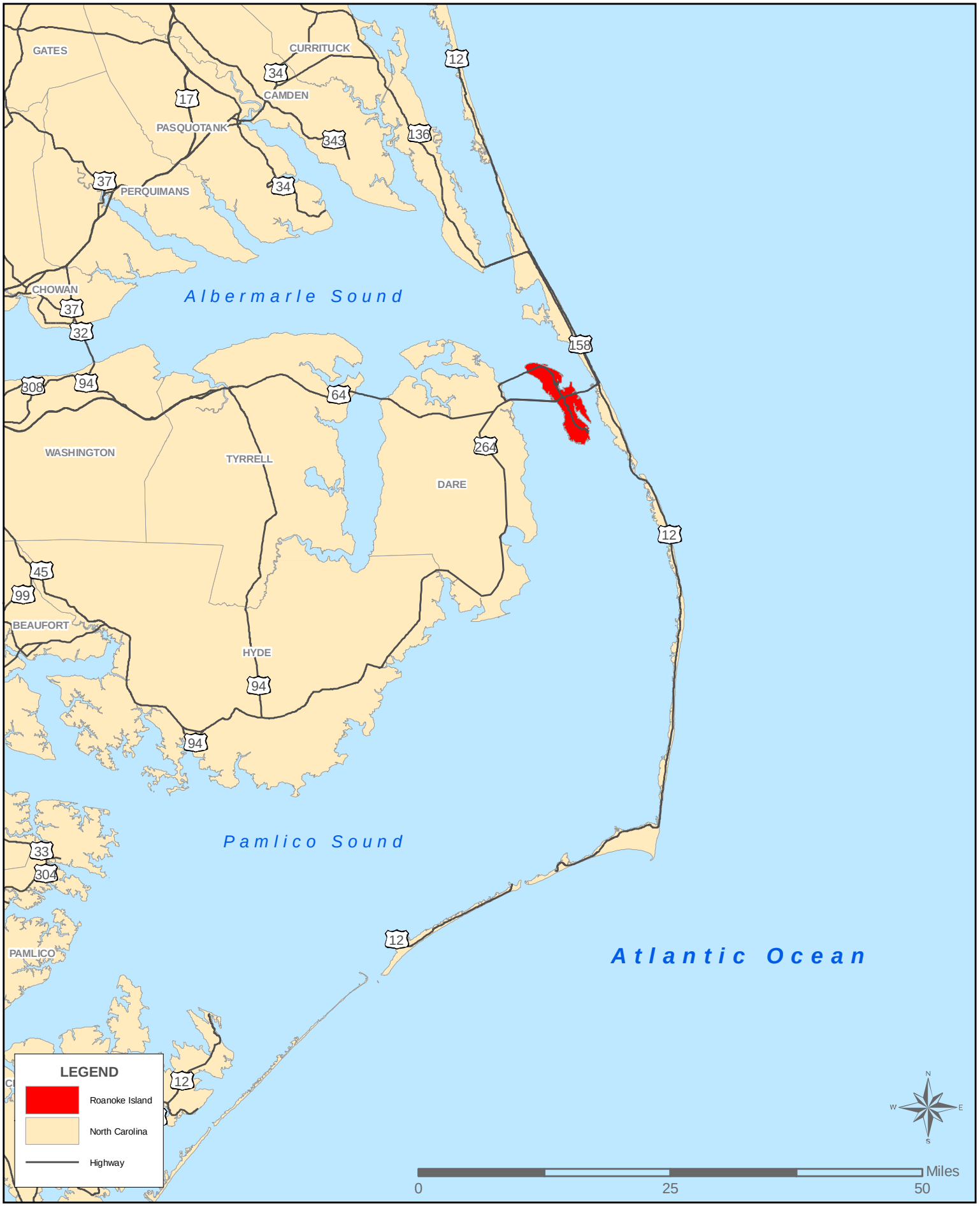

Figure 2-1
Roanoke Island Site Map

Finished water from the WTP is stored in a 2.0 MG concrete ground storage tank, with a typical operating range of elevation 12 feet to elevation 24 feet and a high water elevation of 25.8 feet.

A high service pump station (HSPS) at the WTP pulls water from the ground storage tank and delivers it to customers on Roanoke Island and the northern beaches. The HSPS is equipped with three sets of duplex pump systems, summarized below.

Pumps No. 1 and No. 2
Pumps No. 1 and No 2 serve as the primary transmission pumps from the Skyco WTP to the northern beaches. Each pump is rated 125 horsepower, with a two-speed 480-volt motor.

Pumps No. 3 and No. 4
Pumps No. 3 and No. 4 were originally installed to serve as low-flow backup pumps to the northern beaches. Each pump is rated 5 horsepower, with a 480-volt motor.

Pumps No. 5 and No. 6
Pumps No. 5 and No. 6 serve as the primary transmission pumps from the Skyco WTP to customers located on Roanoke Island. Each pump is rated 30 horsepower, with a 480-volt motor.

High service pumps no. 5 and 6 pump to a tee just outside the Skyco WTP, where water can either fill the existing 200,000 gallon elevated storage tank or pump directly to the distribution system. When the pumps are not running, finished water is supplied by gravity from the 200,000 gallon elevated storage tank to the Roanoke Island/Manteo service area. The tank has a low water elevation of 132.7 feet, high water elevation of 154 feet, and an overflow elevation of 158.7 feet. Operation of Skyco finished water pumps no. 5 and 6 are controlled by the water level in the elevated storage tank. A schematic of the pump and tank configuration at the Skyco WTP site is shown on **Figure 2-2**.

2.3.2 Roanoke Island Service Area

The Skyco WTP has been providing potable water to the Town of Manteo and some unincorporated areas in the central portion of Roanoke Island since 1980. The Dare County and Town of Manteo distribution systems are shown on **Figure 2-3**.

The existing Dare County water distribution system on Roanoke Island consists of approximately 13.7 miles of 2- to 12-inch diameter pipe. The pipe material is predominately polyvinyl chloride (PVC), though asbestos cement and ductile iron materials are also used in some areas. In 2005 there were approximately 2,100 individual water accounts in the unincorporated areas of Roanoke Island that were served by the Skyco WTP (Water System Study, 2006).

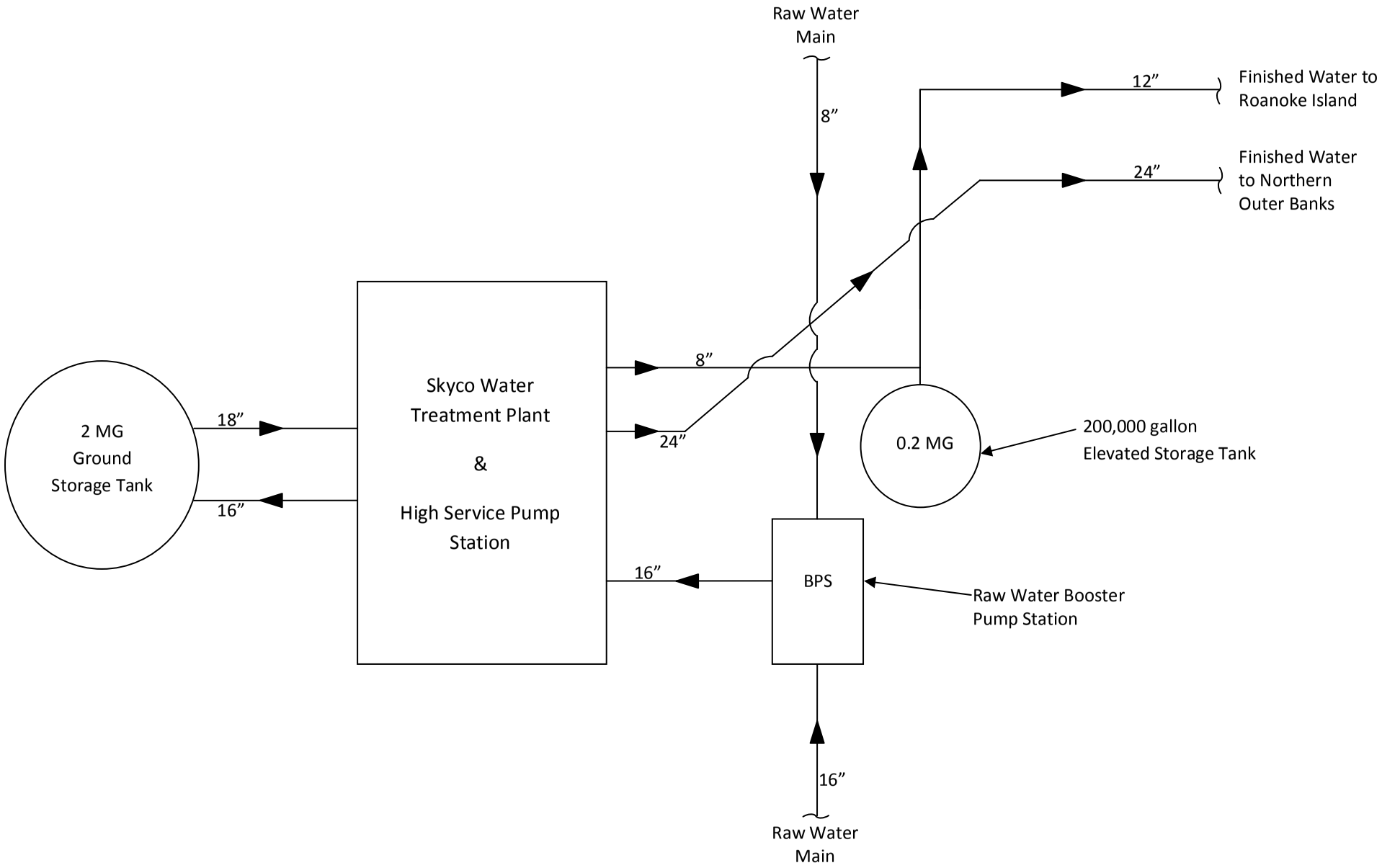

Figure 2-2
Schematic of the Pump and Tank Configuration at the Skyco WTP

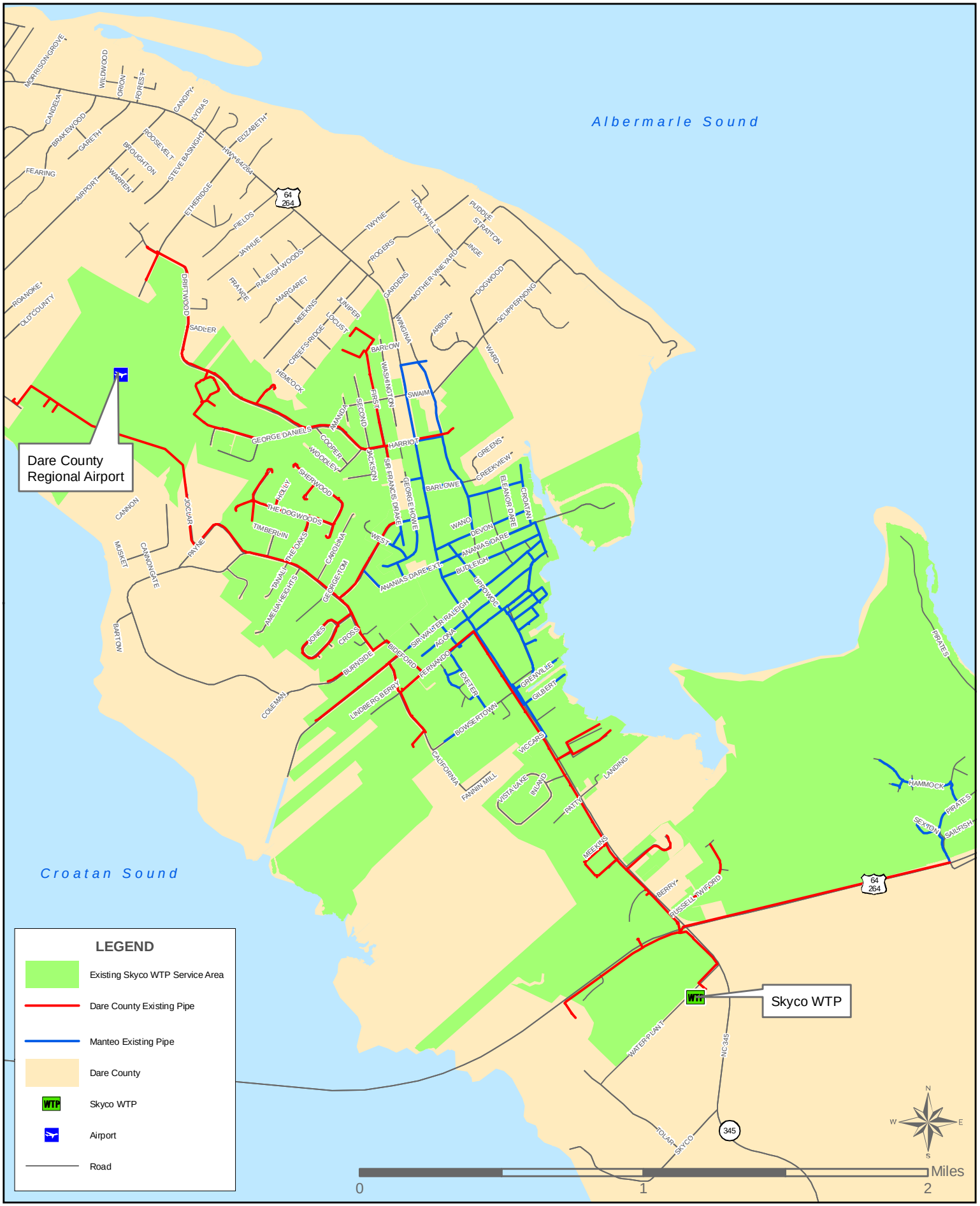

Figure 2-3
Dare County and Town of Manteo
Existing Transmission and Distribution System

CDM

The Town of Manteo water system utilizes Dare County's existing 12 inch water main to provide service to over 100 of their customers. The current meter reading scenario involves reading the Roanoke Island master meter (at the Skyco WTP), and subtracting Dare County customer's use along the 12 inch water main up to the Fernando Street meter, which supplies water to unincorporated Dare County.

A description of the hydraulically-modeled existing system pressures, velocities, and headlosses can be found in the April 2006 *Roanoke Island/Manteo/Wanchese Water System Study*.

2.3.3 Wanchese Service Area

Wanchese is located at the southern end of Roanoke Island and does not currently receive water from Dare County. A portion of Wanchese has been incorporated into the Wanchese Seafood Industrial Park. The State operates and maintains the water supply and distribution system in the Park. However, all Wanchese residents are located outside the Industrial Park and pull water from private wells, which have been documented to have poor water quality and many have been replaced by Dare County.

Consideration was given to taking over and incorporating the Wanchese Seafood Industrial Parks' water supply and distribution system into the Dare County water system. However, due to reduced operating pressures and increased water age, the Wanchese Seafood Industrial Park water system will not be incorporated into the Dare County water system. A description of that evaluation is presented in Section 3.3.2.2.

