The Dare County Water Department
600 Mustian Street
Kill Devil Hills, North Carolina

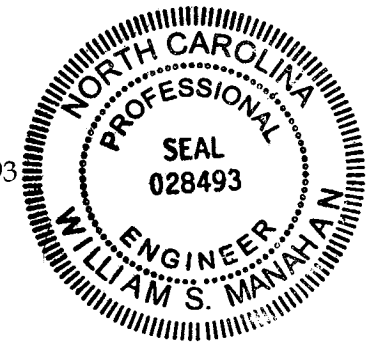
Report on the Construction and Testing of Mid-Yorktown Aquifer Test Wells at Potential Future Production Well Sites 11 Through 16 in Nags Head, North Carolina

May 2003

Report

CERTIFICATION

I hereby certify that this test well completion report prepared for Dare County, North Carolina, was prepared by me or under my direct supervision.



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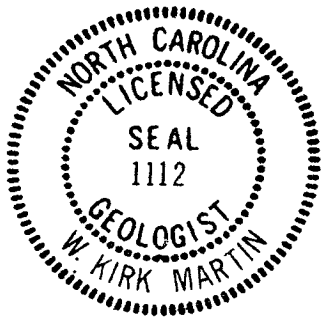
Date: 5/23/03



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Executive Summary

The supply capacity of the Dare County water system must be expanded to meet increased potable water demands associated with population growth in the County. Expansion of the Dare County North Reverse Osmosis (RO) plant and raw water supply wellfield was recommended in the countywide hydrogeological study and groundwater resource evaluation that was conducted in 1998. The North RO plant is presently supplied by 10 wells tapping the Mid-Yorktown aquifer. Expansion of the RO plant will begin upon receipt of a construction permit from the state and the wellfield expansion is currently in the design phase. The Dare County Water Department authorized this investigation to install test wells tapping the Mid-Yorktown aquifer at locations proposed for additional production well construction. The purpose of the test well construction project was to confirm that the yield potential and water quality within the aquifer were adequate for the installation of permanent raw water supply wells at the test sites. The investigation included test well construction, aquifer testing, water quality sampling, and data analysis.

The results of the investigation were somewhat surprising in that the Mid-Yorktown aquifer showed very little yield potential at two of the test sites. Clay was the predominant lithology encountered between the depths of approximately 300 to 400 feet at these two sites, which is the depth interval where the sand aquifer typically occurs. The information obtained during the investigation has influenced decision making regarding the design of the planned raw water wellfield expansion. The installation of permanent supply wells at the distal end of the wellfield alignment first, with additional production wells installed along the raw water transmission main for subsequent RO plant expansions is now proposed. Construction costs will be higher initially due to the increased transmission piping length. However, an overall cost savings will be realized by installing the entire pipeline in one project and there will be less disruption to traffic and residents in the area by completing the work all at once. The proposed wellfield expansion is also beneficial to the resource in that it spreads the raw water withdrawals, and therefore drawdown, over a larger area. This reduces the potential for adverse water quality changes to occur due to pumpage.

The geologic conditions determined as a result of this study were unexpected and have influenced the design of the planned raw water wellfield expansion. However, the investigation results confirm that adequate groundwater resources exist to supply the currently planned RO plant expansions. The information obtained may also provide insight into other water resource development and management options including potential use of the Upper Yorktown aquifer as a raw water supply source or storage zone for a potable water aquifer storage and recovery (ASR) system.

Section 1
Conclusions and Recommendations

Six test wells were constructed at proposed future well sites 11 through 16 in Nags Head, North Carolina to evaluate the feasibility of constructing permanent production wells at the sites to supply additional raw water to the Dare County North Reverse Osmosis (RO) water plant in Kill Devil Hills, North Carolina. A single test well was constructed previously during August 2002 at proposed future well site 17. In addition, test wells were constructed previously at the Orville and Wilbur well sites located north of the RO plant. The conclusions and recommendations presented below are based on the results of the test well construction projects.

1.1 Conclusions

- Six, 4-inch diameter test wells (11s, 12, 13, 14, 15, 16) were installed for this investigation at prospective future production well sites in Nags Head, North Carolina. All of the wells, with the exception of 11s, were completed within the Mid-Yorktown aquifer with screened intervals between approximately 270 and 430 feet below land surface (bls). Test well 11s was completed within the Upper-Yorktown aquifer with a screened interval between 140 and 190 feet bls.

- A facies change in the lithologic sequence beneath Nags Head is present in the vicinity of well sites 11 and 12. Clay is the predominant lithology between the approximate depths of 300 and 450 feet below land surface at these sites. The Mid-Yorktown aquifer, which consists primarily of fine to medium grain sand, typically occurs within this depth interval in the Kill Devil Hills/Nags Head area. The clay facies may be a relict channel feature that has been infilled with fine grain sediment.

- The yield potential of the Mid-Yorktown aquifer is moderate at well sites 13 through 16 based on the results of step-drawdown and constant rate pumping tests conducted on the test wells. Transmissivity values range from approximately 20,000 gpd/ft to 50,000 gpd/ft with a trend of increasing transmissivity from north to south. A transmissivity value of 65,000 gpd/ft was previously determined for the aquifer at well site 17. The Mid-Yorktown aquifer exhibited very low yield potential at well sites 11 and 12. The construction of permanent raw water supply wells tapping the Mid-Yorktown aquifer at well sites 11 and 12 does not appear to be feasible.

- Water quality in the Mid-Yorktown aquifer is brackish with respect to salinity but relatively good for reverse osmosis treatment based on analyses of water samples obtained from the test wells constructed at sites 13 through 17. Dissolved chloride concentrations of the collected water samples ranged from 1000 mg/l to 1400 mg/l and total dissolved solids levels ranged from 2000 mg/l to 3000 mg/l. Arsenic levels were below the detection limit of 0.01 mg/l in all of the test well water samples. The production wells that currently supply the RO plant have dissolved

chloride concentrations that range from approximately 2400 mg/l to 2800 mg/l and arsenic concentrations that vary but may exceed 0.05 mg/l.

- The Upper-Yorktown (Principal) aquifer may serve as a viable raw water source for the RO plant in the distant future. This unit may also be useful as a storage zone for a potable water ASR system. The transmissivity of the aquifer is estimated to be approximately 10,000 gpd/ft at well site 11 based on the limited testing conducted. The dissolved chloride concentration of a water sample obtained from the Upper-Yorktown aquifer test well 11s was approximately 3800 mg/l.

- Sufficient groundwater resources exist in the vicinity of the RO plant to allow expansion of the plant's finished water capacity by at least 2.0 MGD based on the results of this and previous investigations. The installation of new production wells will be necessary to increase the raw water supply to the RO plant.

1.2 Recommendations

- Production wells should be constructed at proposed well sites 16 and 17 in addition to the wells planned for construction at the Orville and Wilbur well sites located north of the RO plant. The four new wells would provide additional raw water supply to the RO plant and allow expansion of the plant finished water capacity by up to 2.0 MGD.

- The proposed production wells should be constructed with 12-diameter PVC casing to a depth of approximately 300 feet below land surface. The wells should be screened with 8-inch diameter stainless steel continuous wrap screen from the casing bottom to the final screen depth. A coarse sand filter pack should be placed around the screen. A hydrogeologist should supervise construction of the wells and select final cased and total depths based on geophysical logging results and lithologic analysis of formation samples obtained during drilling. A biodegradable type drilling fluid should be used to drill through the production zone interval. The wells should be thoroughly developed by compressed air pumping and horizontal jetting of the screen after drilling is complete.

- Step-drawdown tests should be conducted on the new production wells. Specific capacity values calculated based on the test results can be used to assess well yields and confirm the proposed pump setting depths and withdrawal rates. The new wells should be disinfected following development and pump testing.

- Submersible well pumps similar to those used on the existing production wells (wells 1 through 10) near the RO plant should be installed in the new production wells. Larger horsepower motors will likely need to be utilized in the new wells. Motor selection for individual wells will be conducted during the final design of the wellfield expansion project. Piping from the wells would be placed adjacent to Highway 158 and connected to the existing PVC raw water transmission main at well 10 going to the RO plant. The new transmission main should be equipped

with "tee" fittings near each of the other test well sites (13 through 15) to facilitate the connection of additional wells for future wellfield expansions.

- All of the recently completed test wells should be included in the on-going water level and water quality monitoring program conducted by the County. Water quality and water levels should also be monitored in the proposed new production wells. The data collected will enable an evaluation of the performance of the new wells and help to identify potential problems.

- Additional test well construction and aquifer testing at wells sites 11 and 12 is recommended to further evaluate the feasibility of using the Upper Yorktown aquifer as a raw water supply source or potential storage zone for a potable water aquifer storage and recovery (ASR) system.

- The computer models used previously to estimate drawdown impacts and water quality changes due to pumpage from the wellfield should be revised to include the new hydrogeologic data collected during this investigation and proposed alternative wellfield expansion scenarios.

Section 2
Introduction

The Dare County Water Department operates a reverse osmosis plant (North RO plant) in Kill Devil Hills, North Carolina that produces potable water for public supply purposes. Brackish water supplied by 10 Mid-Yorktown aquifer production wells is the raw water source for the RO plant. Currently, the RO plant has a finished water production capacity of approximately 3.0 million gallons per day (MGD). The average pumping rate for the existing supply wells ranges between 400 and 500 gallons per minute (gpm). Expansion of the RO plant finished water capacity by 2.0 MGD is planned to meet the increasing demand for potable water. The contract to add two additional 1.0 MGD RO skids has been awarded. However, a construction permit from the state is pending and must be issued before work can begin.

CDM Missimer was authorized by the Dare County Water Department in November 2002 to construct six test wells (11 through 16) south of the North RO plant in Nags Head, North Carolina on properties that are being considered for use as permanent production well sites. The RO plant and existing and proposed production well locations are shown on **Figure 1**. Prior to beginning the installation of test wells 11 through 16, test well 17 was installed in August 2002. The *Report on the Construction and Testing of a Mid-Yorktown Aquifer Test Well at Future Production Well Site 17 (North RO Plant)* was submitted to the Dare County Water Department in September 2002.

The purpose of this project was to evaluate aquifer yield and water quality conditions within the Mid-Yorktown aquifer to determine the feasibility of installing permanent production wells at the subject properties. The scope of the project included well construction, aquifer testing, water quality testing, data analysis, and preparation of this summary report. The methods and procedures used during the investigation and the results obtained are presented herein. A map of the new test well sites is provided as **Figure 2**. Detailed maps of the new test well sites are provided in **Appendix A**.