2.4 Ground and Aerial Surveys

In order to document additional existing conditions, aerial photogrammetry was completed in mid 2009 for a majority of Roanoke Island. The information will be used to locate visible structures and significant features along the proposed distribution main routes and to provide ground surface contouring. Ground survey is currently being performed to supplement the information provided by the aerial photogrammetry for inclusion on the base aerial survey maps.

The combination of ground and aerial surveys has been used during preliminary design and will continue to be used through final design to determine the pipe routes and alignment and identify potential construction conflicts.

2.5 Geotechnical Investigations

In order to document additional existing conditions, a geotechnical subsurface investigation will be performed to investigate the soil and groundwater conditions for this project.

One geotechnical test boring and three cone penetration test (CPT) soundings were performed for the proposed 2.0 MG ground storage tank at the Skyco WTP. In addition, two geotechnical test borings and two CPT soundings were performed for the proposed elevated storage tank. The explorations extended to depths ranging from 70 to 100 feet. One CPT sounding at each location included seismic shear wave velocity measurements.

In general, hand auger borings will extend to a maximum depth of 10 feet and will be spaced along the proposed pipe route at approximately 1,000 feet for 12-inch diameter and greater pipes, 2,000 feet for 8-inch diameter pipe, and an allowance for 6-inch diameter pipe. A hand auger boring will also be conducted at all roads being crossed by 8-inch diameter or smaller pipes. A single geotechnical test boring will be conducted at all roads being crossed by 12- and 16-inch diameter pipes. A total of two geotechnical test borings will be performed for each stream crossing location with total drilling depths up to 35 feet at each boring location.

Section 3
Hydraulic Model Analysis

As part of the Dare County 2006 water system study, a hydraulic model was developed to provide an initial estimate of the infrastructure improvements required to provide potable water to the developed and improved areas currently not served on Roanoke Island. Demands for these areas, the existing customers in the Town of Manteo, and portions of unincorporated Roanoke Island were developed based on a review of water billing data, available population projections, parcel data, and land use data. The development of the hydraulic model and its use in the conceptual planning of the service area extensions is presented in detail in the April 2006 *Roanoke Island/Manteo/Wanchese Water System Study Final Report*.

This section discusses the refinement of the model since the 2006 study to verify the size and locations of all recommended infrastructure. The water demand scenarios considered in the model included average day and maximum day demands under near-term and build-out land use conditions. A description of how the demands were developed can be found in Section 4.1.3.

3.1 Distribution System Modeling Update and Calibration

The existing water distribution system model for Roanoke Island and the Town of Manteo was originally developed using WaterGEMS™ software. GIS files provided by Dare County were used to develop the existing system distribution network. Model nodes were assigned to pipe endpoints and at intersections. Water demands were allocated by assigning the billing data of each account to the nearest node. The elevated storage tank at the Skyco WTP was modeled using the diameter, capacity, operating range, and high water level elevation. Finished water pumps No. 5 and 6 at the Skyco WTP were modeled using the manufacturers pump curves. See Section 2.1.1 for a description of the high service pump station.

New pipes installed since the 2006 water system study were added to the hydraulic model based on maps provided by Dare County. The water demands were also updated to reflect the summer 2009 demand of 0.5 MGD by applying a global adjustment factor to the demands at all nodes in the model.

The updated hydraulic model was calibrated to hydrant flow tests conducted at 8 locations in June 2009, as shown on **Figure 3-1**. To calibrate the model, the operational conditions (tank level, pump on/off status, demands, hydrant flow, etc.) recorded during the hydrant tests were replicated in the model. The static and residual pressures recorded at the test hydrants were then compared to the model-simulated pressures. Adjustments were made to the modeled junction elevations, pipe network configuration, or pipe roughness factors (Hazen-Williams C Factors), as necessary to better align the compared pressures. Additional tests were conducted

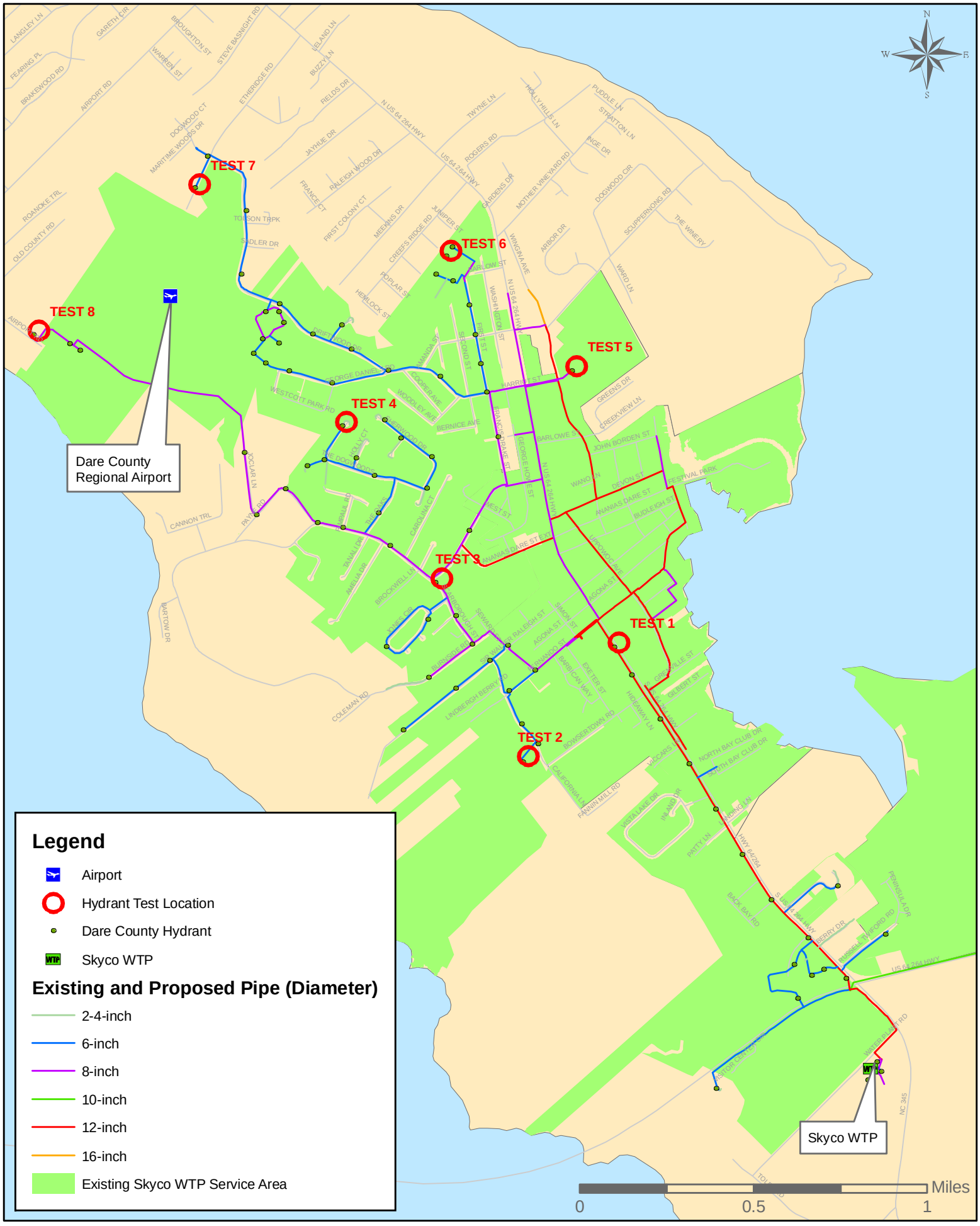

Figure 3-1
Hydrant Test Locations

near locations 6 and 7 in July and August 2009 to confirm the original test results and help further refine the calibration.

Model results were considered within acceptable limits if they were within 5 pounds per square inch (psi) of the static pressures observed in the field and within 10 psi of the residual pressures observed in the field (with an adjustment for the static pressure difference). The model simulations generally meet these criteria for the majority of the hydrant tests, with the exception of tests 4 and 6. However, since these two tests were located on 6-inch diameter, dead-end mains that are not expected to serve additional customers, the hydraulic model was considered sufficiently calibrated to support evaluation of system improvements.

3.2 Evaluation Approach and Criteria

To evaluate the ability of the water system to serve existing developed areas in Roanoke Island, proposed infrastructure was input into the hydraulic model. It was assumed that the water main extensions required would be located within existing road rights-of-way. Demands were distributed in the model based on the developable acreage of each parcel and assigned to the closest model node. Ground elevations were based on topographical information obtained from the North Carolina Department of Transportation (NCDOT).

The proposed infrastructure, which includes new pipes, new and existing elevated tanks, and new high service pumps at the Skyco WTP, were evaluated in the hydraulic model under average day, maximum day, maximum day plus fire flow, and peak hour demand conditions. Computer simulations were also conducted to determine if the system is capable of filling existing and proposed storage facilities during minimum nighttime demand conditions on the maximum day.

The evaluation was based on the following criteria:

- Maintaining the County's desirable minimum system pressure of 60 psi during average day and maximum day demand conditions with the storage tanks in a full condition. System pressures in the 50 to 60 psi range were considered adequate for peak demand conditions when storage tank water levels fluctuate. A minimum system pressure of 30 psi is required by the North Carolina Department of Environment and Natural Resources (NCDENR) during peak demand conditions (North Carolina Administrative Code Title 15A, Subchapter 18C, Section .0901).
- Limiting velocity to 10 feet per second (fps), with velocities less than 5 fps as the desirable range.
- Limiting headloss to 5 feet/1,000 feet.
- Providing a desired fire flow of at least 750 gallons per minute (gpm) throughout the service area, with a minimum of 500 gpm on cul-de-sacs or dead-end roads, while maintaining a minimum pressure of 20 psi throughout the system. The

Insurance Services Office (ISO) estimates a fire flow requirement of 500 gpm for one- and two-family dwellings not exceeding two stories in height, spaced over 100 feet apart (ISO, Guide for Determination of Needed Fire Flow, Edition 05-2008, p. 24).

- Minimize water age while adhering to hydraulic design criteria.

3.3 Hydraulic Model Evaluation and Results

The hydraulic model developed as part of the 2006 Water System Study and calibrated for this project, identified the infrastructure improvements required to serve the developed and improved areas on Roanoke Island, referred to herein as the Base Model. As part of this preliminary engineering evaluation, additional hydraulic modeling analyses were performed to refine the model in an attempt to optimize operational efficiency, customer service, emergency service, and construction costs while adhering to the minimum pressure, maximum pressure, fire flow, and water age design criteria identified in Section 3.2 above. The hydraulic model was refined by evaluating the high service pumps, elevated system storage, and transmission and distribution pipe diameters.

In addition to the above analyses, the County requested that two alternatives be considered: (1) reduce the number of Town of Manteo service connections on County-owned infrastructure and (2) evaluate the benefits and drawbacks of incorporating the existing 250,000 gallon elevated storage tank at the Wanchese Seafood Industrial Park into the County's water system. The results of these evaluations are presented below.

3.3.1 Town of Manteo Service Connections

The Town of Manteo is a wholesale customer to Dare County and is served by the Skyco WTP. Currently there are numerous individual Town services on County-owned transmission and distribution mains, each requiring a separate meter that is read monthly by County staff to determine the Town's usage and associated bill. As part of this project, the County and Town of Manteo desired a system configuration that would reduce the number of Town services to improve billing accuracy and operational efficiency.

The County worked with CDM to identify a configuration that would reduce the number of Town of Manteo customer meters to a single meter at the Skyco WTP. The configuration includes transferring ownership of the existing 12-inch diameter transmission main from the County to the Town, starting at the Skyco WTP and extending northwest along US-64/264 into the Town of Manteo. A single meter would be installed at the Skyco WTP to meter the Town's usage. The proposed 16-inch diameter transmission main from the Skyco WTP north will be dedicated to Dare County customers only (i.e. no Town of Manteo customers) during normal operation. Two interconnections between the Dare County and Town of Manteo water systems will be included for emergency conditions (e.g. main break) at the following locations: (1) at the Skyco WTP and (2) at the west end of Fernando Street, near the existing

metering station. The Fernando Street interconnection will be closed during normal operation. This approach will improve operational efficiency and customer service by eliminating all but one of the number of Town meters that are read by County staff, resulting in more accurate billing data, while still providing emergency service through the proposed interconnections.

Based on the results of the hydraulic modeling, reducing the number of Town service connections results in a slight decrease in minimum pressure and fire flow, a slight increase in maximum pressure and water age, and improved elevated tank storage usage when compared to the Base Model. Figures A-1 through A-4 and A-6 through A-9 in Appendix A show the minimum pressure, maximum pressure, fire flow, and water age model results for the Base Model and the proposed approach, respectively. Although there was a slight reduction in service for some of the design criteria for the proposed alternative, there were no exceedances to the minimum or maximum design criteria. Therefore, the alternative to reduce the number of Town service connections to a single meter at the Skyco WTP is recommended and is assumed to be implemented for the additional analyses described below.

3.3.2 Transmission/Distribution Improvements

As part of this preliminary engineering evaluation, the hydraulic model was further refined to minimize water age and construction costs by reducing transmission and distribution pipe diameters, while maintaining compliance with the design criteria presented in Section 3.2 above.

The Base Model included a combination of 6-, 8-, 12-, and 16-inch diameter pipe. The 6- and 8-inch diameter pipe is utilized for distribution while the 12- and 16-inch diameter pipe is generally utilized for transmission (there would be some individual service connections anticipated on the transmission main). Two options were considered for reducing the transmission main diameters currently included in the Base Model:

- Option 1: Reduce the proposed 16-inch transmission main diameter to a 12-inch diameter north of the Skyco WTP.
- Option 2: Reduce the transmission main diameter to the north of the proposed Bowsertown Elevated Storage Tank.

In an effort to improve water age on dead-end lines, the final design will consider reducing some of the 6-inch diameter pipes at dead-ends to 2-inch diameter pipes. In order to maintain adequate fire flows, customers shall not be located more than 500 feet from a fire hydrant, which will be installed only on pipes 6-inches in diameter or larger. The 2-inch diameter pipes were not included in the model. Minimum and maximum pressures will be calculated as part of final design to determine which 6-inch diameter pipes can be reduced to 2-inch diameter and the corresponding allowable hydrant distance, up to 500 feet.

The two options described above were hydraulically modeled and the results compared to that of the Base Model and each other for minimum pressure, maximum pressure, fire flow, and water age. All model runs are based on maximum day demands for build-out land use conditions unless specified otherwise.

Minimum Pressure

The minimum pressures on the Base Model did not fall below 50 psi at any location. The minimum pressures for Option 1 fell to below 50 psi at numerous locations, including along the transmission main. The minimum pressures for Option 2 fell to be below 50 psi, but only at a few dead-end locations. All other locations generally mimicked the Base Model. See Figures A-1 and A-10 through A-11 in Appendix A for a map showing the Base Model, Option 1, and Option 2 minimum pressures, respectively.

Maximum Pressure

In general the maximum pressures in the Base Model are between 60 and 70 psi, with a few locations in Wanchese between 70 and 80 psi. Under Option 1 all locations within the Town of Manteo and Wanchese are between 70 and 80 psi. Pipes north of the Town of Manteo are similar to the Base Model, which is between 60 and 70 psi. In general, the maximum pressures in Option 2 mimic the Base Model, with the exception of a few locations with the Town of Manteo and Wanchese. See Figures A-2 and A-12 through A-13 in Appendix A for a map showing the Base Model, Option 1, and Option 2 maximum pressures, respectively.

Fire Flow

In general, a majority of Roanoke Island is predicted to have fire flow availability in excess of 750 gpm for the Base Model and Options 1 and 2. The available fire flows in Wanchese and the Town of Manteo show little variation between the three scenarios. However, the available fire flow for the portion of Roanoke Island north of the Town of Manteo slightly decreases from the Base Model to Option 1 and then to Option 2. The design criteria presented in Section 3.2 requires a minimum fire flow of 500 gpm at cul-de-sacs and dead-end roads. There is one location at the upper northwest corner of Roanoke Island in Option 2 that has a modeled fire flow below 500 gpm, which is 481 gpm. See Figures A-3 and A-14 through A-15 in Appendix A for a map showing the Base Model, Option 1, and Option 2 available fire flows, respectively.

Water Age

Water age was evaluated for the Base Model and Option 2 under near-term and build-out average day demands conditions. Option 1 was not modeled as the results are anticipated to very closely mimic the Base Model. In general the water age reduced under Option 2 as compared to the Base Model. See Figures A-4 and A-5 in Appendix A for maps showing the water age results for the Base Model under build-out and near-term land use conditions. See Figures A-16 and A-17 in Appendix A for maps showing the water age results for Option 2 under build-out and near-term land use conditions.

3.3.3 Storage Improvements

The capacities of the 200,000 gallon elevated storage tank and 2 million gallon (MG) ground storage tank at the Skyco WTP are not adequate for the projected peak hour demands and fire protection of the proposed system. As a result, a proposed 300,000 gallon remote elevated storage tank and second 2 MG ground storage tank at the Skyco WTP were recommended in the 2006 water system study. In addition, consideration was given to incorporating the existing 250,000 gallon elevated storage tank at the Wanchese Seafood Industrial Park into the Dare County water system. The following is a description of the hydraulic model analyses for the storage improvements.

3.3.3.1 Proposed Bowsertown Road Elevated Storage Tank

A proposed 300,000 gallon elevated storage tank, located at the end of Bowsertown Road, was evaluated using the hydraulic model, see Figure 1-2. It is recommended that the proposed tank have a high water elevation of 158.7 feet, the same as the existing Skyco elevated tank. It should be noted that County staff are currently in the process of verifying the elevation of the existing Skyco elevated storage tank. If there is a discrepancy between the actual and design elevations, the actual elevation will govern the elevations of the proposed Bowsertown Road elevated storage tank. It is also recommended that the Skyco WTP high service pumps serving Roanoke Island be controlled by the water elevation of the proposed Bowsertown Road elevated storage tank. An altitude valve will be installed at the Skyco elevated storage tank to prevent overflow as a result of the increased hydraulic gradeline.

The general approach to elevated tank storage is to allow the tank to drain approximately one-third of the total volume during daily operation, with the remaining two-thirds dedicated to fire flow and emergency storage. An evaluation of the existing and proposed elevated tanks was included in each of the analyses described above, including the Base Model, the Town of Manteo Service alternative, and Options 1 and 2. It can be seen on Figures A-18 through A-21 in Appendix A that Option 2 provides the most optimal elevated tank usage.

3.3.3.2 Wanchese Seafood Industrial Park Elevated Storage Tank

The Wanchese Seafood Industrial Park currently provides its own water supply by utilizing a 250,000 gallon elevated storage tank (the Wanchese elevated tank). The County worked with CDM to evaluate the hydraulic and operational impacts of incorporating the existing Wanchese elevated tank into the County's water system. A hydraulic model evaluation was performed to determine the system pressures, fire flows, tank usage, and water age. It was assumed that the Option 2 improvements were in-place. The following is summary of the benefits and drawbacks associated with incorporating the Wanchese elevation tank into the County's water system.

Benefits

Some of the benefits associated with incorporating the existing 250,000 gallon Wanchese elevated tank into the County's water system include: emergency storage in case of a pipe break along the proposed 12-inch diameter transmission main paralleling NC-345; improved fire flow in the Wanchese service area; and improved system flexibility during pump or tank maintenance. The hydraulic model evaluated the Wanchese service area with and without the Wanchese elevated tank. The evaluation shows that with the Wanchese elevated tank in service, the maximum pressures are reduced and fire flow is increased in the Wanchese service area. Figures A-22 through A-23 in Appendix A show the maximum pressures and fire flows with the Wanchese elevated storage tank incorporated in the County's water system.

Drawbacks

The drawings provided by the County indicate the existing Wanchese elevated tank has a high water elevation of 138.79 feet, which is approximately 20 feet below that of the existing Skyco elevated tank and the proposed Bowsertown elevated tank. As a result, a separate pressure zone is created with average pressures approximately 10 psi less than the rest of the County's water system. An altitude valve will have to be installed on the transmission main prior to entering Wanchese to prevent the existing Wanchese elevated tank from overflowing. The altitude valve would reduce the pressure in the transmission main by approximately 10 psi before entering Wanchese, thus burning pressure head already generated by the high service pumps. In general, incorporating the Wanchese elevated tank into the County's water system results in reduced minimum pressures and increased water age in the Wanchese service area. Figures A-24 through A-27 in Appendix A show the minimum pressures and elevated tank usage under build-out land use conditions and the water age results under build-out and near-term land use conditions.

The addition of a multi-leg elevated tank will result in increased maintenance costs (e.g. painting). The structural integrity of the Wanchese elevated tank is not currently known. Therefore, if the County were to take ownership of the tank a detailed structural evaluation of the exterior and interior of the tank should be performed prior to operation.

3.3.3.3 Ground Storage Improvements

The County has determined that the capacity of the existing 2.0-MG ground storage tank at the Skyco WTP is inadequate to keep pace with the distribution pumping during the summer months, requiring operators to temporarily discontinue pumping to the northern Outer Banks. Additionally, the existing tank shows signs of structural deterioration and may be nearing the end of its useful service life. The tank was also constructed hydraulically too low for efficient pump performance at lower tank levels. Therefore, as part of this project, the County will construct a new 2.0-MG ground storage tank and associated piping at the Skyco WTP.

3.3.4 High Service Pump Improvements

The existing high service pumps serving Roanoke Island at the Skyco WTP are 30 horsepower pumps with a design flow and head of 400 gpm and 150 feet, respectively. Additional pumping capacity is required at the Skyco WTP to meet demands under projected near-term land use conditions with the ability to be upgraded to meet projected demands under build-out land use conditions. Recommended HSPS improvements are further discussed in Section 4. In addition, the existing 8-inch diameter discharge line from the high service pumps to the existing 200,000 gallon elevated storage tank is inadequate due to high velocities for projected demands. Replacement of the existing 8-inch diameter discharge main with a 16-inch diameter discharge main is recommended.

3.4 Summary of Recommended Improvements

On November 2, 2009 CDM met with the County to present the results of the model analyses described in this section and included in Appendix A. Based on the results of the meeting the County directed CDM to move forward with design of the improvements identified in the bulleted list below. It should be noted that there are additional recommended improvements as part of this project, such as the ground storage tank at the Skyco WTP, that are not included below as they were not developed using the hydraulic model.

It can be seen from the bulleted items below that the County will not take ownership of or incorporate into their water system the existing 250,000 gallon elevated storage tank at the Wanchese Seafood Industrial Park. Factors such as the reduced normal operating system pressures in the Wanchese service area, the financial burden of operating and maintaining the tank, the current risk associated with the unknown structural condition, increased water age, etc. outweighed the benefits of the additional storage.

- <u>Transmission/Distribution Improvements</u>
  - Installation of approximately 56 miles of 6- to 16-inch diameter water transmission/distribution pipe, including:
    - A combination of 16-, 12-, and 8-inch diameter transmission mains (Option 2 presented in Section 3.3.2)
    - A combination of 8- and 6-inch diameter distribution pipe, with some of the 6-inch diameter pipe reduced to 2-inch diameter at specific dead-ends.
  - Transfer ownership of the existing 12-inch diameter transmission main from the County to the Town of Manteo and install a single meter at the Skyco WTP to meter the Towns water usage.

- Storage Improvements

  - Construction of a new 300,000 gallon elevated storage tank at the intersection of Bowsertown Road and California Lane

- High Service Pump Station Improvements

  - Improvements to the finished water pumps at the Skyco WTP to meet demands under near-term land use conditions, with the ability to be upgraded to meet build-out land use conditions.

  - Improvements to the discharge piping at the Skyco WTP

Section 4
High Service Pump Station Improvements

Expansion of the Dare County water system requires that improvements to the Skyco WTP High Service Pump Station (HSPS) be performed. Increasing the capacity of the pumps to accommodate the increased demand will also require improvements to the instrumentation and control (I&C); electrical; heating, ventilating, and air conditioning (HVAC); and site improvements.

CDM met with the County on October 14, 2009 at the Skyco WTP to discuss the I&C, electrical, and HVAC improvements. The minutes from the meeting are provided in Appendix B. The County will design and install the necessary improvements to the HVAC system.

The following is a description of the preliminary engineering and design for the HSPS improvements.

4.1 Pump Improvements

Expansion of the distribution system throughout Roanoke Island will require improvements to the existing pumps at the HSPS. A description of the existing pump configurations can be found in Section 2.3.1. The following is a description of the recommended pump improvements at the HSPS.

4.1.1 Pumps No. 1 and No. 2

Pumps No. 1 and No. 2 are used to serve the northern beaches and therefore do not require an increase in design conveyance capacity to meet the increased demands on Roanoke Island. The County directed CDM to replace the pumps with the same design capacities of the existing pumps. However, improvements are required to improve the reliability and service capability and to allow Dare County staff improved flexibility to meet the water demands on the northern beaches. Therefore improvements to Pumps No. 1 and No. 2 were included as part of this project.

The existing pumps and motors will be replaced "in-kind" with new equipment. The two-speed motors will be replaced with variable frequency drives (VFDs) and other ancillary electrical improvements.

4.1.2 Pumps No. 3 and No. 4

Dare County staff have indicated that Pumps No. 3 and No. 4 are obsolete and have not been utilized in recent years. The existing pumps, motors, piping, and ancillary equipment associated with these pumps will be removed from service.

The location of Pumps No. 3 and No.4 within the HSPS is being considered for new electrical and HVAC equipment required for the new high service pumps.

4.1.3 Pumps No. 5 and No. 6

Pumps No. 5 and No. 6 will require improvements to meet the increased water demands on Roanoke Island. The County directed CDM to design each replacement pump for the maximum day demand under near-term land use conditions, with the ability to upgrade the pumps and equipment in the future to meet maximum day demands under build-out land use conditions. Based on this approach, it is anticipated that there will be peak hourly conditions under near-term and build-out land use conditions where both pumps are required to operate. The VFD's will provide the County the flexibility to reduce flows during periods of low demand.

The 2006 water system study provided average and maximum day demands under build-out land use conditions of 1.133 MGD and 2.833 MGD, respectively. Demands for existing and near-term land use conditions were not provided. Therefore, average and maximum day demands were developed as part of this evaluation under near-term land use conditions. The demands were developed assuming a linear growth rate for population and applying that rate to the build-out demands to back-calculate the near-term demands. For this evaluation it was assumed that near-term and build-out occur at years 2015 and 2035, respectively. **Table 4-1** summarizes the design parameters of the proposed Pumps No. 5 and No. 6.

Table 4-1
Summary of Pump Design Parameters

Demand Scenario	Near-Term		Build-Out	
	MGD	Gpm	MGD	Gpm
Average Day Demand	0.804	560	1.133	790
Max Day Demand(1)	2.011	1,400	2.833	2,000

Notes:

1. Individual pumps will be designed to meet maximum day demands

Reliability and service capability should be improved to allow Dare County staff flexibility to meet the water demands on Roanoke Island. The one-speed motors will be replaced with VFDs and other ancillary electrical improvements.

4.2 Instrumentation and Control

The high service pumps will be controlled based on levels in the proposed 300,000 gallon Bowsertown Road elevated storage tank, see Section 5 for a description of the proposed elevated tank. The pumps will operate in a lead/lag pumping sequence, where the lead and lag sequence (or alternation mode) will be selected at the pump control panel. The proposed elevated tank level will be monitored and used for pump control. VFDs will also be adjustable within the I&C system. Additional I&C design considerations can be found in the October 14, 2009 meeting minutes,

provided in Appendix B. CDM will work with County staff to identify the necessary instrumentation and control infrastructure.

4.3 Electrical Considerations

The existing 480 volt, 3-phase motor control center (MCC) that is located in the pump room at the HSPS will be replaced with a new switch board and individual variable frequency drive (VFD) motor controllers. The existing MCC loads, which consist of two transmission, two high service pumps, 480 V panel, and two lighting panels will be fed from the new switch board. The new equipment will be installed in the HSPS where Pumps No. 3 and No.4 are currently located. Additional electrical design considerations can be found in the October 14, 2009 meeting minutes, provided in Appendix B.

4.4 Site Improvements

Yard piping improvements will be required to accommodate the increased flows immediately outside of the HSPS as well as the new 2.0 MG ground storage tank. The addition of the 300,000 gallon Bowsertown elevated storage tank will require that an altitude valve be installed at the existing 200,000 gallon elevated storage tank to prevent overflow.

Section 5
Proposed Ground and Elevated Storage Tank

5.1 Introduction

Expansion of the Dare County water transmission and distribution system on Roanoke Island requires that additional storage volume be provided for peak hour demands, fire flow protection, and emergency storage. Based on the results of the hydraulic modeling analysis described in Section 3 of this PER, this project includes a new 2.0 MG ground storage tank at the Skyco WTP and a 300,000 gallon elevated storage tank in the distribution system. The following is a description of the preliminary engineering and design efforts for the ground and elevated storage tanks.

5.2 Ground Storage Tank

The County currently operates a 2.0 MG ground storage tank at the Skyco WTP, shown here. The tank appears to have been constructed using cast-in-place concrete. The County has determined that the capacity of the existing 2.0-MG ground storage tank is inadequate to keep pace with the distribution pumping during summer months, requiring operators to temporarily discontinue pumping to the northern Outer Banks. The problem is caused in part to hydraulic pump limitations, described in Section 5.2.8. In addition, discussions with Skyco WTP operations staff indicate the 30-year old ground storage tank is in need of rehabilitation or possibly even replacement. CDM performed a structural inspection of the tank on October 14, 2009. A technical memorandum summarizing the results of the inspection can be found in Appendix C.