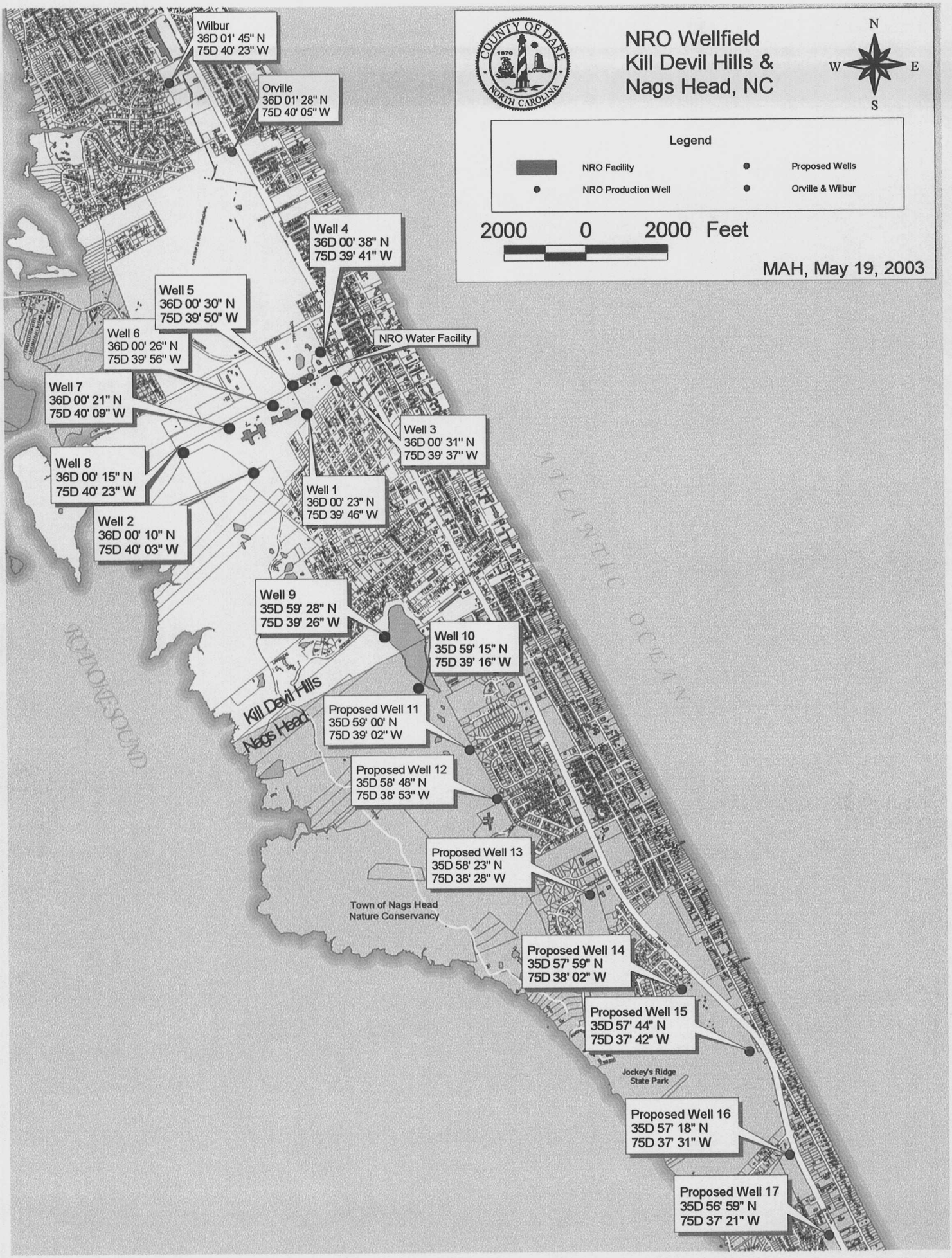
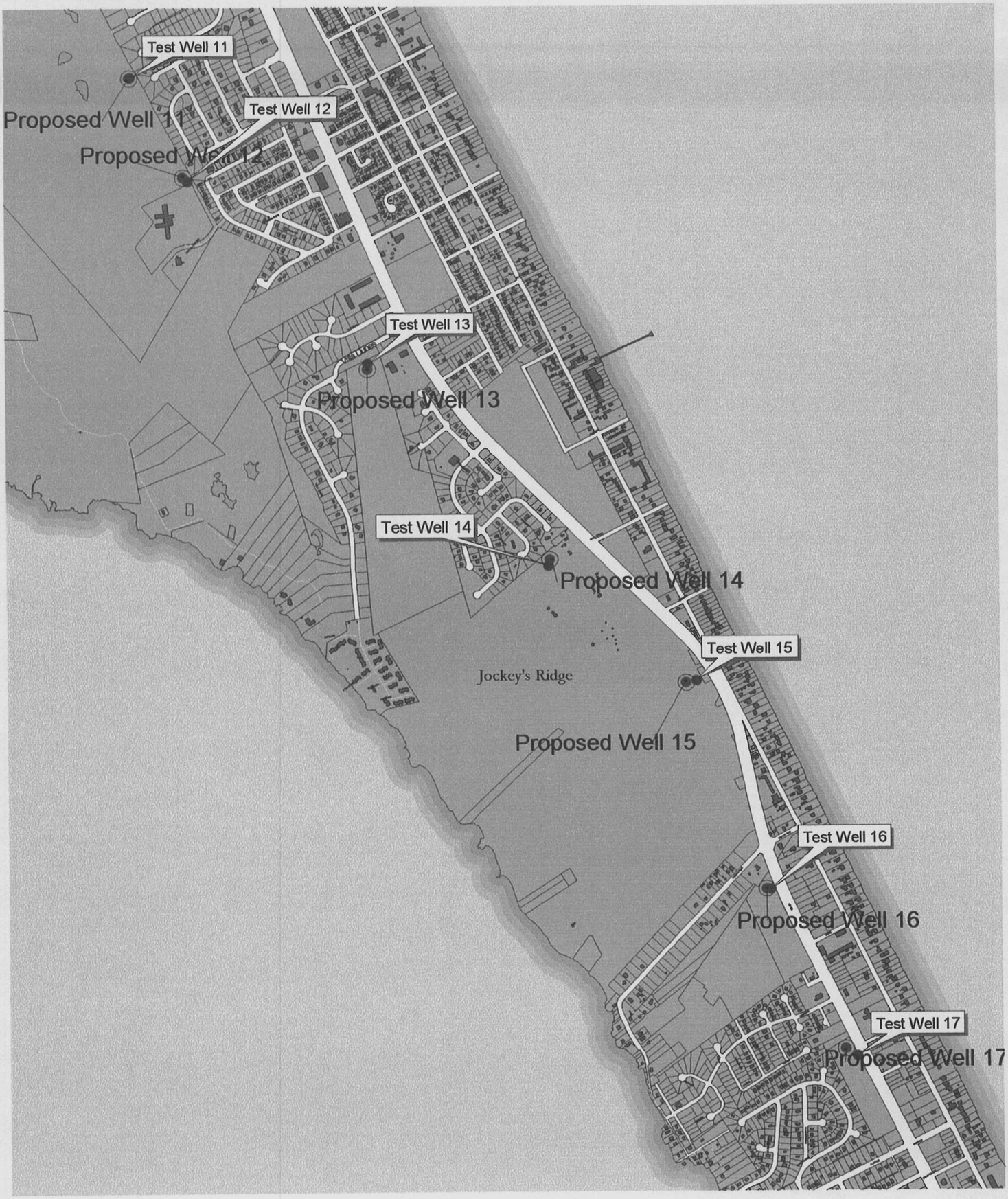


Figure 1. Site Map Showing Existing and Proposed Well Locations.



COUNTY OF DARE 1870 NORTH CAROLINA

DARE COUNTY WATER
GIS
MATTHEW HIBLER
MAY 19, 2003

TEST WELLS
NAGS HEAD, NC
500 0 500 1000 Feet

N
W E
S

LEGEND
- Test Wells
- Proposed Well

Figure 2. Site Map Showing New Test Well Locations.

Section 3
Field Investigation Methods

3.1 Test Well Construction

All of the new test wells (11 through 16) were installed south of the RO plant, at spacings of approximately 2000 feet or more, starting south of existing production well 10 (Figure 1). Skipper's Well Drilling from Leland, North Carolina was subcontracted to construct the wells, conduct geophysical logging, and perform step-drawdown and 24-hour constant rate pump tests on each newly installed well. CDM Missimer staff provided on-site supervision during drilling, review of the geophysical logs, determined cased and total depths for the wells, collected formation samples for lithologic analysis, and obtained water samples for analysis.

The drilling methods used were similar for each of the wells and are described below. Each boring was advanced with a nominal 9-inch diameter bit using the mud-rotary method. Electric and natural gamma ray geophysical logs were conducted on each of the bentonite mud filled boreholes after the drill pipe had been removed. Drilling and well construction activities at each new test well site are discussed below. Copies of the geologist's logs and geophysical logs for each of the test wells are provided in **Appendix B** and **Appendix C**, respectively.

Test Well #11

Drilling began at the test well 11 site on December 4, 2002. Because anticipated productive zones were not encountered from 300 to 400 ft bls, the boring was advanced to a depth of 475 feet bls. Based on the apparent lack of productive formation material determined by review of the geologist's and geophysical logs, it was decided to abandon the borehole. The borehole was filled with neat cement grout from the bottom to land surface.

During drilling at site 11, a medium to coarse sand unit was encountered from approximately 140 to 190 feet bls. This sand unit was verified by review of the geophysical logs. It was decided to install a shallow well, with a screen interval targeting the medium to coarse sand zone, adjacent to the abandoned test hole at the well 11 site. On January 20, 2003, test well 11s was installed. A well string consisting of 50 feet of 4-inch diameter, 0.025-inch slotted Schedule 40 PVC pipe was placed in the borehole from 140 to 190 bls followed by 140 feet of 4-inch diameter Schedule 40 PVC casing to land surface. A coarse sand filter pack (Morie #2) was placed around the screen and the well was then developed with compressed air. The well was developed for approximately 4 hours and subsequently grouted with neat Portland cement from the top of the gravel pack to land surface. Construction details for the well are shown on **Figure 3** and provided in **Table 3-1**.

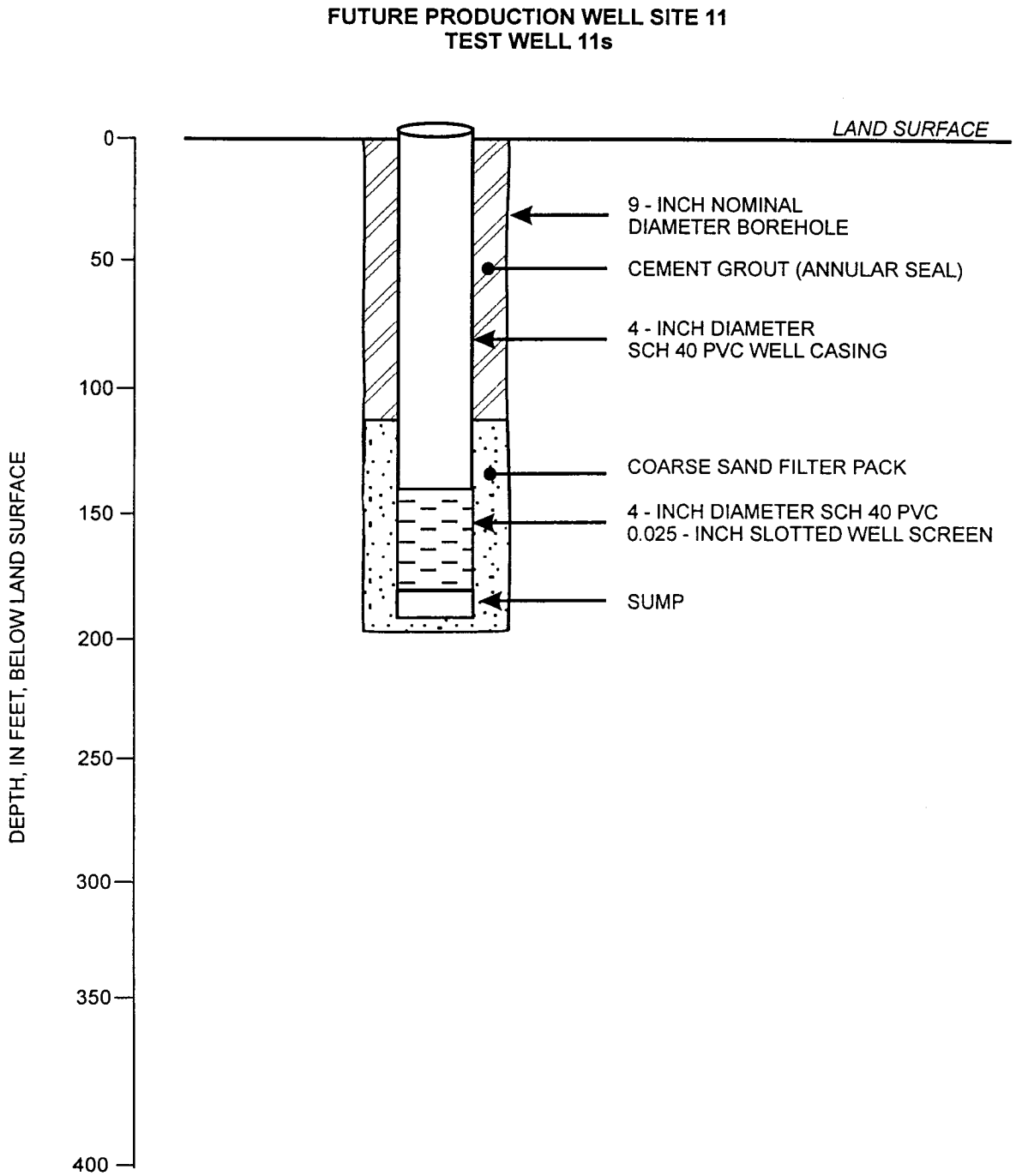


Figure 3
Dare County Test Wells
Schematic Diagram Showing Construction Details of Test Well 11s.

Table 3-1. Well Construction Details Dare County Test Wells (11s through 16)

Well ID	Total Borehole Depth (Feet bls)	Total Well Depth (Feet bls)	Cased Depth (Feet bls)	Top of Gravel Pack (Feet bls)	Specific Capacity* (gpm/ft)	Aquifer Unit	Approximate Well Location (Lat./Long.)
TW-11s	195	190	140	130	2.2	Upper Yorktown	N 35° 59' 00" W 75° 39' 02"
TW-12	475	430	330	280	**	Mid Yorktown	N 35° 58' 48" W 75° 38' 53"
TW-13	400	350	280	240	3.6	Mid Yorktown	N 35° 58' 23" W 75° 38' 28"
TW-14	400	380	280	250	3.6	Mid Yorktown	N 35° 57' 59" W 75° 38' 02"
TW-15	400	380	270	250	4.2	Mid Yorktown	N 35° 57' 44" W 75° 37' 42"
TW-16	400	390	290	265	4.7	Mid Yorktown	N 35° 57' 18" W 75° 37' 31"

Notes:
bls – below land surface
All wells constructed of 4-inch diameter PVC with 0.025-inch slotted screen.
*Specific capacity values calculated at pumping rates of 95-100 gpm.
**Due to insufficient yield during development, no pump tests were performed on well TW-12.

Test Well #12

Drilling began at test well site 12 on December 11, 2002. Because anticipated productive zones were not encountered from 300 to 400 feet bls, the boring was advanced to a depth of 475 feet bls. Based on review of the geologist's and geophysical logs, it was decided to install a test well screened from 330 to 430 feet bls, although the formation did not appear to be favorable for yielding high volumes of water.

A well string consisting of 100 feet of 4-inch diameter, 0.025-inch slotted Schedule 80 PVC pipe was placed in the borehole followed by 80 feet of 4-inch diameter Schedule 80 PVC casing and 250 feet of 4-inch diameter Schedule 40 PVC casing to land surface. A coarse sand filter pack was placed around the screen and the well was then developed with compressed air. The well was initially developed on December 13, 2002, using compressed air for 6 hours. The annulus was subsequently grouted with neat Portland cement from the top of the gravel pack to land surface. Production during initial development was minimal. The driller returned on December 16, 2002, to further develop the well, but reported no increase in production. Well construction details are provided on Table 3-1. A diagram showing typical well construction for wells 12 through 16, is shown on **Figure 4**.