This project includes construction of a new ground storage tank and associated piping.

5.2.1 Preliminary Ground Storage Tank Site Selection

A field survey of the Skyco WTP property was conducted for the purpose of identifying a location suitable for construction of a new ground storage tank, as shown on **Figure 5-1**. As part of the site selection process, areas of environmental concern (AECs) within the property were delineated, verified by the North Carolina Division of Coastal Management (NCDCM), and included in the survey. Assuming a minimum footprint equal to that of the existing ground storage tank (123 feet), it can

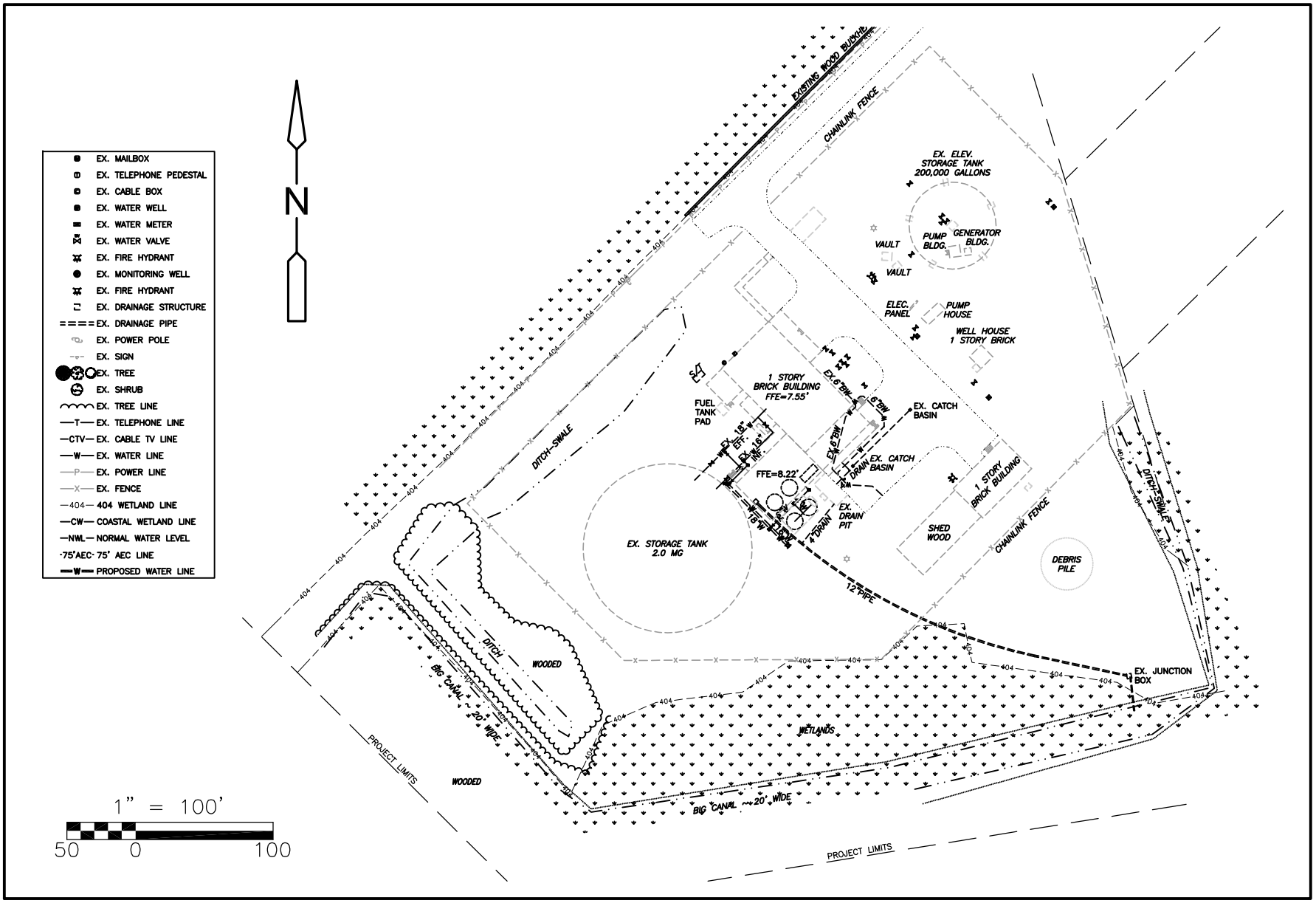

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Figure No.5-1
SKYCO WTP SITE MAP

be seen on Figure 5-1 that there are no locations on the Skyco WTP property that do not result in either an AEC, utility, or structure impact. Acquisition of surrounding property was not considered a cost-effective alternative given the available, although somewhat impacted, space within the Skyco WTP property. Therefore, the next step was to identify a location that resulted in the least impact.

There is a location at the southeast corner of the property where a 123-foot diameter tank would not impact an AEC boundary or building, as shown on **Figure 5-2**. There are three discharge pipes that run through the proposed footprint, but could be relocated to accommodate the proposed ground storage tank.

5.2.2 Recommended Tank Style

Two types of ground storage tank styles were considered for this project: (1) prestressed concrete and (2) glass-lined, bolted-steel. Both styles have proven histories of success and would be suitable for this application. A brief description of each tank style followed by the recommended style is presented below.

5.2.2.1 Prestressed Concrete Tank

Prestressed concrete tanks are constructed in accordance with the American Water Works Association (AWWA) standard D110 and consist of a steel shell diaphragm, shotcrete encasement, and wire prestressing to provide a watertight composite wall. The tanks are typically finished with a low silhouette dome roof.

Under most operating conditions, interior surfaces of the tank do not require painting, which can lower the initial cost. Exposed exterior surfaces can be painted for improved appearance.

5.2.2.2 Glass-Lined, Bolted-Steel Tank

Glass-lined, bolted-steel tanks consist of a series of steel panels joined together with bolts in the field. All joints that are required to contain water or to be weather-tight are sealed with a suitable gasket material and/or sealant as required. Bolted-steel tanks are supported on a concrete ringwall, concrete slab, or structurally-compacted granular berm.

A glass fused-to-steel coating is applied in the tank manufacturer's factory to form a hard, inert barrier for both the interior and exterior tank surfaces to guard against weather and corrosion. The surface does not require painting. Regular inspection and repair of damaged or deteriorated areas are required (usually every 3 to 5 years).

5.2.2.3 Recommended Tank Style

Neither tank style offers a distinct hydraulic advantage over the other and aesthetics is not a critical issue given the proposed locations. The County has more familiarity with concrete tanks and prefers the lower amount of maintenance they offer. Therefore, the prestressed concrete tank style will be designed for the new ground tank at the Skyco WTP.

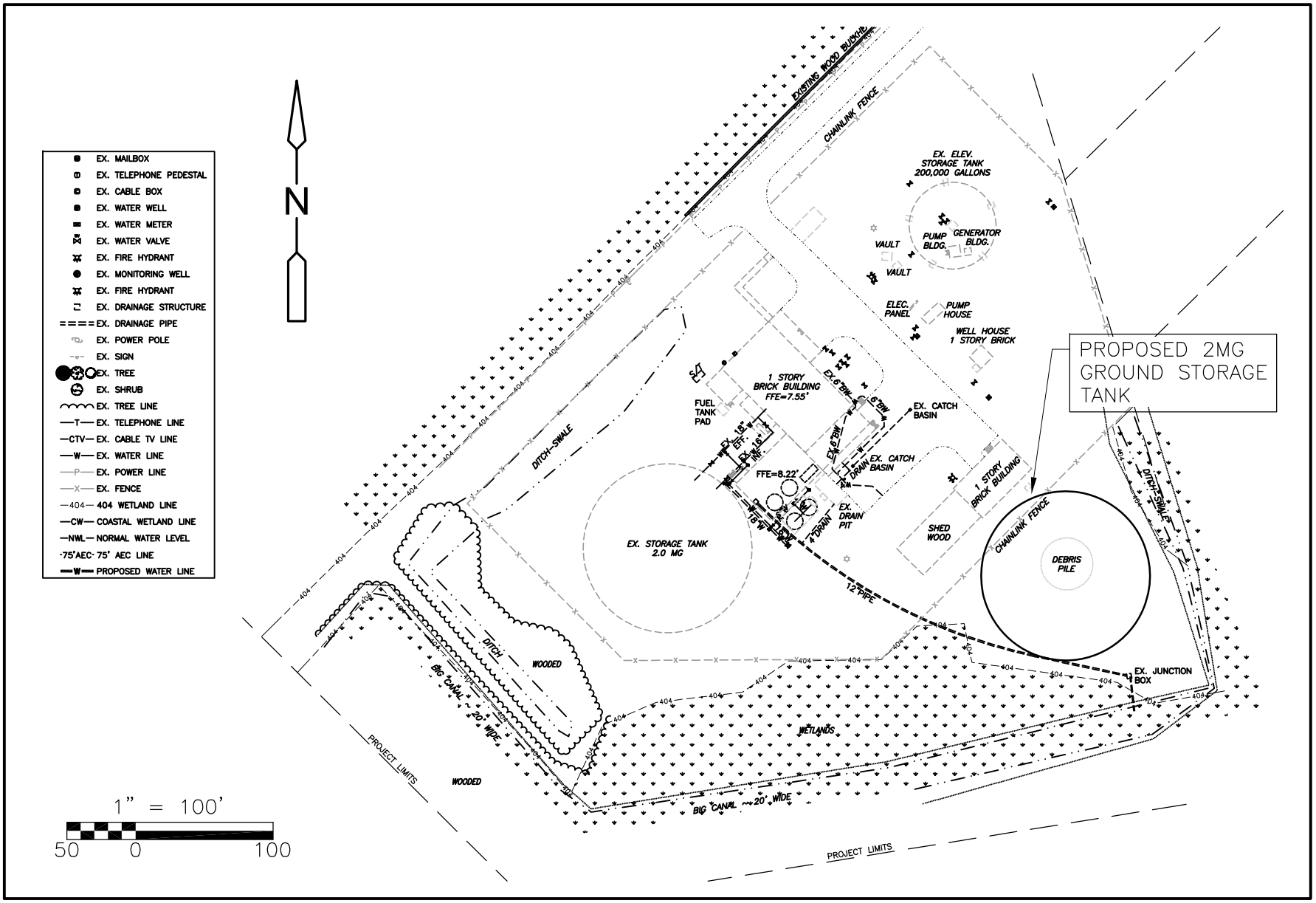

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Figure No.5-2
PROPOSED 2MG GROUND STORAGE TANK
LOCATION

5.2.3 Recommended Tank Volume

The new ground storage tank will reduce the strain on the existing 2.0-MG ground storage tank during peak demand conditions, provide flexibility to the Skyco WTP operators, and provide redundancy in the case of emergencies. The County has indicated that the existing 30-year old, concrete tank will be rehabilitated or replaced in the future. The recommended volume for the proposed ground storage tank at the Skyco WTP is 2.0 MG. The proposed tank will be constructed at the proper elevation to allow for efficient pump performance to the greatest extent practicable and minimize the potential for causing pump damage.

5.2.4 Recommended Tank Operation

5.2.4.1 Minimum Operating Volume

The Skyco WTP uses the Upper Yorktown aquifer as its water source. Although there are currently no contact time (CT) requirements for disinfection, the recently promulgated Groundwater Rule will require Dare County to complete water source monitoring. As an alternate, Dare County can provide a level of treatment and disinfection to achieve a 4-log removal or inactivation of viruses.

The CT required for 4-log inactivation of viruses is 6.0, assuming the lowest groundwater temperature will be above 10 degrees Celsius (50 degrees Fahrenheit), free chlorine is used, and a pH in the range of 6.0 to 9.0. Assuming a minimum free chlorine residual of 0.5 mg/L in the storage tank, the required actual detention time (T_{10}) is 12 minutes. The expected ratio of actual detention time/ theoretical detention time (T_{10}/T), assuming poor baffling, is 0.30. Therefore, the theoretical detention time is 40 minutes (12 minutes / 0.30 = 40 minutes). At a peak flow rate of 6.8 MGD (2006 Water System Study), the volume required to provide 40 minutes of detention time is 189,000 gallons. Therefore the minimum operating volume in the storage tank will be 189,000 gallons.

5.2.4.2 Operating Flexibility

The addition of a second ground storage tank at the Skyco WTP will allow staff flexibility in how they operate the tanks. During the summer months both tanks may be used simultaneously to meet peak hourly demands. During all other seasons one tank could potentially be taken out of service. This will be particularly beneficial when the existing 2.0-MG ground storage tank is being rehabilitated or replaced.

5.2.5 Appurtenances

The ground storage tank will be outfitted with standard accessories. These will be determined during final design, but are expected to include a wall manway, exterior ladder, interior ladder, roof hatch cover, pressure relief valve/vent, liquid level indicator, and overflow. Pipes will enter the tank through the bottom slab, where possible. Specific site conditions and water quality parameters will be evaluated during final design to determine the required interior and exterior coatings. The ground storage tank will be designed with inlet and outlet piping locations to maximize efficient water flow and water quality. Design consideration will be give to allow the future installation of a mechanical mixer if deemed to be necessary.

5.2.6 Site Improvements and Security

The proposed 2.0-MG ground storage tank will be located on a flat, grassed open area at the southeast corner of the existing Skyco WTP property, see Figure 5-2. Minimal site preparation work is anticipated.

Because the proposed ground storage tank will be located at the existing Skyco WTP, it will be incorporated into the existing security measures provided at the site. The security fence extending around the current facilities will be extended to include the proposed ground storage tank.

5.2.7 Electrical Considerations

Power requirements for equipment associated with the new ground storage tank will be tied into the existing power supply at the Skyco WTP. The proposed electrical improvements will comply with all federal, state, and local laws and ordinances, as well as all applicable codes, standards, regulations, and/or regulatory agency requirements.

5.2.8 Instrumentation and Control

The existing 2.0-MG ground storage tank is approximately 123 feet in diameter and has a normal operating range of between 12 to 24 feet, with an overflow level of 24.8 feet. Based on discussions with Skyco WTP operations staff, a vortex is created when the water level is approximately 4 feet in the tank, causing the high service pumps to shut down. As part of this project, the two existing single-stage pumps will be replaced with two larger pumps with VFDs (discussed in Section 4.1.3). Therefore, the proposed pump and ground storage tank will be designed to maximize the volumes within the existing 2.0-MG and proposed 2.0-MG ground storage tanks while maintaining the minimum operating volume of 189,000 gallons (discussed in Section 5.2.4.1). The proposed improvements may result in a change to the current operating approach. CDM will work with County staff to identify the necessary instrumentation and control infrastructure.