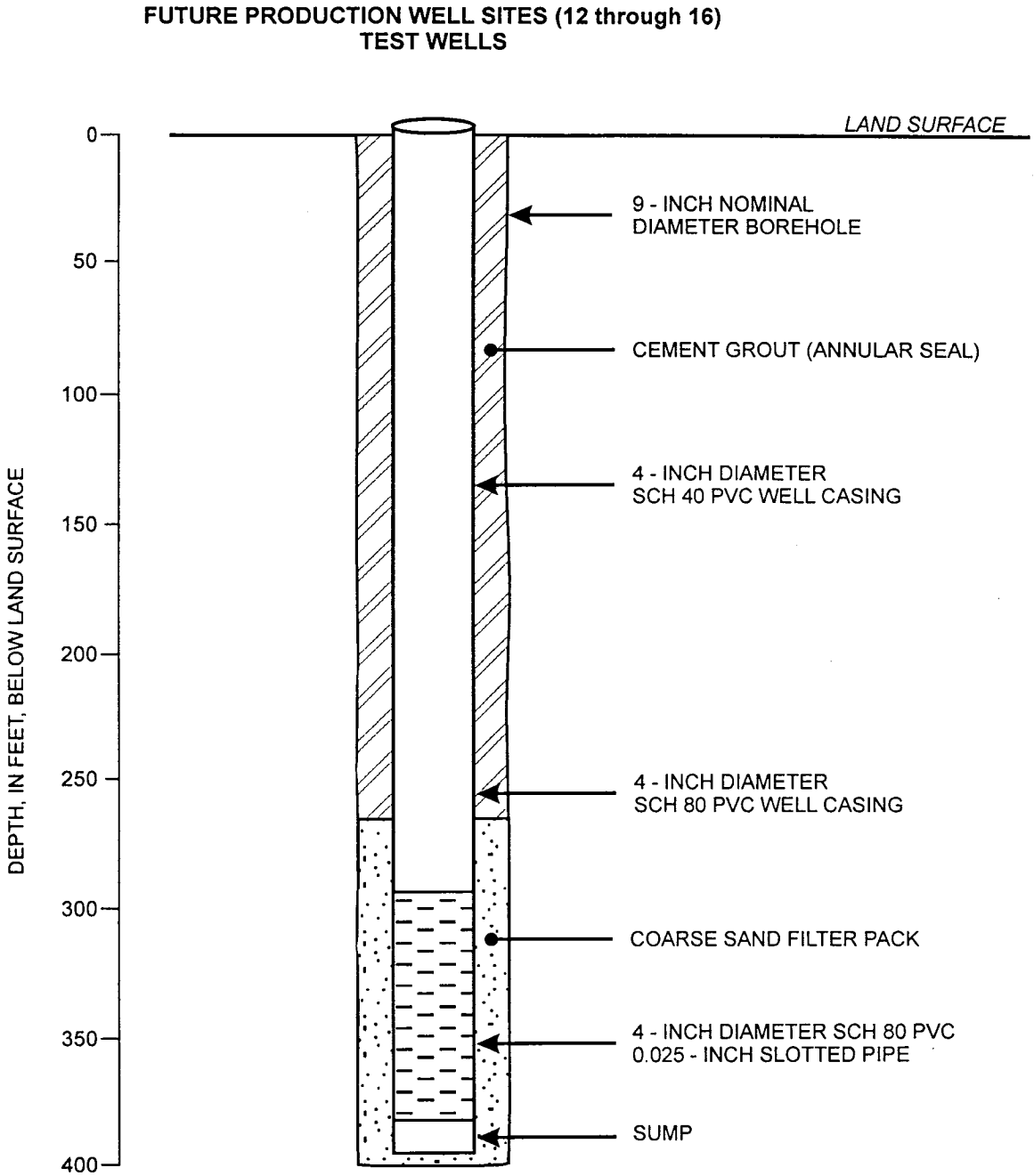


Figure 4
Dare County Test Wells
Schematic Diagram Showing General Construction Details of Test Wells 12 through 16. Well depths and screened intervals vary.

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Test Well #13
Drilling began at test well site 13 on February 18, 2003. A moderately well sorted, fine to medium grained sand unit was encountered within the interval from 280 to 350 feet bls. Based on review of the geologist's log and geophysical logs, the well screen interval was set between 280 and 350 feet bls.

A well string consisting of 70 feet of 4-inch diameter, 0.025-inch slotted Schedule 80 PVC pipe was placed in the borehole followed by 30 feet of 4-inch diameter Schedule 80 PVC casing and 250 feet of 4-inch diameter Schedule 40 PVC casing to land surface. A coarse sand filter pack was placed around the screen and the well was then developed with compressed air. The well was initially developed on February 19, 2003, using compressed air for 6 hours. The annulus was subsequently grouted with neat Portland cement from the top of the gravel pack to land surface. The driller returned on February 20, 2003, to further develop the well for another 4 hours. Well construction details are provided on Table 3-1.

Test Well #14
Drilling began at test well site 14 on February 11, 2003. A moderately graded, fine to medium grained sand unit was encountered between the approximate depths of 290 to 350 feet bls. Based on review of the geologist's log and the geophysical logs, the well screen interval was set between 280 and 380 feet bls.

A well string consisting of 100 feet of 4-inch diameter, 0.025-inch slotted Schedule 80 PVC pipe was placed in the borehole followed by 30 feet of 4-inch diameter Schedule 80 PVC casing and 250 feet of 4-inch diameter Schedule 40 PVC casing to land surface. A coarse sand filter pack was placed around the screen and the well was then developed with compressed air. The well was developed on February 12, 2003, using compressed air for 6 hours. The annulus was subsequently grouted with neat Portland cement from the top of the gravel pack to land surface. Well construction details are provided on Table 3-1.

Test Well #15
Drilling began at test well site 15 on January 29, 2003. A moderately graded, fine to medium grained sand unit was encountered from 285 to 380 feet bls. Based on review of the geologist's log and geophysical logs, the well screen interval was set between 270 and 380 feet bls.

A well string consisting of 110 feet of 4-inch diameter, 0.025-inch slotted Schedule 80 PVC pipe was placed in the borehole followed by 20 feet of 4-inch diameter Schedule 80 PVC casing and 250 feet of 4-inch diameter Schedule 40 PVC casing to land surface. A coarse sand filter pack was placed around the screen and the well was then developed with compressed air. The well was developed on January 31, 2003, and February 3, 2003, using compressed air for a total of 6 hours. The annulus was subsequently grouted with neat Portland cement from the top of the gravel pack to land surface. Well construction details are provided on Table 3-1.

Test Well #16

Drilling began at test well site 16 on March 31, 2003. A moderately graded, fine to medium grained sand unit was encountered from 280 to 380 feet bls. Based on review of the geologist's log and geophysical logs, the well screen interval was set between 290 and 390 feet bls.

A well string consisting of 100 feet of 4-inch diameter, 0.025-inch slotted Schedule 80 PVC pipe was placed in the borehole followed by 40 feet of 4-inch diameter Schedule 80 PVC casing and 250 feet of 4-inch diameter Schedule 40 PVC casing to land surface. A coarse sand filter pack was placed around the screen and the well was then developed with compressed air for 1 hour. The annulus was subsequently grouted with neat Portland cement from the top of the gravel pack to land surface. After the grout had been allowed to cure, the well was further developed on April 1 and 2, 2003, using compressed air for a total of 6 hours. Well construction details are provided on Table 3-1.

3.2 Aquifer Testing

A 5-hp electric submersible pump was placed in each of the new test wells (with the exception of test well 12, where no aquifer testing was conducted) with the pump intake set at 86 feet bls. Each well was pumped at three separate rates ranging from approximately 60 to 100 gpm. Drawdown in the wells was measured with a pressure transducer coupled to an electronic data logger, with the exception of test well 11s. Drawdown in test well 11s was measured manually with an electronic water level indicator. Results of the step-drawdown test for each well are summarized in **Table 3-2**. Specific capacity values ranged from 3.6 to 4.7 gpm/ft in the Mid-Yorktown aquifer test wells and a value of 2.2 gpm/ft was recorded for the Upper-Yorktown aquifer test well 11s. The reported specific capacity values were those obtained on the final step at the highest test rate (95-100 gpm). The pumping test data are shown on graphics and tables included with **Appendix D**.

Following the step-drawdown tests on test wells 13, 14, 15, and 16, an additional constant rate pump test was conducted. Each of the wells was pumped at a constant rate of 95 to 100 gpm for a period of approximately 24 hours. Drawdown in each well was measured at closely spaced time intervals and a semi-log plot of drawdown vs. time was constructed for analysis purposes. At the completion of the constant rate pump tests, recovery data were collected. The recovery in each well was measured at closely spaced time intervals and a semi-log graph of recovery vs. time was constructed for comparison to the drawdown plots. Copies of the semi-log plots of drawdown vs. time are provided in the appendix. It should be noted that the semi-log graph generated from the test well 15 data has some marked data inconsistencies near the end of the test. This data scattering was due to a poor connection between the data logger and the transducer. Although some of the recorded data is suspect, the general slope of the curve is correct and suffices for data analysis purposes.

3.3 Water Quality Sampling

Water samples were obtained from test wells 13, 14, 15, and 16 near the end of the constant rate pumping tests. Dare County Water Department staff and STL Laboratories in Tampa, Florida conducted detailed analyses of the samples. Analytical reports of the sampling results are included in **Appendix E**. A discussion of the water quality sampling results is included in the following section of this report.

Section 4
Hydrogeology

4.1 Geology

Various government agencies and private consultants, including CDM Missimer, have investigated the geology of Dare County. A general description of the sediments underlying the new test well sites is provided herein. Detailed discussions of the geologic conditions at Nags Head and throughout the Outer Banks are provided in the reports included in the reference section of this report.

Generally, the uppermost strata encountered include undifferentiated very fine to medium pebble sized sand units with some shell beds and interbedded clays. Permeable sediments within these deposits form the surficial aquifer, which is typically about 90 feet thick, but ranges from roughly 50 to 110 feet thick at the new test well sites.

The Yorktown formation of Miocene age lies beneath the surficial sand deposits. The formation consists of beds of fine to coarse grained sand and dense clay units with a thickness that can exceed 500 feet in eastern Dare County. The Yorktown formation is described in more detail below, beginning with the upper confining beds.

At the new test well sites, the upper part of the Yorktown formation includes olive-gray to medium-gray marine clay units with varying amounts of fine sand, shell, and phosphate material. The thickness of the upper confining unit ranges from about 40 to 90 feet at the new test well sites. The clay beds have a very low hydraulic conductivity and provide confinement between the surficial sands and underlying aquifer units.

Beneath the upper Yorktown confining beds is a unit of very fine to very coarse grained sand with minor amounts of interbedded shell and clay. The Principal or Upper Yorktown aquifer occurs within this unit which ranges from a thickness of 100 feet or more in some locations to very thin or absent in southern Dare County. The Upper Yorktown aquifer ranges from approximately 20 to 40 feet thick at the new test well sites.

A low permeability dense marine clay layer that contains minor amounts of silt, sand, and shell lies beneath the Upper Yorktown aquifer and separates it from the underlying Mid-Yorktown aquifer. The thickness of this confining unit averages approximately 100 feet at the new test well locations and exceeds 150 feet at the locations of test wells 11 and 12 where the Mid-Yorktown aquifer was not encountered.

The Mid-Yorktown aquifer was encountered at a depth of approximately 280 feet at test well sites 13, 14, 15, and 16. The Mid-Yorktown aquifer was not encountered at test well sites 11 and 12. Where encountered, the aquifer consists primarily of very

fine to coarse grained sand with occasional shell, phosphate, and trace amounts of clay. The thickness of the aquifer ranges from about 40 feet at test well 13 to over 100 feet at test well 16. The aquifer appears to thicken from north to south. The formation sediments are similar to those encountered in previously installed test and production wells near the RO plant and in test well 17. However, the sand is moderately sorted and the aquifer is not as thick as it is near the RO plant. For these reasons, the specific capacity of production wells constructed at the test well sites (particularly 13, 14, and 15) may be lower than the specific capacity of the existing wells near the water plant.

4.2 Aquifer Hydraulic Characteristics

The method developed by Jacob (1952) was used to analyze the data collected during the constant rate test on wells 13, 14, 15, and 16. A straight line segment is selected from the semi-log plot of drawdown vs. time (Appendix C) and the change in drawdown over one log cycle is determined and substituted into equation (1) to determine the aquifer transmissivity.

$$T = \frac{264\,Q}{\Delta S} \qquad (1)$$

where,

T = transmissivity (gpd/ft)
Q = pumping rate (gpm)
ΔS = head difference between log cycles (feet)

Transmissivity values ranging from approximately 20,000 gpd/ft in test well 13 to 50,000 gpd/ft in test well 16 were calculated for the Mid-Yorktown aquifer using the time and drawdown data obtained during testing. The transmissivity values are summarized in **Table 4-1**. Aquifer performance testing conducted following the installation of existing raw water supply wells nearer the RO plant, and test well 17, yielded transmissivity values that ranged from approximately 63,000 gpd/ft to over 100,000 gpd/ft. The calculated transmissivity values for the Mid-Yorktown aquifer at test sites 13 through 16 are lower than those calculated for the aquifer near the existing wellfield and the test well 17 site. In summary, the Mid-Yorktown aquifer exhibits good yield characteristics near the existing production wells and at well site 17, low to moderate yield potential at well sites 13 through 16, and little to no yield potential at well sites 11 and 12.

Table 4-1. Transmissivity Values Calculated from Constant Rate Test Data

Well ID	Transmissivity (gpd/ft)
TW-11s	*
TW-12	*
TW-13	20,800
TW-14	21,800
TW-15	23,000
TW-16	50,200

*Due to insufficient yield constant rate pumping tests were not performed on wells TW-11s and TW-12.