5.3 Elevated Storage Tank

The capacity of the existing 200,000 gallon elevated storage tank at the Skyco WTP is inadequate to meet the projected peak hour demands, emergency needs, and fire protection of the system. Therefore a new 300,000 gallon elevated storage tank will be constructed within the distribution system.

5.3.1 Preliminary Elevated Tank Site Selection

The 2006 water system study identified two potential locations for placement of a proposed 300,000 gallon elevated storage tank. Site A is located at a closed rest stop in the northern portion of Roanoke Island. Site B is located adjacent to the Manteo High School. An additional location, Site C, was identified as part of this preliminary engineering evaluation and is located in an unused portion of the closed Bowsertown Landfill at the end of Bowsertown Road. **Figure 5-3** shows the location of each of the three proposed sites.

Each site was ranked from one to three, with one being the best and three the worst, based on six unique siting criteria. **Table 5-1** presents the results of the ranking.

Table 5-1
Siting Criteria Evaluation

Criteria	Description	Proposed Site		
		A	B	C
Land Availability	Is the land private or county owned and is there sufficient space?	3	2	1
Impacts to Surrounding Development During Construction	To what degree and how many citizens will incur potential safety, traffic, noise, etc. impacts during construction?	2	3	1
Hydraulic Effectiveness	Will the tank operate at an effective hydraulic gradient?	3	2	1
Environmental Impact	Are there any impacts to areas of environmental concern anticipated during construction?	1	1	1
Existing Power Supply	Is there an existing power supply in close proximity?	1	1	1
Piping Impacts	Which location requires the least amount of transmission piping?	3	2	1
	Totals =	**13**	**11**	**6**

It can be seen that Site C had the lowest and therefore best score among the three potential sites. Based on the results of this evaluation and discussions with County staff, Site C is the recommended location for a new elevated storage tank.

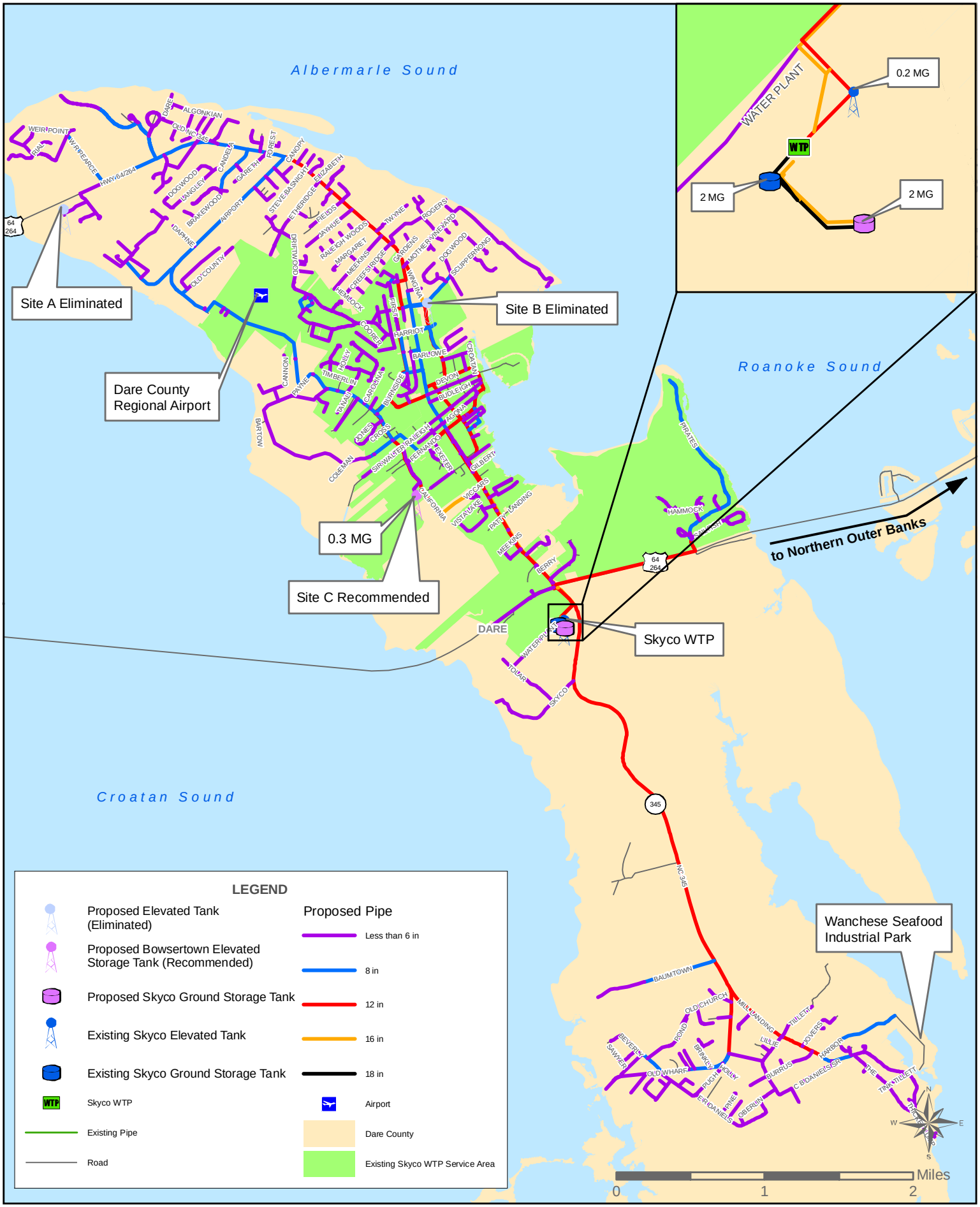


Figure 5-3
Proposed Elevated Tank Locations

5.3.2 Recommended Tank Style

There are several elevated tank styles that have proven histories of success and would be suitable for this application, including pedesphere, multi-leg, fluted column, and composite. Based on conversations with County staff, the two most preferred tank styles for the proposed 300,000 gallon elevated storage tank are the pedesphere and multi-leg tanks. The following is a brief description of the two tank styles followed by the recommended style for this project.

5.3.2.1 Pedesphere Tank Style

Pedesphere elevated tanks are considered to be attractive and simplistic in appearance. A single support column, which does not contain water, includes access ladders and piping. Controls and storage are included in the flared base section, which is accessible through a lockable doorway. For 300,000 gallons, the tank will likely have a spheroidal shape. The pedestal shaft and base cone diameters are designed to suit site conditions and other requirements. The entire tank is constructed of steel in accordance with AWWA standard D100. Given its steel construction, painting is typically required every 5 to 10 years. However, there are paint systems available that have longer service lives, but have a higher initial cost.

A cellular antenna corral and an inter-tank antenna duct for antenna cable installation will be included.

5.3.2.2 Multi-Leg Steel Tank Style

The existing 200,000 gallon elevated tank at the Skyco WTP is a multi-leg steel tank. Multi-leg tanks are typically less costly than a pedesphere style tank, but are also considered less aesthetically pleasing and require increased maintenance costs for items such as painting. These tanks use multiple steel columns to support the tank, which can be several different shapes. Typically a balcony and handrail surround the tank with access ladders on the tower column and tank.

5.3.2.3 Recommended Tank Style

Neither tank style offers a distinct hydraulic advantage over the other and aesthetics is not a critical issue given the proposed locations. The Pedesphere offers lower on-going maintenance and painting costs and will therefore be designed for the proposed Bowsertown Road elevated storage tank.

5.3.3 Volume and Operation

The proposed elevated storage tank will have a volume of 300,000 gallons to help supplement the HSPS during peak hourly conditions, which typically occur during early morning and late afternoon in Dare County. The tank will be fed by a 16-inch diameter pipe from the HSPS and will discharge through a 12-inch diameter pipe into the distribution system. The tank will have a high water elevation of 158.7 feet and ground elevation of approximately 5 feet, resulting in an approximate tank height of 154 feet.

5.3.4 Coatings

There are several types of protective coating systems for use on the interior and exterior of the tank to prevent the deterioration of the steel walls. The coating systems are not necessarily equivalent in terms of expected service life or initial cost. The selection of a coating system is dependent upon site-specific conditions, such as external atmospheric exposure, internal water chemistry, and temperature variations. During detailed design, these data will be collected and evaluated with the coatings manufacturer to determine the most appropriate coatings systems and specific products. The following is a brief description of the interior and exterior coatings that will be considered during final design.

5.3.4.1 Interior Coating Systems

Interior coatings in contact with potable water will be tested and certified in accordance with NSF/ANSI 61. AWWA D102 describes five inside coating systems (ICS): Nos. 1, 2, 3, and 5 are two-component epoxies, and No. 4 is based on polyurethane and/or polyurea technology.

ICS-1 is a two-coat system intended for normal service. ICS-2 is a three-coat system for extended service as compared to ICS-1. ICS-3 is a three-coat system consisting of a zinc-rich primer, two-component epoxy intermediate, and epoxy topcoat. The zinc-rich coating is applied in the shop to surfaces above the high water level (HWL) for additional corrosion protection. The remaining epoxy coats in ICS-3 are the same as those used in ICS-2. The single-coat ICS-4 provides for increased film-build coverage over deteriorated or pitted steel. Specially designed application equipment is required owing to the rapid-cure characteristics of this system. Furthermore, additional staging equipment is often required for ICS-4 coatings. ICS-5 includes a zinc-rich primer applied to all internal surfaces (above and below the HWL), and the same two-coat epoxy intermediate and finishing coatings as ICS-2.

CDM will work with the County on determining the appropriate interior coating. The manufacturer's recommendations will be followed for surface preparation and application.

5.3.4.2 Exterior Coating Systems

In addition to corrosion resistance, color and gloss retention, as well as resistance to graffiti, are typical characteristics to be evaluated for exterior coatings. AWWA D102 recognizes the following six outside coating systems (OCS) for steel water storage tanks:

- OCS-1 consists of a three-coat alkyd system, providing reasonable and durable protection in mild environments. An optional fourth coat can be applied to offer increased corrosion protection and service life.
- OCS-2 coatings are three-coat, single-component polyurethane systems that provide improved protection in mild to moderately severe environments. A key distinguishing factor of the OCS-2 system is the wide range of temperature and humidity conditions that are acceptable for application.
- OCS-3 coatings are a three-coat water-based acrylic emulsion system. These coatings offer similar corrosion resistance to the alkyd enamels of OCS-1, yet generally dry faster and offer improved color and gloss retention.
- OCS-4 is a three-coat system consisting of zinc-rich primer, aliphatic urethane intermediate coat, and a fluorourethane finish coat. OCS-4 coatings offer improved gloss and color retention over aliphatic polyurethane finish coats; however, the fluorourethane finish coat may require unique application methods.
- OCS-5 coatings consist of a two-component epoxy prime and intermediate coat and a two- component aliphatic polyurethane finish coat. Very good color and gloss retention can be achieved, as well as increased resistance to windblown debris. The addition of a UV absorber can further improve the long-term color and gloss retention. These coatings are typically used where bright-colored logos are included on tank exteriors.
- OCS-6 coatings are comprised of a zinc-rich primer and the same two-component epoxy intermediate coat and two-component aliphatic polyurethane finish coat as OCS-5. The zinc-rich primer provides increased corrosion protection, and the use of a UV absorber can also prolong the color and gloss retention of the paint.

CDM will work with the County on determining the appropriate exterior coating as well as the preferred logo, if desired. The manufacturer's recommendations will be followed for surface preparation and application.

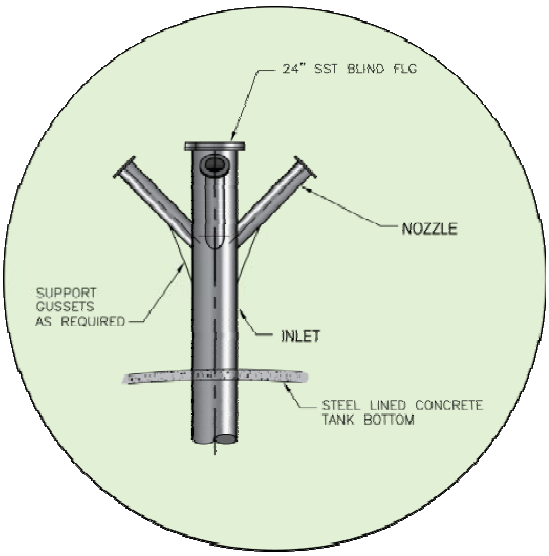
5.3.5 Cathodic Protection

Steel surfaces submerged in water are subject to galvanic corrosion. This corrosion process can be reversed and corrosion reduced with the application of direct current via a cathodic protection system. A DC power supply controller (rectifier) and an anode system are the two principal components of an automatically controlled, impressed-current cathodic protection system.

Cathodic protection systems are generally used in conjunction with coated tanks, provided that the coatings are resistant to an alkaline environment and water permeation. Cathodic protection is intended to supplement protective coatings where flaws exist due to poor surface preparation, improper application, or deterioration over time. The application of coatings or cathodic protection alone can be effective in reducing corrosion; however, the combination of the two can be more economical and cost-effective than using a single system alone.

Cathodic protection systems require periodic inspection and maintenance, typically by a specialized contractor or corrosion specialist. These inspections are generally performed annually, in addition to the regular rectifier potential meter readings taken approximately every 60 days.

Dare County does not have cathodic protection on their existing elevated storage tank at the Skyco WTP. The cost considerations for adding regular inspection and maintenance requirements for a new system to the County's program are anticipated to outweigh the potential advantages of providing supplemental protection from a cathodic system. However, should pinholes develop in the coating system, a cathodic protection system can be installed inside the tank as an added measure of protection in the future.



5.3.6 Appurtenances

The tank inlet and outlet pipes will be designed to enhance water mixing, turnover during regular fill/drain cycles, and minimize potential water quality issues. The inlet pipe will be carbon steel with a three nozzle configuration for enhancing water mixing, shown here. A base vault with an access hatch will be constructed to house all piping, fittings, and valves. An overflow pipe will be provided through the center column and base vault. A valve will be installed in the base vault, and yard piping will extend to nearest surface water discharge point. The overflow pipe and inlet pipe will be connected to allow the tank to be drained.

The elevated tank will be equipped with a vent at the apex of the water-bearing portion of the bowl. The vent will be adequately sized to safely vent the tank during periods of maximum pumping or withdrawal. The vent will be covered from the inside with a mesh screen. A hinged roof entry hatch will be installed. Additionally, an exhaust hatch will be provided.

The appropriate valves and associated vaults will be identified during final design.

5.3.7 Site Conditions and Recommendations

The elevated tank is proposed to be located on an unused section of the former Bowsertown Landfill site, located at the end of Bowsertown Road just outside the Town of Manteo limits, as shown on **Figure 5-4**. This approximately 13-acre site operated as a municipal and construction waste facility until the mid-1980s when it was capped. The site continued to operate as a waste transfer station until 2007, at which time it was permanently closed. The majority of the site is closed; however, Dare County continues to operate a mosquito control service from a structure located at the southeast corner of the site.