4.3 Water Quality

The laboratory analysis results for the samples obtained from test wells 13, 14, 15, and 16 indicate that water quality in the Mid-Yorktown aquifer at the test sites is brackish, but less saline than the water obtained from the existing wellfield. Salinity parameters are summarized in **Table 4-2.**

Table 4-2. Water Quality Summary Dare County Test Wells 13 through 16 (Winter 2003)

	Dissolved Chloride Concentration (mg/l)		Total Dissolved Solids (mg/l)	
Well	Dare County Lab	STL Tampa Lab	Dare County Lab	STL Tampa Lab
13	1,000	1,000	1,945	2,000
14	1,250	1,200	2,455	2,600
15	1,150	1,300	2,490	2,500
16	1,250	1,200	2,290	2,400

By comparison, the average dissolved chloride concentration of the raw water from the production wells currently supplying the RO plant ranges from approximately 2400 - 2800 mg/l. It should be noted that production wells 9 and 10 produced water with a dissolved chloride concentration of approximately 1000 mg/l when they were initially put on-line and there was a relatively rapid increase in dissolved chloride concentration in the water obtained from these wells. Production wells 9 and 10 currently yield water with a salinity level comparable to the original eight production wells. A relatively rapid initial increase in production well salinity followed by a

leveling off of the salinity changes frequently occurs in coastal areas due to pumpage. This phenomenon is thought to be due to expansion of the cone of influence around the withdrawal points. An asymptotic equilibrium condition is approached as the aquifer area contributing to the withdrawals expands in an outward direction. Arsenic levels were below the detection limit of 0.01 mg/l in all of the test well water samples. The production wells that currently supply the North RO plant have arsenic concentrations that vary but may exceed 0.05 mg/l. The limited historic data that are available suggest that arsenic levels slowly increase with time due to pumpage. Complete laboratory reports from the Dare County Lab and the STL Tampa lab are provided in Appendix E.

Section 5
Water Supply Evaluation

Data collected during the installation and testing of test wells at proposed future well sites 11 through 16 show that the yield potential of the Mid-Yorktown aquifer varies widely between the test sites. Well sites 11 and 12 showed little to no yield potential from the Mid-Yorktown aquifer. Well sites 13, 14, and 15 showed low to moderate yield potential and sites 16 and 17 (tested previously) showed moderate to good yield potential. Transmissivity values range from approximately 20,000 gpd/ft at well site 13 to 65,000 gpd/ft at well site 17 with a general trend of increasing transmissivity from north to south.

The installation of permanent supply wells capable of yielding 400 to 500 gpm is feasible at well sites 13 through 17. However, pumping water levels of 100 feet or more below land surface may be experienced at the lower yielding sites in order to achieve the design production rate. Pumping water levels of 40 to 80 feet below land surface may be expected in production wells constructed at sites 16 and 17 at the design production rate of 400 to 500 gpm. The estimated pumping water levels are based on calculated transmissivity values, static water level in the aquifer, anticipated interference drawdown effects, and historic pumpage and water level data from the existing production wells. The actual yield and pumping water levels of the proposed production wells will vary. Step-drawdown testing of newly constructed production wells will be necessary to more fully assess the well yield and determine an appropriate setting depth for the permanent supply pump.

The installation of production wells at well sites 16 and 17, in addition to the wells planned for construction at the Orville and Wilbur sites, is recommended. The yield potential of the Mid-Yorktown aquifer at well sites 16 and 17 is greater than the other test sites and relatively similar to the aquifer yield at the existing wellfield alignment based on the aquifer testing results. Well sites 16 and 17 are distant (over 2.5 miles) from existing production well 10. Placing wells at sites 16 and 17 spreads pumpage over a larger area, which reduces drawdown in the aquifer and lessens the potential for adverse water quality changes due to the withdrawals. The installation of four new production wells will allow expansion of the RO plant finished water capacity by up to 2.0 MGD. Additional production wells should be installed at well sites 13, 14, and 15 as needed to meet increased raw water demands associated with future RO plant expansions. Use of the Upper Yorktown aquifer at well sites 11 and 12 or other areas as a raw water supply source for the RO plant may be pursued in the long term.

Computer modeling to estimate water quality changes that might occur within the Mid-Yorktown aquifer due to withdrawals from the proposed additional production wells was beyond the scope of this investigation. However, previous modeling studies and operational data have shown that spreading pumpage over a larger area is effective in reducing the rate of water quality degradation in the source aquifer. Water obtained from the proposed new production wells would have a lower salinity level than water from the existing production wells. It is anticipated that salinity

levels in the new production wells would increase over time due to pumpage. The rate of water quality degradation would be directly related to the magnitude and duration of pumpage. The existing computer models used to estimate drawdown impacts and water quality changes due to pumpage from the wellfield should be revised to include the new hydrogeologic data collected during this investigation and proposed alternative wellfield expansion scenarios. The model structure will need to be altered to include another layer to account for the Upper Yorktown aquifer.

Section 6
Selected References

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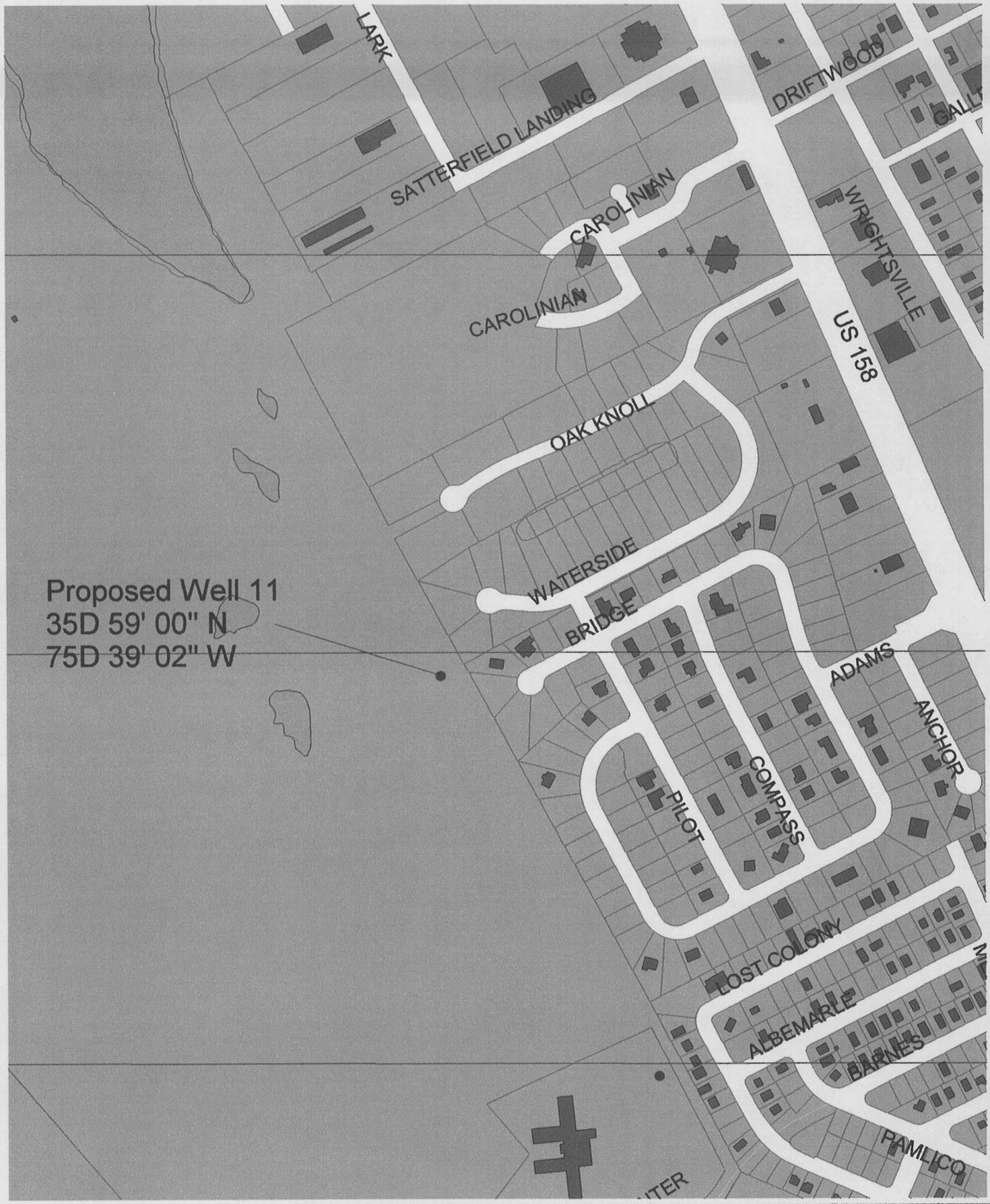
ViroGroup, Inc. 1994. Report on the construction and testing of the Dare County Water Production Department Reverse Osmosis Wells #9 and #10, Dare County, North Carolina: Report to the Dare County Water Production Department, Kill Devil Hills, North Carolina, 39 p.

APPENDIX A

Detailed Site Maps



DARE COUNTY WATER
GIS
MATTHEW HIBLER
NOVEMBER 6, 2002

NRO Proposed Wells
Kill Devil Hills, NC

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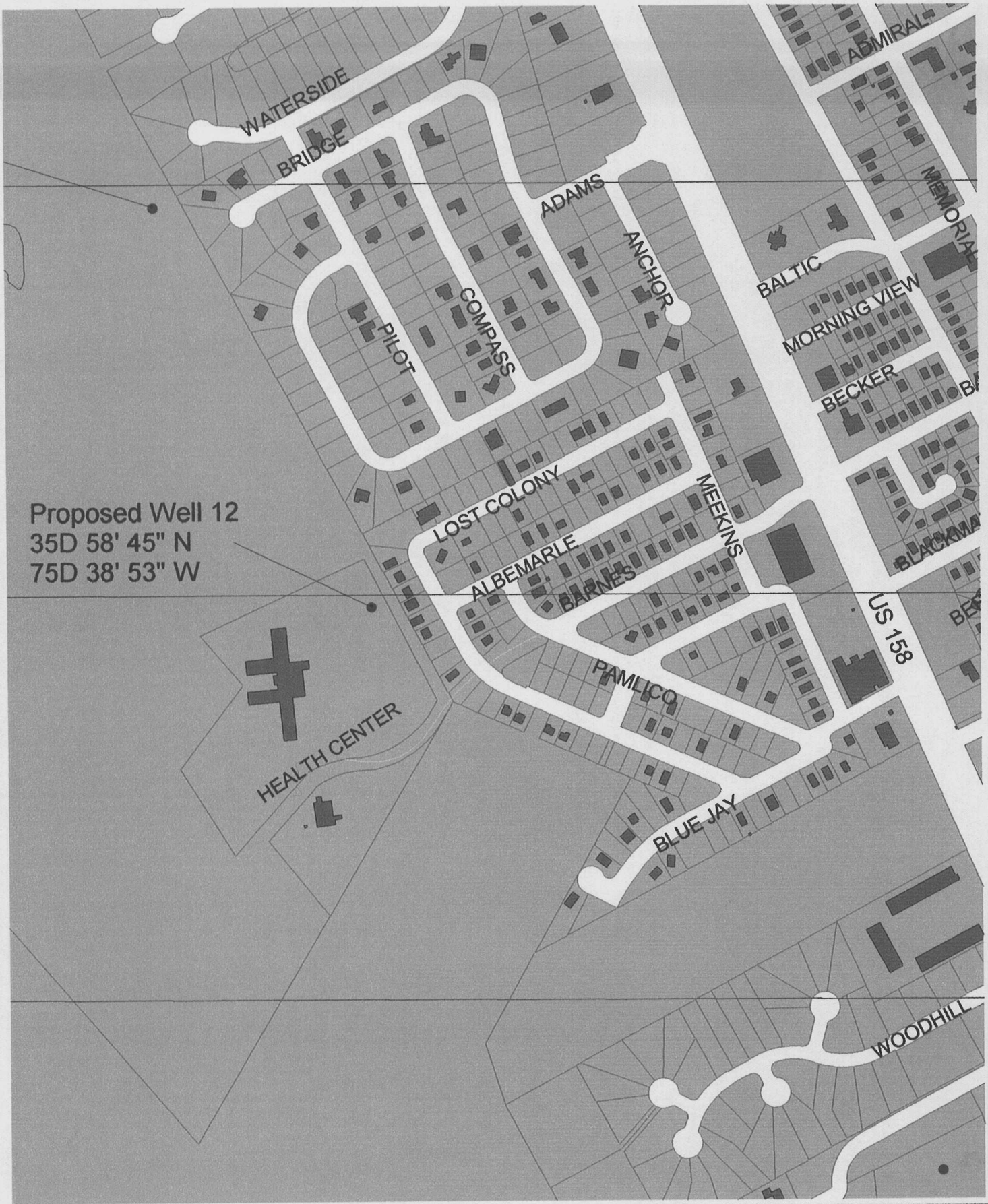
Structures Centerline
Proposed Wells
NRO Treatment Facili



DARE COUNTY WATER
GIS
MATTHEW HIBLER
NOVEMBER 6, 2002

NRO Proposed Wells
Kill Devil Hills, NC

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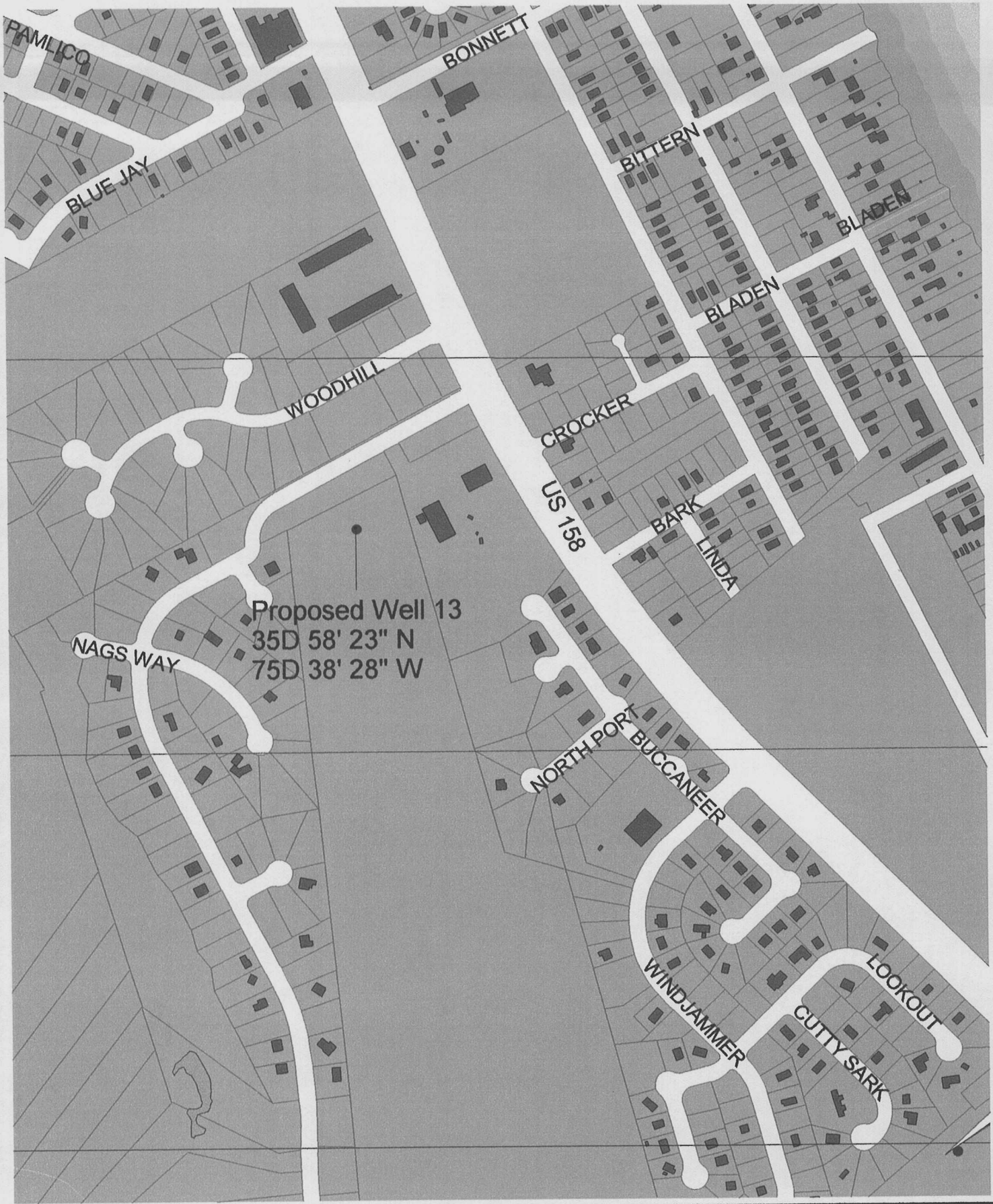
NRO Treatment Facili



DARE COUNTY WATER
GIS
MATTHEW HIBLER
NOVEMBER 6, 2002

NRO Proposed Wells
Kill Devil Hills, NC

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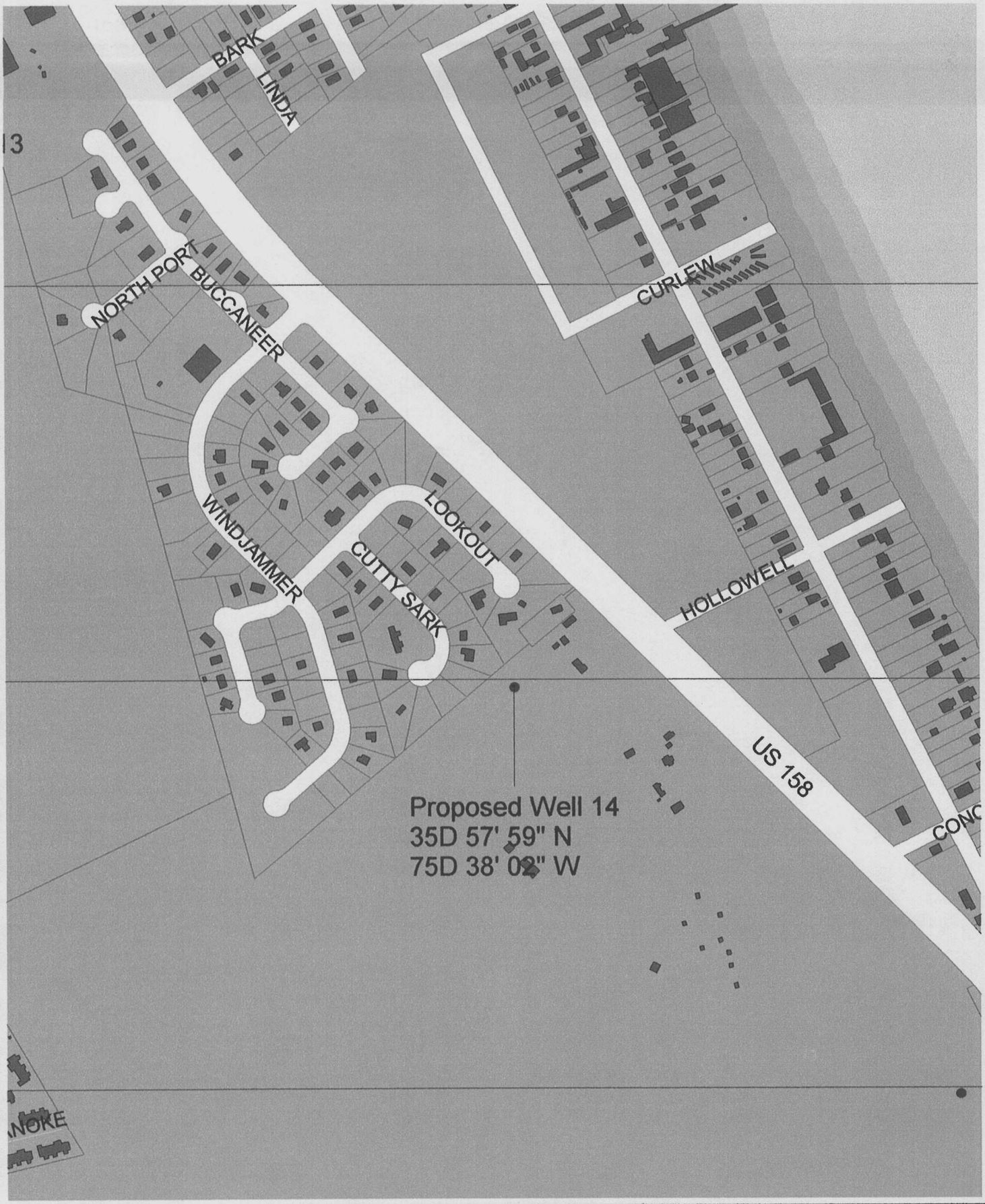
- Proposed Wells
- NRO Treatment Facilit



DARE COUNTY WATER
GIS
MATTHEW HIBLER
NOVEMBER 6, 2002

NRO Proposed Wells
Kill Devil Hills, NC

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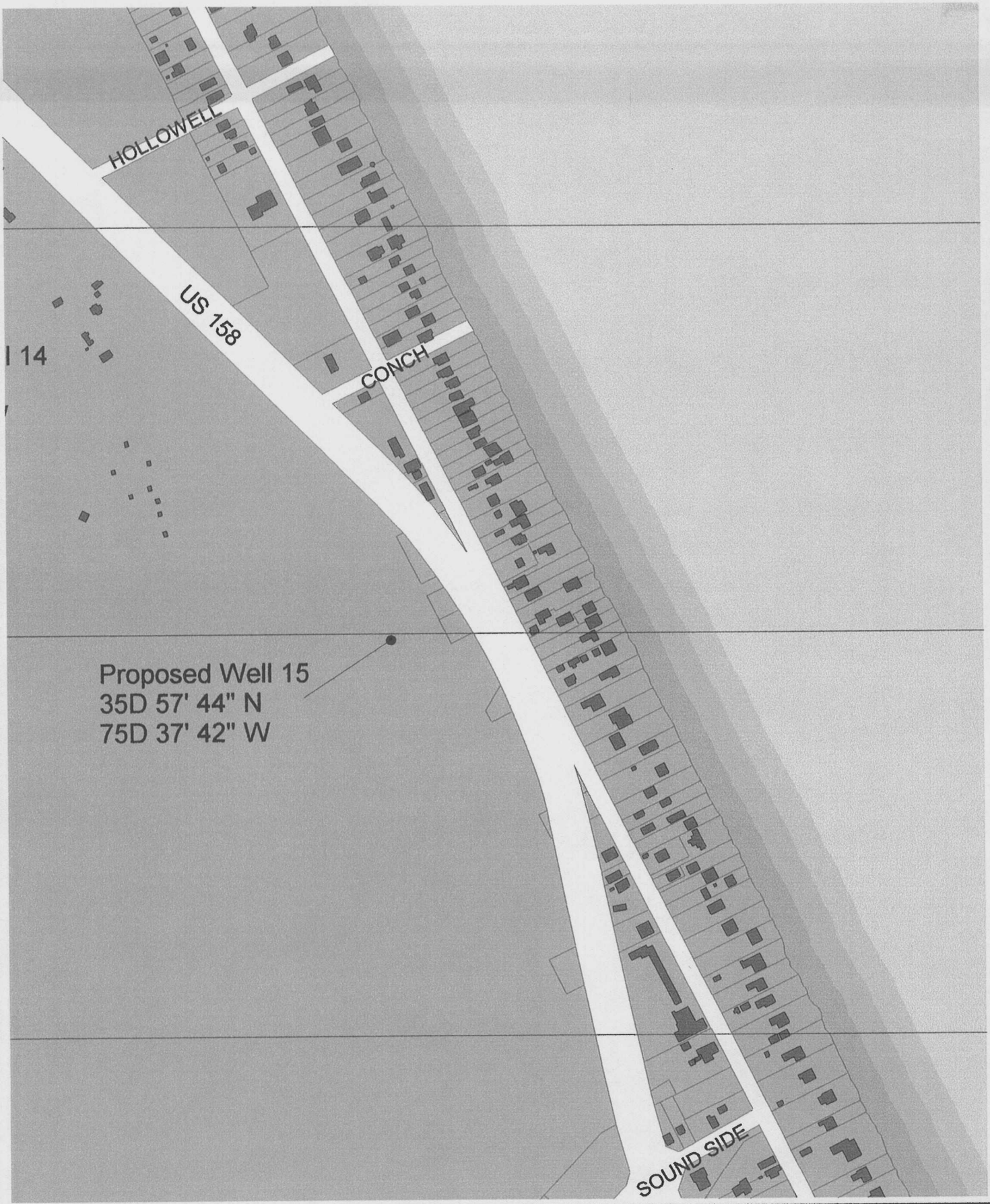
- Structures Centerline
- Proposed Wells
- NRO Treatment Facility



DARE COUNTY WATER
GIS
MATTHEW HIBLER
NOVEMBER 6, 2002

NRO Proposed Wells
Kill Devil Hills, NC

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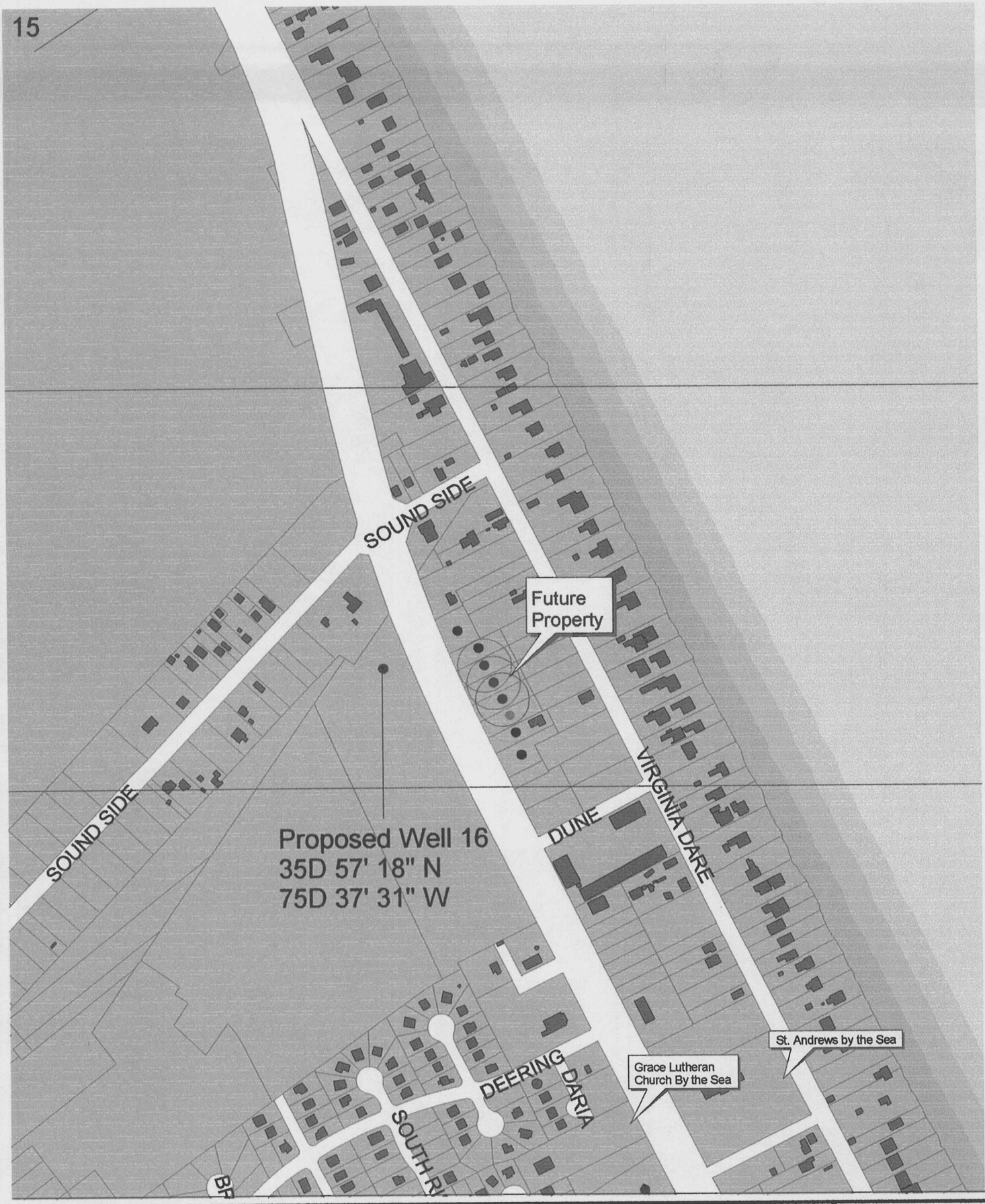