5.3.7.1 Environmental Evaluation

Although the tank will be located outside of the capped landfill, a preliminary evaluation of the groundwater and soils was performed to assess the potential for contamination. Based on preliminary groundwater and soil sample analyses, there were no exceedances of North Carolina Division of Water Quality Groundwater Quality Standards. However, formaldehyde and alpha BHC exceeded the Solid Waste Section Limits. The concentrations detected do not appear to pose any acute or immediate health risk.

Preliminary results from CPT borings have not identified any concerns with contamination. It is assumed at this point that there is no contamination of the site. If any issues are identified during construction they will be addressed appropriately.

5.3.8 Site Security Recommendations

The proposed tank will be constructed within the confines of Dare County's Bowsertown Landfill site, but in an area that is not in continuous view of Dare County staff. At a minimum, the exterior of the elevated tank will be encompassed by a chain link security fence topped with barbed wire with access provided through a lockable gate. "No Trespassing" signs will be posted on the fence exterior.

5.3.9 Electrical Considerations

The miscellaneous electrical loads to the elevated storage tank will be served from a 200 ampere, 120/240 volt, 1-phase panelboard located within the tank pedestal. The power supply to this panelboard will come from a new electric service provided by the local power company. The panelboard will serve lighting and miscellaneous power loads.

5.3.10 Instrumentation and Control

The proposed 300,000 gallon elevated storage tank will be used to control the two Roanoke Island-dedicated high service pumps at the Skyco WTP. A pressure sensing level will be used at the tank and transmitted to the Skyco WTP via radio telemetry. CDM will work with County staff to identify an efficient operating range for the tank and the necessary instrumentation and control equipment.

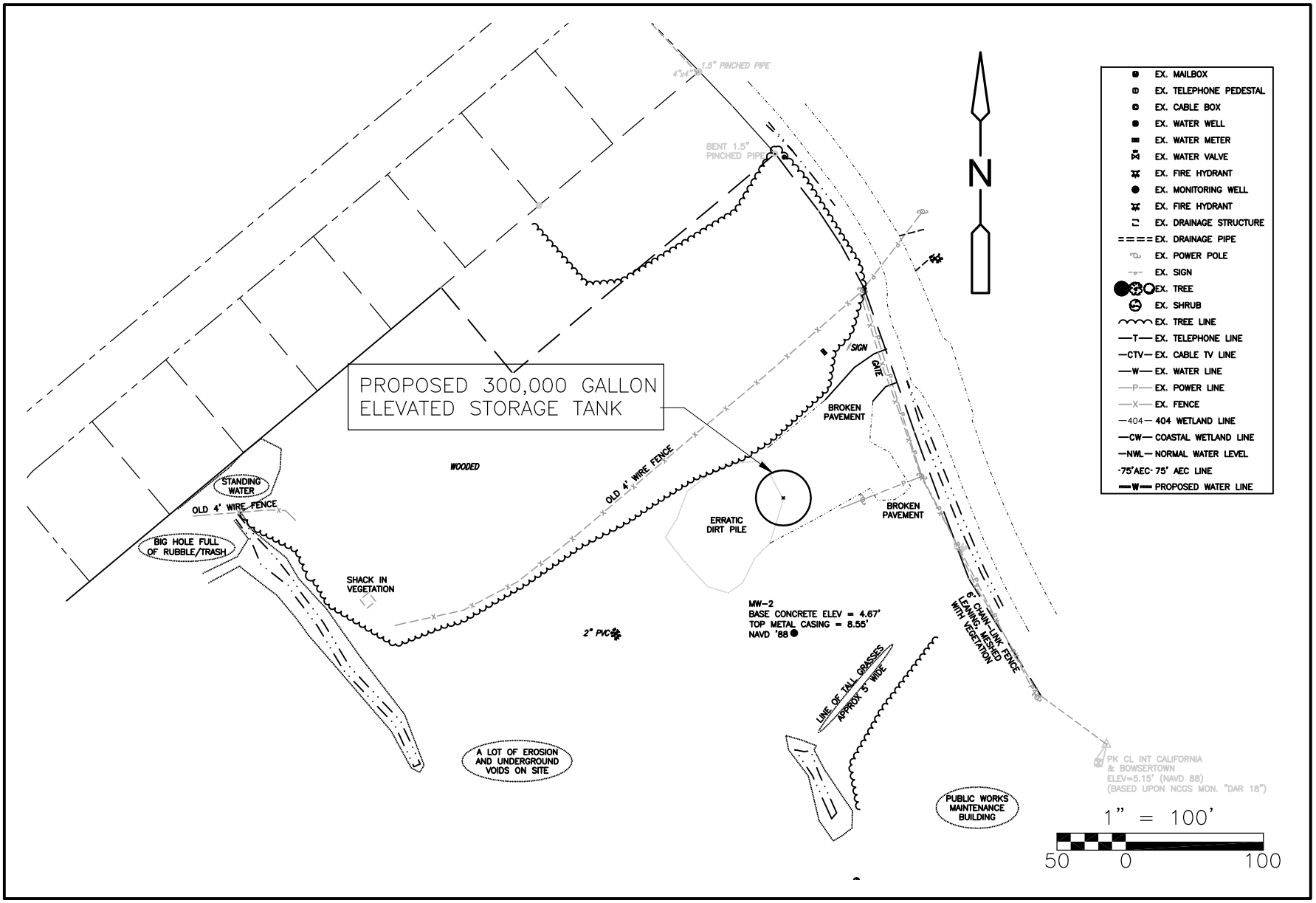


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Figure No.5-4
PROPOSED 300,000 GALLON
ELEVATED STORAGE TANK LOCATION

5.3.11 Water Quality Sampling

The proposed 300,000 gallon Bowsertown Road elevated storage tank will be provided with sampling ports at various levels within the tank bowl to monitor water quality. Parameters such as chlorine residual, pH, conductivity, dissolved oxygen, temperature, and redox potential are conducive to real time monitoring. Selection of parameters to be monitored will be made by Dare County with input from CDM during final design. Sampling piping will be 1 to 2 inches in diameter and run from inside the tank bowl at various locations to both an automated sampling device and a manual sample port. Also, two ¾ inch taps will be installed on the stand pipe, one for level instrumentation and the other for water sampling.

Section 6
Proposed Transmission/Distribution Pipelines

6.1 Introduction

The goal of this project is to provide potable water to the developed and improved areas on Roanoke Island. In order to accomplish that goal, the existing Dare County water transmission and distribution system must be expanded such that each potential customer can hook onto the water system within a reasonable distance from their property boundary. This project includes approximately 56 miles of 6- to 16-inch diameter transmission and distribution pipe as well as approximately 250 feet of 18-inch diameter pipe at the Skyco WTP. A description of the hydraulic modeling performed to determine the pipe layout and diameters can be found in Section 3.

The purpose of this section is to present the engineering evaluations that have been and will be conducted as part of the transmission and distribution pipe design for the project. The following discusses the recommended pipe route, the evaluation criteria that will be used for determining the location of the pipe along the route, and preliminary design of the pipe.

6.2 Description of Proposed Pipe Route

As part of the hydraulic analysis described in Section 3 of this PER, a general route was laid out for the proposed transmission and distribution piping that will allow the County to provide potable water to the developed and improved areas on Roanoke Island. **Figures 6-1** and **6-2** show the proposed pipe route for the northern and southern portions of Roanoke Island, respectively. **Table 6-1** summarizes the approximate length of proposed pipe by diameter. It should be noted that final design will consider reducing some of the 6-inch diameter pipes at dead-ends to 2-inch diameter to enhance the water quality while ensuring that adequate fire protection is maintained.

Table 6-1
Recommended Transmission and Distribution Pipe Improvements

Diameter (inches)	Approximate Length of Pipe	
	(feet)	(miles)
6	204,700	38.8
8	40,700	7.7
12	39,200	7.4
16	8,400	1.6
18	250	0.05
Totals	293,250	55.5

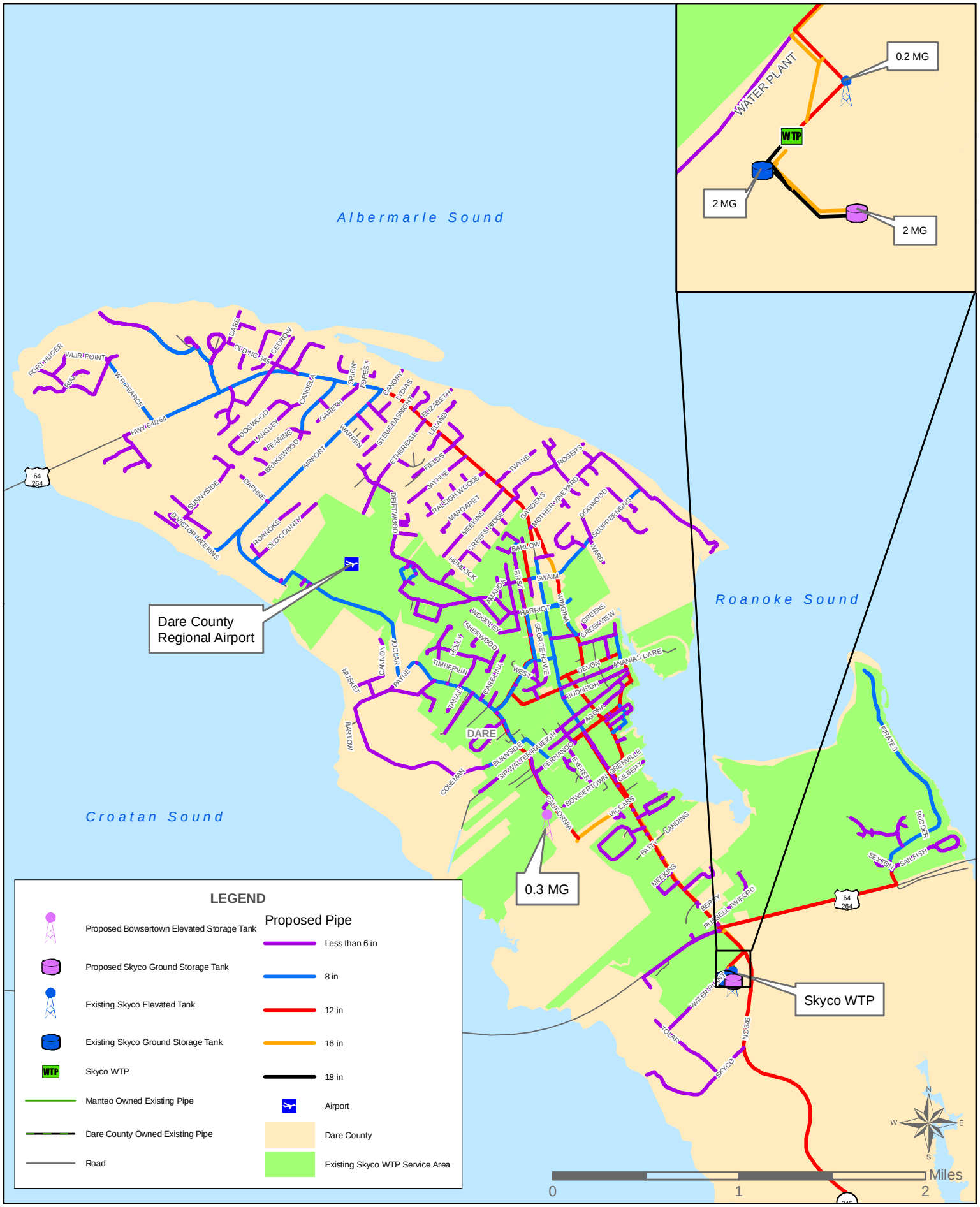


Figure 6-1
North Roanoke: Recommended Water Distribution System Improvements

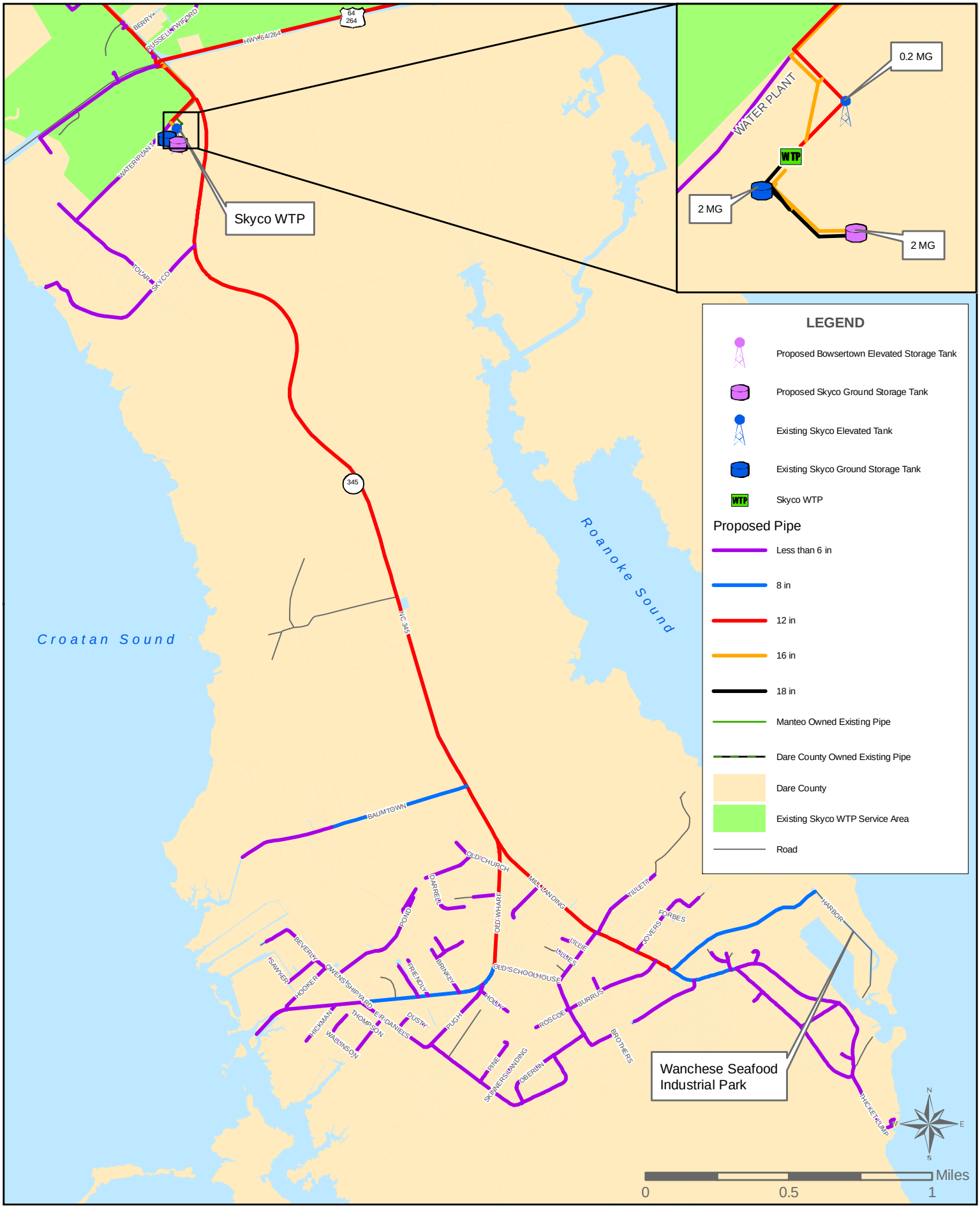


Figure 6-2
South Roanoke: Recommended Water Distribution System Improvements

6.2.1 Transmission Main

A new 16-inch diameter PVC transmission main will be installed within the Skyco WTP property and extend along Water Plant Road until intersecting with NC-345. There the transmission main will split to the northwest towards the Town of Manteo and northern reaches of Roanoke Island (refer to Figure 6-1) or extend southeast towards Wanchese and the southern reaches of Roanoke Island (refer to Figure 6-2).