DARE COUNTY WATER
GIS
MATTHEW HIBLER
NOVEMBER 6, 2002

NRO Proposed Wells
Kill Devil Hills, NC

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- Structures
- Centerline
- Proposed Wells
- NRO Treatment Facilit

APPENDIX B

Geologist's Logs

GEOLOGIST'S LOG
TEST WELL SITE #11
CITY OF NAGS HEAD
DARE COUNTY, NORTH CAROLINA
DECEMBER 2002

Depth (feet)	Lithology
0 - 12	SAND, dark yellowish orange (10 YR 6/6), fine to medium grained quartz, well sorted.
12 - 19	SAND, moderate yellowish brown (10 YR 5/4), fine to medium grained quartz, well sorted.
19 - 20	CLAY, dusky brown (5 YR 2/2), roots, organic.
20 - 37	SAND, moderate yellowish brown (10 YR 5/4), fine to medium grained quartz, well sorted.
37 - 46	SAND, light olive gray (5Y 5/2), fine to very coarse, quartz, with shell fragments, poorly sorted.
46 - 55	SAND, olive gray (5Y 4/1), coarse, quartz, some shell fragments, well to moderate sorted.
55 - 64	SAND, olive gray (5Y 4/1), very fine, quartz, some shell fragments, well sorted.
64 - 75	CLAY, dark greenish gray (5G 4/1), some quartz sand and shell fragments, trace very fine phosphate (<1%). Interbedded with fine to medium SAND (beds 1' to 2' thick). Increasing shell and rounded coarse quartz sand content with depth.
75 - 86	CLAY, dark greenish gray (5G 4/1), trace shell fragments.
86 - 94	CLAY, dark greenish gray (5G 4/1), some rounded, coarse, quartz sand and shell fragments.
94 - 100	CLAY, dark greenish gray (5G 4/1) and fine to coarse quartz sand. Very soft.
100 - 122	CLAY, dark greenish gray (5G 4/1) and very fine sand. Very soft.
122 - 150	CLAY, dark greenish gray (5G 4/1), some shell fragments. Interbedded with very soft sandy CLAY.

GEOLOGIST'S LOG
TEST WELL SITE #11
CITY OF NAGS HEAD
DARE COUNTY, NORTH CAROLINA
DECEMBER 2002

Depth	Lithology
150 - 175	SAND, olive gray (5Y 4/1), medium to coarse, semi-rounded, quartz, moderately sorted. Becoming mostly coarse around 170 feet. Some fine phosphate.
175 - 188	SAND, olive gray (5Y 4/1) and multi-colored, coarse, some clay and shells.
188 - 207	CLAY and SAND, greenish gray (5G 6/1), soft.
207 - 238	CLAY, light bluish gray (5B 7/1), soft, trace coarse quartz sand, fine phosphate, and shell fragments. Shell fragment content increasing with depth.
238 - 294	CLAY and very fine SAND, dark greenish gray (5GY 4/1), some shell fragments, soft.
294 - 309	SAND, dark greenish gray (5GY 4/1), shell fragments.
309 - 360	CLAY, dark greenish gray (5GY 4/1), with shell fragments, very little sand or phosphate.
360 - 365	CLAY, grayish olive green (5GY 3/2), and fine sand. Some shell fragments and very fine phosphate.
365 - 425	SAND, grayish olive green (5GY 3/2), fine to medium, some clay, shell fragments, very fine phosphate. Trace semi-rounded, quartz pebbles. Amount of shell fragments varies.
425 - 460	SAND, grayish olive green (5GY 3/2), very fine to fine, with CLAY and shell fragments. Trace rounded quartz pebbles, very fine phosphate.
460 - 475	SAND, dusky yellow green (5GT 5/2), medium to coarse, shells. Trace to little clay and phosphate.

Total Depth of Boring = 475 feet Below Land Surface

GEOLOGIST'S LOG
TEST WELL SITE #12
CITY OF NAGS HEAD
DARE COUNTY, NORTH CAROLINA
DECEMBER 2002

Depth (feet)	Lithology
0 - 10	SAND, dark yellowish orange (10 YR 6/6), fine to medium grained quartz, well sorted.
10 - 20	SAND, light brownish gray (5YR 6/1), very fine grained quartz, well sorted.
20 - 35	SAND, medium light gray, (N6), very fine to fine, quartz, moderately sorted.
35 - 54	SAND, dark greenish gray (5GY 4/1), fine to coarse, angular, quartz, trace shells, poorly sorted. Becoming coarser with depth.
54 - 74	CLAY, dark greenish gray (5G 4/1), soft, some fine sand and shell fragments.
74 - 77	SAND, dark greenish gray (5G 4/1), fine to coarse, quartz, poorly sorted, some clay, wood fragments from 74 to 75.
77 - 97	CLAY, dark greenish gray (5G 4/1), and very fine to fine, quartz SAND, trace phosphate.
97 - 115	CLAY, dark greenish gray (5G 4/1), and very fine to fine, quartz SAND, trace shell fragments, very fine phosphate (<1%).
115 - 147	CLAY, medium gray (N5), some fine sand, shell fragments, phosphate. Alternating beds with varying amounts of medium sand, shells, trace rounded quartz pebbles from 125 to 147.
147 - 169	SAND, greenish gray (5G 6/1), medium to coarse, semi-rounded, quartz, some shell fragments. Increasing shell content with depth.
169 - 237	CLAY, medium light gray (N6), some medium sand, shells, phosphate. Very soft.
237 - 272	CLAY, dark greenish gray (5G 4/1), some fine sand, shells, phosphate. Very soft.
272 - 286	CLAY, dark greenish gray (5G 4/1), some fine sand, shells, phosphate, trace rounded quartz pebbles.

GEOLOGIST'S LOG
TEST WELL SITE #12
CITY OF NAGS HEAD
DARE COUNTY, NORTH CAROLINA
DECEMBER 2002

Depth	Lithology
286 - 342	CLAY and shells, dark greenish gray (5GY 4/1), some very fine phosphate, quartz sand. Increasing clay content with depth.
342 - 425	CLAY, olive gray (5Y 4/1), with shell fragments, trace fine phosphate and quartz sand.
425 - 475	CLAY, olive gray (5Y 4/1), with shells. Trace very fine phosphate and quartz sand.

Total Depth of Boring = 475 feet Below Land Surface

GEOLOGIST'S LOG
TEST WELL SITE #13
CITY OF NAGS HEAD
DARE COUNTY, NORTH CAROLINA
FEBRUARY 2003

Depth (feet)	Lithology
0 - 8	SAND, dark yellowish orange (10 YR 6/6), medium grained quartz, well sorted.
8 - 32	SAND, moderate yellowish brown (10 YR 5/4), fine to medium grained quartz, well sorted.
32 - 50	SAND, olive gray (5Y 4/1), fine to coarse, quartz, some rounded pebbles and shell fragments, poorly sorted.
50 - 69	CLAY, medium gray (N5), trace to little fine to medium quartz sand and shell fragments.
69 - 74	CLAY, medium dark gray (N4), trace to little very fine to fine sand and shell fragments.
74 - 76	SAND, olive gray (5Y 4/1), fine to coarse quartz, poorly sorted, some clay.
76 - 100	SAND, olive gray (5Y 4/1), fine to coarse quartz, some shell fragments, poorly sorted.
100 - 132	SAND, olive gray (5Y 4/1), fine to medium quartz, moderately sorted, increasing clay content with depth.
132 - 153	CLAY, medium gray (N5), trace fine sand, shell fragments.
153 - 173	SAND, greenish gray (5GY 5/1), medium to coarse quartz, increased sorting with depth, little shell fragments.
173 - 181	CLAY, medium gray (N5), very soft, some fine quartz sand and shell fragments.
181 - 222	CLAY, medium light gray (N6), very soft, trace very fine sand.
222 - 250	CLAY, medium gray (N5), soft, some shell fragments, trace fine sand.

GEOLOGIST'S LOG
TEST WELL SITE #13
CITY OF NAGS HEAD
DARE COUNTY, NORTH CAROLINA
FEBRUARY 2003

Depth	Lithology
250 - 284	CLAY, medium gray (N5), soft, some shell fragments and fine sand.
284 - 333	SAND, medium dark gray (N4), medium, quartz, well sorted, with fine phosphate and shells.
333 - 350	SAND, medium gray (N5), fine, quartz, and CLAY, medium gray (N5), trace shells and phosphate.
350 - 375	CLAY and very fine quartz SAND and phosphate, medium dark gray (N4).
375 - 400	CLAY, dark greenish gray (5G 4/1), some very fine sand, shell fragments, phosphate.

Total Depth of Boring = 400 feet Below Land Surface

GEOLOGIST'S LOG
TEST WELL SITE #14
CITY OF NAGS HEAD
DARE COUNTY, NORTH CAROLINA
FEBRUARY 2003

Depth (feet)	Lithology
0 - 12	SAND, dark yellowish orange (10 YR 6/6), medium grained quartz, well sorted.
12 - 18	SAND, light brownish gray (5YR 6/1), fine to medium grained quartz, well sorted.
18 - 25	SAND, medium gray (N5), fine, well sorted, and shells.
25 - 50	SAND, medium gray (N5), medium to coarse, quartz and shell fragments, moderately sorted.
50 - 71	CLAY, medium bluish gray (5B 5/1), trace fine sand and shells.
71 - 75	SAND, medium gray (N5), medium, quartz, some clay, trace rounded coarse sand, very little shell fragments.
75 - 100	SAND, medium gray (N5), medium, quartz, interbedded with medium gray (N5) CLAY, trace shell fragments. Very small beds (1 inch +/-) of brownish gray clay - hardpan).
100 - 118	SAND, medium gray (N5), medium to coarse, some interbedded clay, trace shells, moderately sorted..
118 - 125	CLAY, medium gray (N5), with medium quartz sand, shell fragments.
125 - 153	CLAY, medium gray (N5) to dark greenish gray (5GY 4/1), some medium to coarse quartz, shell fragments.
153 - 180	SAND, medium light gray (N6), medium, quartz, some clay, trace phosphate and shell fragments.
180 - 237	CLAY, medium light gray (N6), very soft, some very fine sand.
237 - 270	CLAY, medium dark gray (N4), trace shell fragments and medium sand.

GEOLOGIST'S LOG
TEST WELL SITE #14
CITY OF NAGS HEAD
DARE COUNTY, NORTH CAROLINA
FEBRUARY 2003

Depth	Lithology
270 - 293	CLAY, medium dark gray (N4), soft, some fine quartz sand, phosphate, shell fragments.
293 - 305	CLAY, medium dark gray (N4), some medium, quartz sand, phosphate and shells.
305 - 325	SAND, dark greenish gray (5GY 4/1), fine to medium, quartz, some clay, with shells and phosphate.
325 - 350	SAND, dark greenish gray (5GY 4/1), fine to medium, quartz, with phosphate and shells. Interbedded with CLAY, dark greenish gray (5GY 4/1) and shells. Clay and shell content increasing with depth.
350 - 400	CLAY, dark greenish gray (5G 4/1), some fine sand, shell fragments, phosphate.

Total Depth of Boring = 400 feet Below Land Surface

GEOLOGIST'S LOG
TEST WELL SITE #15
CITY OF NAGS HEAD
DARE COUNTY, NORTH CAROLINA
JANUARY 2003

Depth (feet)	Lithology
0 - 2	SAND, dark yellowish orange (10 YR 6/6), medium grained quartz, well sorted.
2 - 5	SAND, light brownish gray (5YR 6/1), fine to medium grained quartz, well sorted.
5 - 12	SAND, olive gray (5Y 6/1), medium to coarse, well sorted.
12 - 25	SAND, olive gray (5Y 6/1), medium to coarse, quartz and shell fragments, moderately sorted.
25 - 100	SAND, olive gray (5Y 6/1), coarse, rounded, quartz, moderate to well sorted, with shell fragments and small (<6 inches) clay interbeds.
100 - 117	SAND, olive gray (5Y 6/1), medium to coarse, rounded quartz, moderately sorted, some clay and shells.
117 - 146	CLAY, medium dark gray (N4), trace fine to medium quartz sand and shells.
146 - 155	SAND, medium gray (N5), medium, quartz, moderately sorted, with some small (<2 feet) interbedded clay lenses.
155 - 180	SAND, medium gray (N5), coarse, rounded, quartz, trace fine sand, clay, poorly sorted.
180 - 213	CLAY, medium gray (N5) and fine SAND, some pale red (10R 6/2) clay, trace phosphate.
213 - 225	CLAY, medium light gray (N6), with very fine sand.
225 - 250	CLAY, medium light gray (N6), very soft, some very fine sand, trace shell fragments, semi-rounded coarse sand.
250 - 270	CLAY, light gray (N7), with fine quartz sand.