6.2.1.1 Northern Transmission Main

At the intersection of Water Plant Road and NC-345, a 16-inch diameter PVC transmission main will extend northwest, paralleling an existing 12-inch diameter PVC transmission main, until the intersection of Viccars Lane and US-64/264. The 16-inch diameter transmission main will turn southwest and parallel Viccars Lane, cross over private property, parallel Fanning Mill Road, and then turn northwest and parallel California Lane, until reaching the proposed 300,000 gallon elevated storage tank at the intersection of Bowsertown Road and California Lane. A tee-connection will allow water to fill the tank, drain the tank, or bypass the tank. The 16-inch diameter main will transition to a 12-inch diameter transmission main at the tee-connection and follow secondary roads along and through the Town of Manteo before intersecting US-64/264 at Barlow Street. The 12-inch diameter main will continue northwest and parallel US-64/264 up to Airport Road, where it will transition to an 8-inch diameter main and continue paralleling US-64/264 up to the northwest corner of Roanoke Island.

6.2.1.2 Southern Transmission Main

At the intersection of Water Plant Road and NC-345, a 12-inch diameter ductile iron transmission main will extend southeast along NC-345 until intersecting Harbor Road in Wanchese. From there PVC distribution lines will branch off to serve the developed areas in Wanchese and southern Roanoke Island.

6.2.2 Distribution Pipe

A combination of 6- and 8-inch diameter PVC distribution pipes will be used to serve the developed and improved areas on Roanoke Island. In an effort to improve water age on dead-end lines, the final design will consider reducing some of the 6-inch diameter pipes at dead-ends to 2-inch diameter pipes. In order to maintain adequate fire flows, customers shall not be located more than 500 feet from a fire hydrant, which will be installed only on pipes 6-inches in diameter or larger. Minimum and maximum pressures will be calculated as part of final design to determine which 6-inch diameter pipes can be reduced to 2-inch diameter and the corresponding allowable distance, up to 500 feet. In general, the distribution pipes will follow NCDOT primary and secondary roads and some private roads. There will also be locations where developed or improved parcels are landlocked and therefore cannot parallel existing roads. The County is currently working with the landlocked property owners to determine if water is desired and if so, acquiring the necessary easements to get the distribution line to the landlocked property.

6.3 Pipe Alignment Evaluation

Though the pipeline routes are generally set, there are a number of key factors that will be considered during final design when determining the location of the proposed pipe within/along an existing road. In general, the proposed pipe will be installed within a road right-of-way, on the side that results in the least impact.

In order to determine the area of least impact, the following evaluation criteria will be considered during final design: relative costs, property impacts, traffic impacts, permit requirements, environmental impacts, maintenance access, and utility conflicts. The following is a brief explanation of each criterion.

6.3.1 Relative Cost Basis

The general pipeline alignment will follow existing roads with minimal opportunities for alternative routes. However, during final design a conceptual cost comparison will be performed as part of the evaluation process to determine which side of the road the pipe should be installed. Other non-cost permanent and temporary impacts will be considered.

6.3.2 Property Impacts

One of the goals for this project is to minimize the impacts to individual properties that will be located along the selected route. Impacts can be temporary such as removal and restoration of lawns, gardens, fences, sidewalks and/or driveways associated with trenching. Impacts can also be permanent such as removal of large trees or structures within the pipeline right-of-way. Where possible, the pipeline alignment will be adjusted to avoid permanent impacts.

It is anticipated that a majority of the construction will occur within existing road rights-of-way. However, there will be locations where the pipe alignment will require that permanent or temporary easements be acquired. In the case of permanent easements, the pipe alignment will follow existing property boundary lines to avoid dividing parcels. Temporary and permanent impacts will be avoided to the greatest extent practicable in the temporary construction easements.

6.3.3 Traffic Impacts

In order to serve existing developed areas, a majority of the proposed pipeline will be constructed within road rights-of-way. Due to the small diameter of pipe being installed, predominately 6-inch diameter, it is likely that construction can occur within the right-of-way in a manner such that traffic will not be directly impacted (i.e. causing one or more lane closures). However, there are likely locations where utility conflicts, trenching requirements, insufficient right-of-way width, open-cut road crossings, etc. will result in traffic impacts. The County and CDM have initiated discussions with local NCDOT staff to employ the appropriate traffic controls to ensure the safety of all persons during construction.

6.3.4 Permit Requirements

CDM and County staff have met with representatives of the North Carolina Department of Transportation, North Carolina Division of Water Quality, North Carolina Division of Land Quality, North Carolina Division of Coastal Management, North Carolina Public Water Supply Section, North Carolina Wildlife Resource Commission, North Carolina Division of Marine Fisheries, and U.S. Army Corps of Engineers to present the Roanoke Island Water Expansion Project and discuss anticipated permit requirements. Based on preliminary engineering analyses and discussions and emails with the above referenced regulatory agencies, an environmental assessment (EA) will likely not be required for this project. Appendix D includes an email correspondence with an NCDENR representative regarding the potential exemption for an EA.

CDM and County staff met with Town of Manteo staff on October 8, 2009 to discuss permitting requirements for work conducted within Town limits. Based on the results of the discussion, the Town of Manteo does not have any permitting requirements for work performed within the NCDOT road rights-of-way within Town limits.

Continued communication with the above-referenced regulatory agencies as well as other federal, state, municipal, and private agencies will be required throughout the project to ensure that the project permitting requirements are met and carried out during construction.

6.3.5 Constructability

The ease with which the project can be constructed generally impacts the overall project cost. Constructability issues considered as part of the pipe alignment evaluation include contractor access to the site, ability to store materials and access to potential project staging areas, speed of construction, and construction safety.

6.3.6 Environmental Impacts

Environmental impacts considered during the pipe alignment evaluation will include wetland impacts, stream crossings, AEC impacts, woodland clearing, and rare species habitat impacts. Despite the significant length of pipeline being installed, a limited amount of environmental impacts are anticipated since a majority of construction is expected to occur within road rights-of-way.

Preliminary route analyses have identified five potential locations where a stream crossing may be required. In these cases the pipeline will be installed using trenchless techniques (e.g. horizontal direction drill, micro-tunneling, or jack-and-bore methods).

The amount and location of anticipated environmental impacts will be determined during final design.

6.3.7 Access

In general, adequate construction and maintenance access is anticipated for pipeline installed within road rights-of-way. For locations where a road right-of-way does not exist or is insufficient in width, adequate right-of-way will be acquired so that the route and pipeline can be maintained.

6.3.8 Utility Conflicts

Utility conflicts are anticipated due to the recommended construction within road rights-of-way. The conflicts will be avoided to the greatest extent practicable, particularly for large utilities that are not easily moved such as power transmission poles. However, all utility conflicts cannot be avoided and will have to be addressed during design and the contractor will have to handle each conflict as the pipe is installed.

6.4 Preliminary Engineering and Design

After the transmission and distribution route and alignment has been determined, a preliminary design will be performed to determine the appropriate type of pipe and associated appurtenances as well as specific constructability issues.

The pipeline design will adhere to Dare County's *Standard Specification for Water System Construction* (1999), or other applicable standards and engineering practices.

6.4.1 Pipe Material

A variety of pipe materials are suitable for transmission and distribution mains of this type and size. Typically, projects of this type feature ductile iron pipe (DIP) and/or PVC pipe. Each type of pipe has unique requirements for field assembly, trenching, joint assembly, and installation. The ultimate construction cost for each of these unique pipe systems is dependent on the features selected by the designer, the availability of pipe in the local area, and the cost of construction in the local area.

The existing County-owned water system infrastructure in the Roanoke Island service area consists primarily of 2- to 12-inch diameter PVC pipe, though asbestos cement and ductile iron materials are also used in some areas. The County has indicated their preference for continued installation of PVC pipe for this project due to past successes with PVC and familiarity. However, the County has indicated that DIP shall be installed for the single transmission main from the Skyco WTP to Wanchese due to the additional strength and durability of DIP versus PVC. PVC pipe will conform with AWWA C-900 for sizes 6 inch through 12 inch, and AWWA C-905 for 16 inch. All pipe shall be PVC C-900 – DR18 (pressure rating 150 psi), PVC SDR 21 or ductile iron pressure class 350 with slip joint gaskets.

6.4.2 Trench Requirements

Trenching requirements will vary depending on the location where the pipe will be installed. Trenches will be open-cut using suitable equipment. Trench boxes or shoring will be used to stabilize the pipe trench during construction where necessary. The construction contractor will open only as much trench as length of pipe that can be placed during a work shift and the location of the trench.

The depth of cover for the project will vary based on the need to avoid conflicts with other utilities. Pipe will be buried to provide a minimum of 36 inches of cover over the top of the pipe, unless otherwise determined during final design and approved by the Dare County Water Department.

6.4.2.1 Pipe Installed Outside of Road Pavement

It is anticipated that a majority of the proposed pipe will be installed within existing NCDOT-owned road rights-of-way, as well as some privately-owned road rights-of-way; there are currently no Town of Manteo- or Dare County-owned roads. CDM and the County met with local NCDOT staff on August 25, 2009 to present the anticipated distribution system improvements and discuss construction requirements for installation of pipe within NCDOT right-of-way. In general, installation of pipe within the existing NCDOT rights-of-way will be permitted so long as it is in accordance with their construction policies.

The right-of-way widths are currently being identified for all affected roads. There may be some cases where construction extends outside the right-of-way, which would result in the need for a temporary or permanent construction easement.

6.4.2.2 Pipe Installed Cross-Country

Preliminary route analyses have identified some developed areas that are landlocked (i.e. they are not contiguous to any public road access). For these locations cross-country access may be required. This type of installation will have minimal impact on traffic and utilities, but will impact property owners and require acquisition of the full utility right-of-way. For these areas, a minimum 10-foot permanent easement width and 20-foot temporary easement width will be acquired by the County.

6.4.2.3 Pipe Installed Within Road Pavement

The preliminary design does not currently consider installation of pipes within road pavement. Though impacts to property owners and utilities are reduced, traffic impacts are significantly increased if new pipes are constructed under existing road pavement. Also, access to the pipe after construction for maintenance is considerably more difficult. However, if there are locations where pipe is to be installed within road pavement, the construction will generally require that one lane of traffic be closed as construction of the pipeline is advanced. Traffic control will be implemented as required by NCDOT and other applicable local agencies.

6.4.3 Trenchless Installations

Trenchless installation of transmission, distribution, and service pipes will be utilized at some NCDOT road crossings and all stream/wetland crossings recognized as AECs. These locations will be confirmed during final design.

6.4.4 Thrust Restraints

Where PVC Megalugs and joint harnesses are not used, thrust blocking will be required at all bends, fittings, etc. that induce pressure which would cause separation of pipe or breakage. Thrust restraints will be formed from 3,000 psi concrete and positioned such that the pressure exerted at the point of blocking will be transferred to firm, undisturbed earth at a maximum load of 2,000 pounds per square foot.

6.4.5 Corrosion Protection

It is not anticipated that corrosion protection will be required for the PVC pipeline being used for this project. The primary corrosion protection for DIP is anticipated to be a high-density, cross-laminated polyethylene encasement, commonly referred to as polywrap and is governed by AWWA standard C105.

6.4.6 Right-of-Way Requirements

All proposed transmission and distribution piping will be located within an existing right-of-way (NCDOT or Town of Manteo) or will require acquisition of a permanent easement. A minimum 10-foot permanent easement width and 20-foot temporary easement width will be acquired by the County if necessary.

Construction methods for installation of proposed pipeline within existing rights-of-way will adhere to the requirements set forth by the right-of-way holder.

6.4.7 Isolation Valves

Isolation valves will be provided so that sections of the pipeline can be taken out of service for inspection, cleaning, or repair. The isolation valves will be placed in easily accessible locations. Easy access to the valves will allow rapid isolation of pipeline segments for repairs during operation. Disposal of water from the transmission main is also a factor in isolation valve selection. Once a section of pipe is isolated for inspection or other purposes, the water in the pipe will be drained via blow-off locations at system low points. Isolation valves will be located in conjunction with placement of blow-off valves for drainage.

Dare County requires gate valves for water service in pipelines 16 inches in diameter or smaller. Gate valves will conform with AWWA C-509 and be of iron body, bronze mounted, resilient seat type. Buried valves will have a 2-inch square operating nut. 16-inch valves will have a bypass to equalize pressure on both sides of the valve to facilitate opening. Gate valve connections will be bolted mechanical joints. All buried valves will be provided with a cast iron or ductile iron valve box set to grade.

6.4.8 Air Release and Vacuum Relief Valves

Air release and combination air release/vacuum relief valves will be incorporated at specific locations on the transmission mains such as high points in the system, long horizontal reaches, vertical ascending reaches, and vertical descending reaches. Due to the flat topography on Roanoke Island, air release/vacuum relief valves will not generally be required for distribution lines. However, the vertical alignment of the distribution lines will be evaluated and air release/vacuum relief included if appropriate.

6.4.9 Blow-Offs

Blow-offs will be installed at low points in the system in order to remove water from a pipeline following isolation of a pipe section. A 2-inch drain line is connected to the pipeline by a tee connection below the springline of the pipe. Dual gate valves are used with the redundant valve left in the open position. A house connection in a precast valve vault is used to extract water from the isolated section of pipeline.

Where possible, blow-offs will be located such that water drained from the transmission mains can be discharged into a nearby sewer system. If no sewer system is nearby, the water will be discharged into the storm drain system.

6.4.10 System Connections

The transmission mains from the Skyco WTP will provide connections at several locations to existing and future distribution mains.

The smallest distribution main will be 2 inches in diameter. This main will be tapped to provide service connections to new residential customers. A minimum 3/4-inch corporation stop will be installed at a tapping saddle, from which polyethylene pipe will extend to a minimum 3/4-inch curb stop within a meter box. The Dare County Water Department will provide a meter and check valve at each service connection.