GEOLOGIST'S LOG
TEST WELL SITE #15
CITY OF NAGS HEAD
DARE COUNTY, NORTH CAROLINA
JANUARY 2003

Depth	Lithology
270 - 295	SAND, dark greenish gray (5GY 4/1), medium, quartz, some shell fragments, medium light gray (N6) clay, trace very fine phosphate.
295 - 303	SAND, dark greenish gray (5GY 4/1), fine to medium, quartz and phosphate, with sandstone fragments, trace clay and shells.
303 - 384	SAND, dark greenish gray (5GY 4/1), fine to medium, quartz and phosphate, trace semi-angular quartz pebbles, small (<1 foot) clayey sand and sandstone beds, with shell fragments.
384 - 400	SAND, dark greenish gray (5GY 4/1), fine to medium, quartz, with phosphate and shells. Interbedded with CLAY, dark greenish gray (5GY 4/1) and shells. Clay content increasing with depth.

Total Depth of Boring = 400 feet Below Land Surface

GEOLOGIST'S LOG
TEST WELL SITE #16
CITY OF NAGS HEAD
DARE COUNTY, NORTH CAROLINA
MARCH 2003

Depth (feet)	Lithology
0 - 12	SAND, light brownish gray (5YR 6/1) to dusky yellow (5 Y 6/4), fine to medium grained quartz, moderately sorted, some roots and organics.
12 - 13	CLAY, dusky brown (5YR 2/2), some roots, hardpan.
13 - 18	SAND, light olive gray (5Y 5/2), fine to very fine, quartz, moderately sorted.
18 - 25	SAND, light olive gray (5Y 5/2), medium to coarse, quartz and shell fragments, moderately sorted.
25 - 42	SAND, light olive gray (5Y 5/2), medium to coarse, rounded, quartz, moderate to well sorted, with shell fragments.
42 - 52	CLAY, medium gray (N5), some very fine sand and shells.
52 - 60	SAND, medium dark gray (N4), fine to medium quartz, some shells and clay.
60 - 98	SAND, olive gray (5Y 4/1), medium to coarse quartz, moderately sorted, with some small (<2 feet) interbedded clay lenses.
98 - 125	SAND, medium dark gray (N4), fine to medium, quartz, trace coarse sand, clay, poorly sorted. Increasing clay with depth.
125 - 148	CLAY, medium dark gray (N4) and fine SAND, some pale red (10R 6/2) clay, trace shell fragments.
148 - 183	SAND, medium dark gray (N4) to medium gray (N5), fine to coarse, quartz. Increasing coarse sand and sorting with depth.
183 - 237	CLAY, medium gray (N5), very soft, with very fine sand, trace shell fragments, semi-rounded coarse sand. Alternating beds of clayey sand and sandy clay.
237 - 250	CLAY, medium gray (N4) to medium dark gray (N5), some fine quartz sand, trace shell fragments.

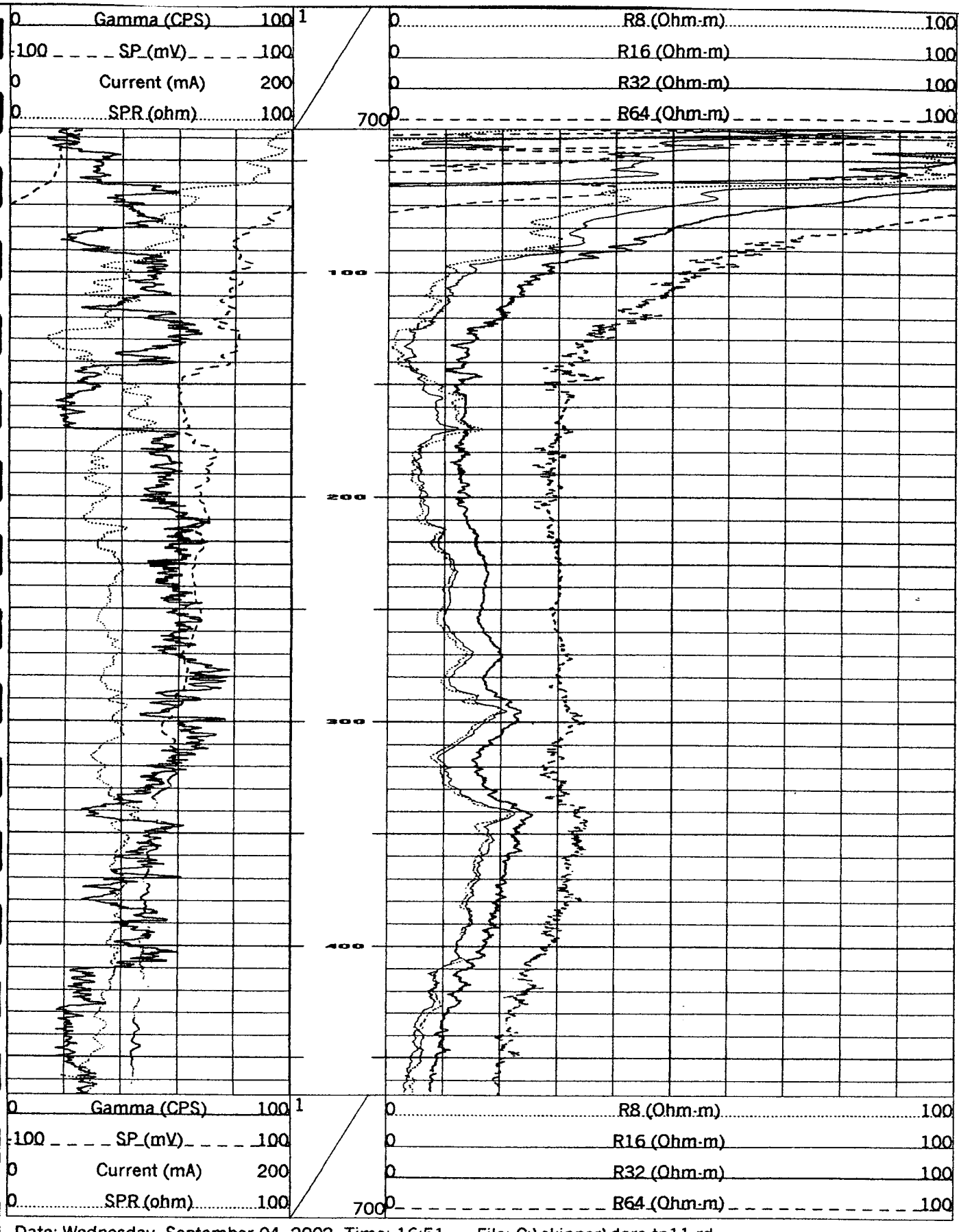
GEOLOGIST'S LOG
TEST WELL SITE #16
CITY OF NAGS HEAD
DARE COUNTY, NORTH CAROLINA
MARCH 2003

Depth	Lithology
250 - 278	CLAY, dark greenish gray (5GY 4/1), some very fine to fine quartz sand, trace shell fragments.
278 - 300	SAND, olive gray (5Y 4/1), fine to medium, quartz and phosphate, with shell fragments, some clay.
300 - 375	SAND, olive gray (5Y 4/1), fine to medium, quartz and phosphate, trace semi-angular quartz pebbles, small (<1 foot) clayey sand and sandstone beds, with shell fragments.
375 - 400	SAND, olive gray (5GY 4/1), fine to medium, quartz, with phosphate and shells. Interbedded with clay and silt, and shells. Clay/silt content increasing with depth.

Total Depth of Boring = 400 feet Below Land Surface

APPENDIX C

Geophysical Logs



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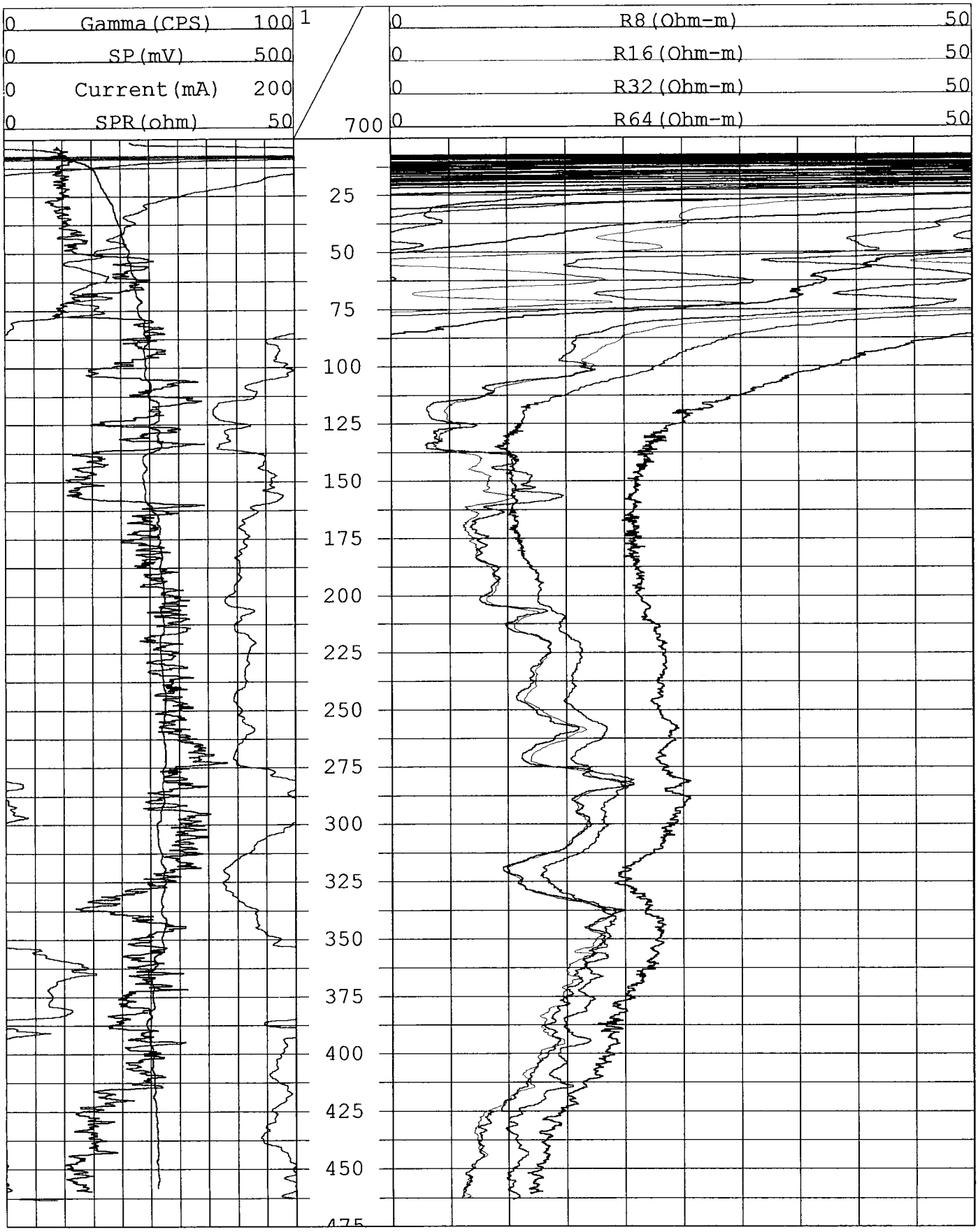
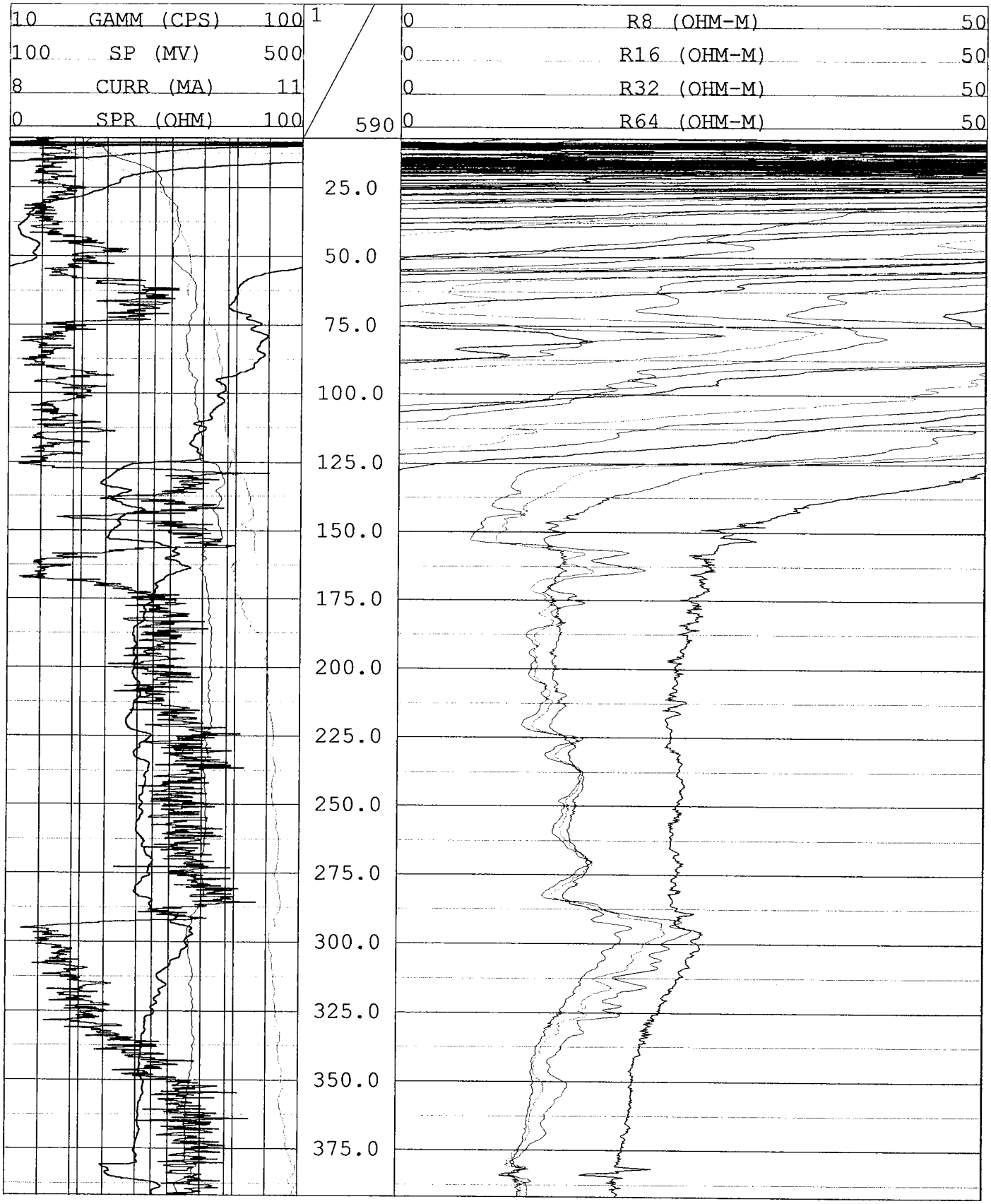
Dare County Test Site 11