6.4.11 Utility Conflicts/Relocations

Many of the pipeline routes have potential conflicts with existing utilities. The final design will address these conflicts, and the contractor will have to handle each conflict during installation. Preliminary routes have been evaluated to minimize conflicts between utilities, particularly large utilities that are not easily moved.

In general, utility conflicts are greatest along roads. Preliminary information is being obtained for existing overhead and underground power lines, water mains and sewers, cable conduits, and telephone and fiber optic lines. Particular attention was given to utilities that cannot easily be moved such as large water mains and sewers and electric transmission lines and towers. The depth of the transmission and distribution piping will be adjusted as necessary during final design to avoid conflicts with utilities.

Section 7
Permitting Requirements

This section provides an assessment of the anticipated regulatory requirements and issues associated with construction of the Dare County – Roanoke Island Water System Expansion Project.

7.1 Existing Environmental Conditions

The transmission and distribution pipelines will be installed along existing road rights-of-way throughout Roanoke Island. The pipelines will be installed approximately three feet below the ground surface and disturbed areas will be restored back to their pre-construction condition to the greatest extent practicable. A minimal number of long-term impacts are anticipated for this project.

Using aerial photography, field survey, and extensive site visits, AECs were delineated on base maps and verified in meetings and telephone conversations with the NCDCM. The delineations were used to identify preliminary pipe routes and alignments and locations for ground and elevated storage tanks that will result in the least environmental impact practicable.

Based on the location of AECs and preliminary pipe routes and alignments, there are six potential locations where a stream may be crossed and no locations where a wetland may be crossed. All stream, and wetland if necessary, crossings will be accomplished using trenchless methods so as to avoid impacts to the stream.

The new 2.0-MG ground storage tank at the Skyco WTP will be constructed adjacent to the existing ground storage tank, outside of any known stream and wetland impacts. The 300,000 gallon elevated storage tank will be constructed on an unused portion of the closed Bowsertown Landfill, at the intersection of Bowsertown Road and California Lane, outside of any known stream and wetland impacts. Due to the height of the proposed elevated storage tank and proximity to the Dare County Regional Airport, a Determination of No Hazard to Air Navigation permit is required. The permit was obtained on August 25, 2009 and expires on February 25, 2011, included in Appendix E.

This project does not require an environmental assessment, per Article 1, Chapter 113A-12 of the North Carolina Environmental Policy Act as well as meetings and discussions with representatives of the NCDENR, see Appendix E for an email correspondence with an NCDENR representative regarding the potential exemption for an EA. The pipelines to be installed for this project will be in the road right-of-way, and stream crossings will be by trenchless methodologies. Additionally, the project will not use federal funding.

7.2 Permit Requirements

A number of permits and approvals will be needed from federal, state, county, and local authorities for the water system improvements. **Table 7-1** presents a list of the anticipated permit and approval requirements, the agency or authority responsible for issuing each approval, and the activity that triggers the need for each approval. This list of anticipated regulatory requirements was developed through meetings and telephone conversations with various regulatory agencies, review of applicable guidelines and regulations, and field visits along the proposed water main routes and storage tanks.

7.3 Permitting Schedule

The project will be divided into individual packages for bidding and construction in order to target qualified contractors, preferably local, specializing in the various components (e.g., ground storage tanks, elevated storage tanks, pump station improvements, pipeline construction, etc.). The distribution will be determined during final design, in consultation with the County and the Construction Manager at Risk. The permitting schedule will be adapted to the final arrangement of the construction packages.

Table 7-1
Anticipated Regulatory Requirements

	Permit/Approval	Responsible Authority	Activity Requiring Permit/Additional Information
FEDERAL	Department of the Army Section 404 Dredge and Fill Permit	US Army Corps of Engineers	Required for discharge of dredged or fill material into waters of the US (including wetlands) e.g., backfill and bedding associated with pipeline construction
	Determination of Hazard to Air Navigation	Federal Aviation Administration (FAA)	Permit has been approved and is valid through 2/25/2001, see Appendix E
STATE	Compliance with Coastal Area Management Act (CAMA)	North Carolina Division of Coastal Management	Required because portions of the project will occur within CAMA regulated areas of environmental concern
	Section 401 Water Quality Certification	DENR DWQ	Triggered by need for other federal/state permits for activities in waters of the US (ACOE). Notification to DWQ not required if project complies with conditions of Nationwide 12.
	Erosion and Sedimentation Control Plan Approval	DENR Div. of Land Resources, Land Quality Section	Required if more than 1 acre of land disturbed (requires state approval if project proponent is municipal authority)
	National Pollutant Discharge Elimination System Permit	DENR Div. of Land Resources, Land Quality Section	Required for a stormwater discharge during construction on a greater than 5-acre site
	Approval of Engineering Plans and Specifications for Water Supply Systems	DENR Division of Environmental Health	Required for extension or alteration of a municipal water distribution system
	Encroachment Agreements/Street Opening Permits	NCDOT Div. of Highways	Required for construction of a pipeline across state roadway rights-of-way
	Section 106 Historic Preservation Review	Dept. of Cultural Resources, Div. of Archives & History	Project review to identify potential impacts to any significant archaeological/historical resources
	Natural Heritage Program (NHP) Review	DENR Division of Parks and Recreation - NHP	Project review to identify potential impacts to rare species habitats or other significant natural resources
OTHER	Approval for Construction under Creeks/Channels	Dare County Engineering Department	Required for construction under creeks/channels
	County/Local Encroachment and Utility Agreements	Dare County Engineering Department; Utility Companies	Required for construction of pipelines in/across county roads or utility rights-of-way
	Right-of-Way Easements/ Property Acquisition	Property Owners	Required for construction on non-county owned land

Abbreviations:
ACOE – Army Corps of Engineers
SEPA – State Environmental Policy Act
EA – Environmental Assessment
DWQ – Division of Water Quality
DOT – Department of Transportation
DENR – Dept. of Environment & Natural Resources

Section 8
Preliminary Construction Cost Estimate

8.1 Preliminary Construction Cost Estimate

A preliminary construction cost estimate of approximately $20,230,000 has been developed for the improvements presented in this PER, an itemized breakdown is presented in **Table 8-1**. This estimate reflects the preliminary design presented in this report and relies on the use of previous estimates and historical data from comparable work, estimating guides, handbooks, and costing curves. Bid tabulations provided by Dare County, budget costs from equipment suppliers, and recent bid tabulations from similar projects were also considered. The accuracy of this construction cost estimate will increase as the project moves into detailed design and, eventually, to project bidding and construction.

Table 8-1
Preliminary Construction Cost Estimate

Description	Unit	Quantity	Cost Estimate ($)
Skyco WTP Pump & Electric	Ls	1	$620,180
0.3 MG Elevated Storage Tank	Ea	1	$1,906,520
2.0 MG Ground Storage Tank	Ea	1	$2,382,560
Open Cut 6" PVC	Lf	196,360	$4,673,440
Open Cut 8" PVC	Lf	37,520	$1,088,290
Open Cut 12" PVC	Lf	33,340	$1,624,140
Open Cut 12" DIP	LF	4,620	$413,370
Open Cut 16" PVC	Lf	7,680	$526,480
Open Cut 18" DIP	LF	250	$36,220
3/4"Service Connections	Ea	2,758	$1,242,350
Pavement Replacement	Sy	15,150	$494,910
HDD 6" HDPE	Lf	8,340	$757,100
HDD 8" HDPE	Lf	3,180	$366,220
HDD 12" HDPE	Lf	1,420	$244,150
HDD 16" HDPE	Lf	720	$288,810
Fire Hydrant Assembly	Ea	122	$527,750
Valves, Fittings, & Appurtenances	Ls	1	$870,920
New Town of Manteo Meter	Ls	1	$40,280
Transfer 3 Service Connections[1]	Ls	1	$46,600
Subtotal			**$18,150,270**
15% Construction Contingency[2]			**$2,079,640**
Total			**$20,230,000**

Note:

1. *Assume 3 services will be transferred from the existing 12" transmission main to the new 16" transmission main between the Skyco WTP and Town of Manteo, along US-64/264.*
2. *The construction contingency is applied to the labor, material, subcontract, equipment, and other miscellaneous items. The subtotal shown above also includes escalation to mid-point of construction, construction management, bonds, and insurance.*

The following assumptions were used to develop the cost estimate for the recommended improvements:

- Other costs such as engineering design, legal, financial, engineering construction administration, and easements are not included in Table 8-1.
- Easements will be acquired by the County.
- Piping will be installed within existing easements and rights-of-way to the extent feasible.
- All road and stream pipeline crossings will utilize trenchless methods.
- Pipe will be buried with three feet of cover.
- The 12-inch diameter transmission piping from the Skyco WTP to Wanchese will be DIP.
- The yard piping at the Skyco WTP will be DIP.
- DIP 12-inches in diameter or less will be pressure class 350. DIP greater than 12-inches in diameter will be pressure class 300
- PVC 6- and 8-inches in diameter will be C900. PVC 12- to 16-inches in diameter will be C905.
- The 300,000 gallon Bowsertown elevated storage tank will be pedesphere style with pile foundation.
- The proposed Skyco WTP ground storage tank is assumed to be 2.0 MG prestressed concrete tank with pile foundation.
- Pumps No. 1 and No. 2 at the HSPS will be replaced "in-kind" and with new variable frequency drives.
- Pumps No. 3 and No. 4 at the HSPS will be removed and new electrical equipment placed in the area.
- Pumps No. 5 and No. 6 at the HSPS will be replaced with higher capacity pumps (125HP) designed to meet the future water demands of Roanoke Island and new variable frequency drives.
- Electrical and I&C improvements at the HSPS will be required.
- HVAC improvements will be performed by others and are not included in this estimate.
- Costs presented are in 2009 dollars with an Engineer News Record (ENR) Construction Cost Index of 8585.71 (September 2009).

Since the 2006 Water System Study the following improvements have been identified and incorporated into the project:

- The addition of high service pump station improvements, including new pumps, VFDs, electrical improvements, instrumentation and control improvements, piping improvements, etc.
- The addition of a new 2.0-MG ground storage tank at the Skyco WTP.
- State permitting and NCDOT are requiring trenchless construction at stream crossing and road crossings, respectively.
- The addition of approximately 30,450 feet of distribution pipeline, a 12 percent increase from the 2006 estimate.
- The addition of electrical improvements to the pump room at the Skyco WTP.
- The material change from PVC to DIP for the transmission main from the Skyco WTP to Wanchese and the yard piping at the Skyco WTP.

Section 9
Implementation Schedule

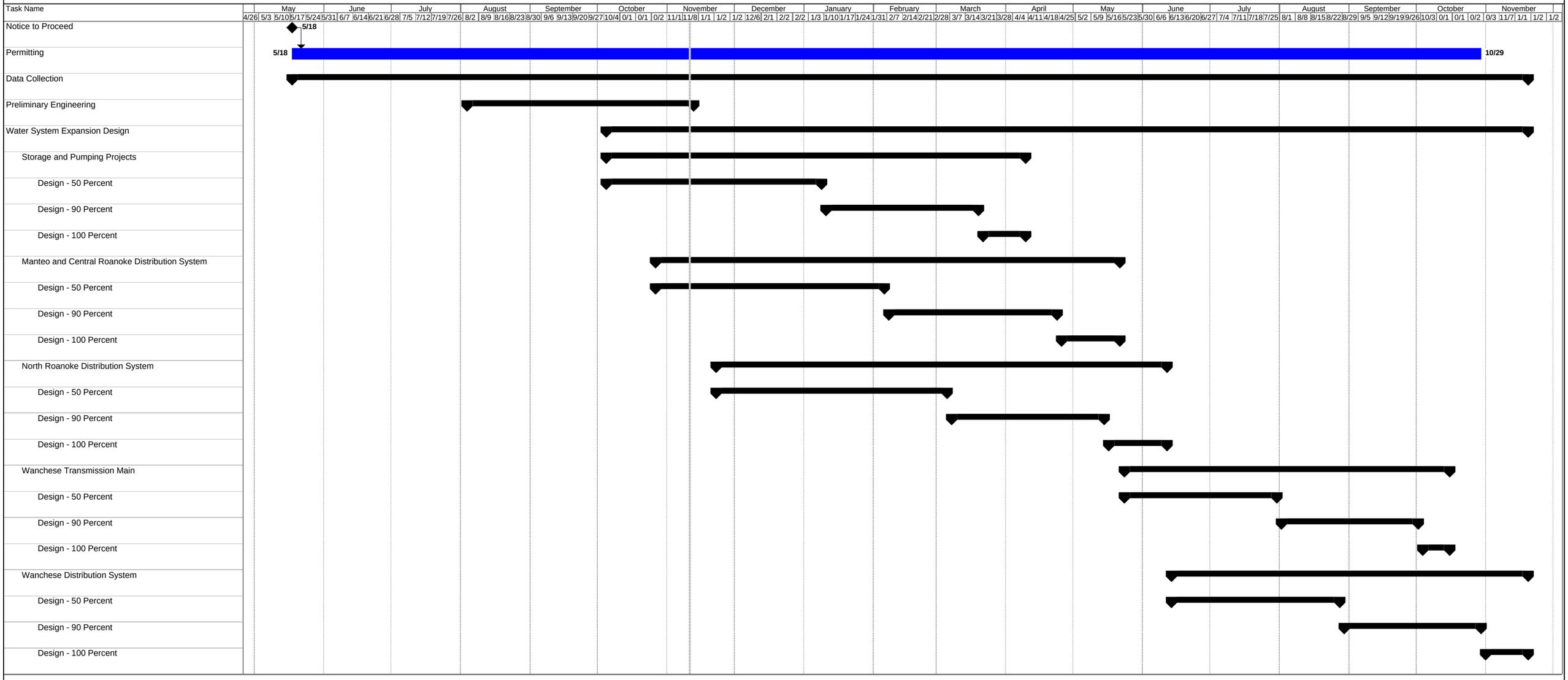
Figure 9-1 presents the proposed design schedule for the project. The schedule shows the following five individual design packages:

- Design Package #1: HSPS improvements, ground storage tank, and elevated storage tank design
- Design Package #2: Transmission and distribution piping in central Roanoke Island
- Design Package #3: Transmission and distribution piping in the northern part of Roanoke Island
- Design Package #4: Transmission main from the Skyco WTP to Wanchese
- Design Package #5: Transmission and distribution piping in Wanchese

Construction will also be completed in various packages, with the first construction package anticipated to begin after Design Package #1 has been finalized, in the first quarter of 2010.

Concurrent with final design, permit applications for the relevant construction packages will be prepared and submitted. These permits are presented in Section 7. All necessary permit approvals are expected to be received prior to the proposed bid advertisement date.

DARE COUNTY
ROANOKE ISLAND WATER SYSTEM EXPANSION PROJECT
DESIGN SCHEDULE - NOVEMBER 11, 2009



Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress
Split
External Tasks
Project Summary
Group By Summary
Deadline

Notes:
1. Schedule Assumes No EA or EIS is Required for the Project
2. Schedule is independent of easement acquisition