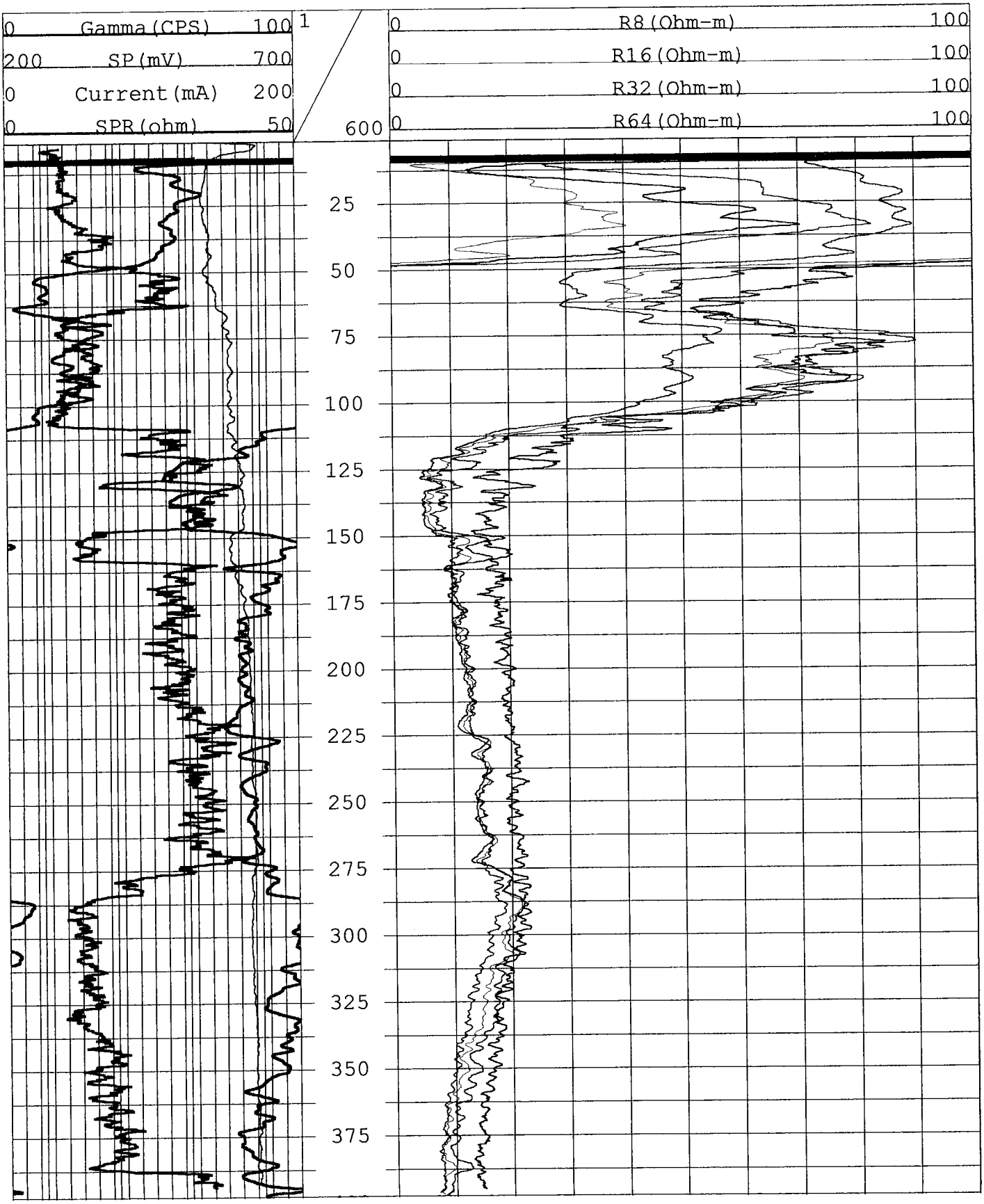
DARE CO. TEST SITE 12



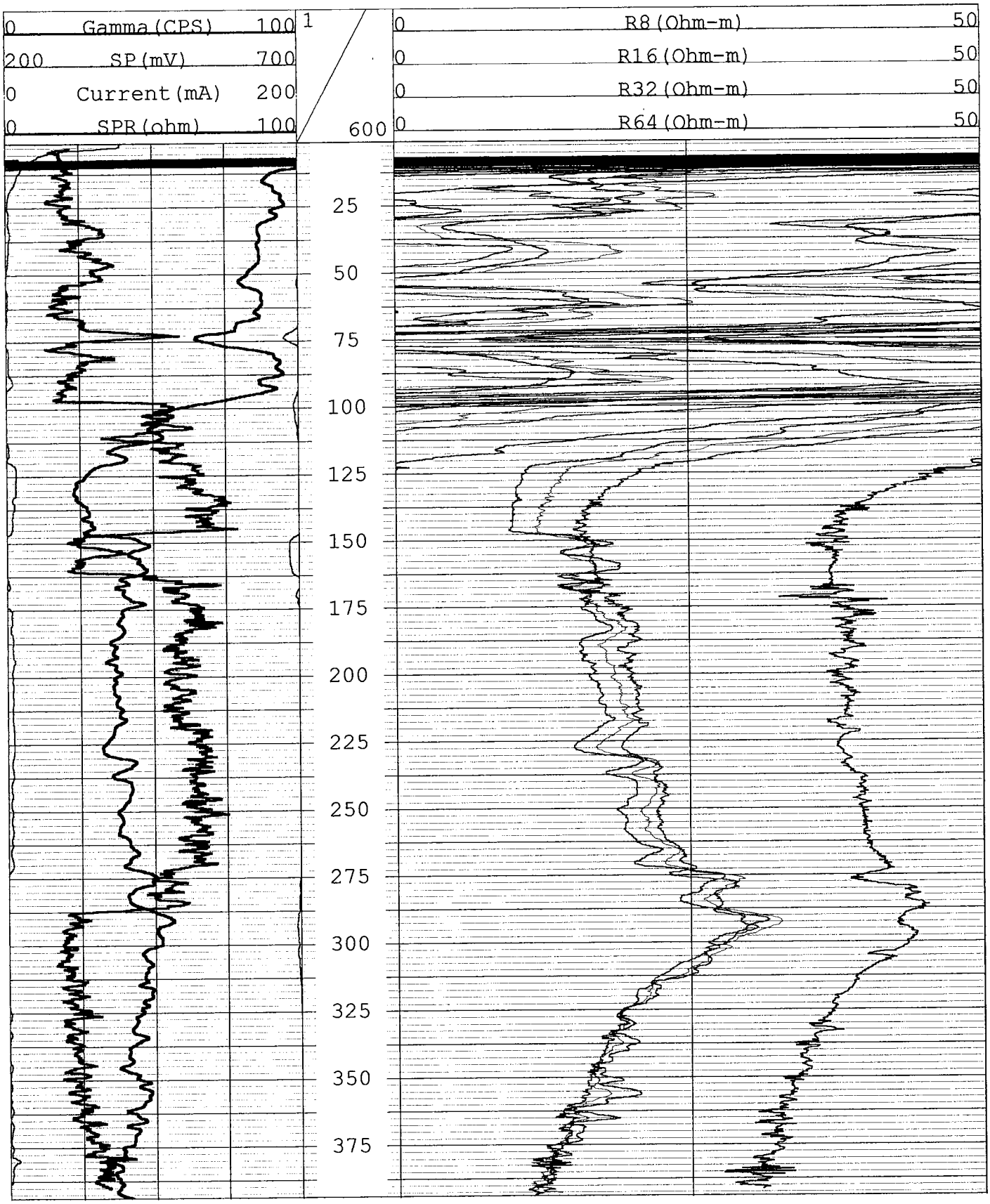
DARE CO. TEST SITE 13



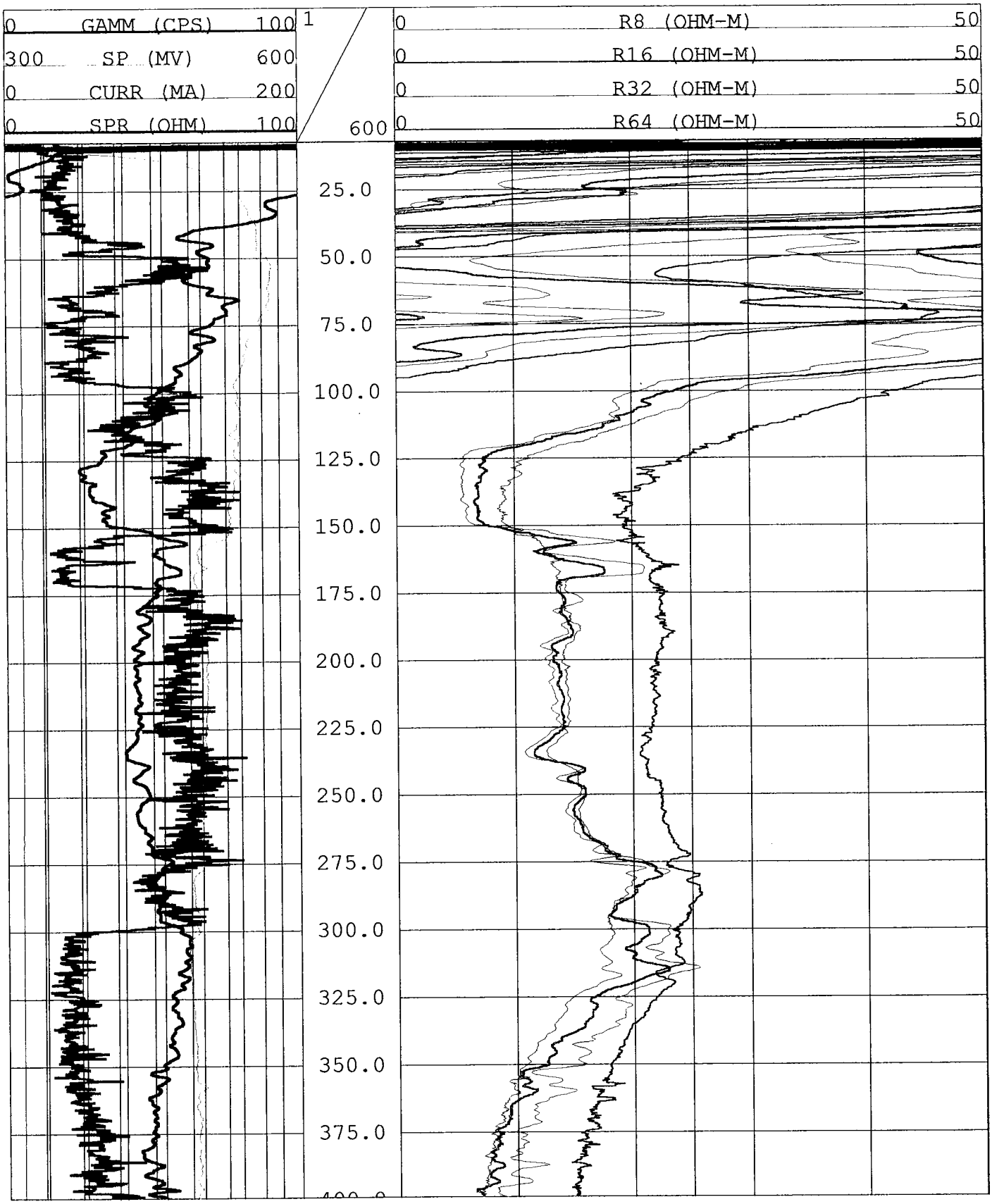
DARE CO. TEST SITE 14



DARE CO. TEST SITE 15



DARE CO. TEST SITE 16



APPENDIX D

Pumping Test Tables and Graphs

Step-Drawdown Test Results for Test Well 11s at the Future Production Well Site 11

Test well 11s Test Date: 28 January 2003 Recorded by: M. Colone Static Water Level: 28.46 feet Below Top of Casing (btoc)				
Pumping Rate (GPM)	Time (Minutes)	Water Level (btoc)	Drawdown (feet)	Specific Capacity (gpm/ft)
60	0	28.46	0	
	10	51.55	23.09	
	20	51.85	23.39	
	40	52.85	24.39	
	60	53.10	24.64	
	80	52.50	24.04	
	100	52.88	24.42	
	120	52.90	24.44	2.5
80	0	52.90	24.44	
	10	61.60	33.14	
	20	61.09	32.63	
	40	61.72	33.26	
	60	61.80	33.34	
	80	61.89	33.43	
	100	62.65	34.19	
	120	62.21	33.75	2.4
90	0	62.21	33.75	
	10	68.24	39.78	
	20	68.35	39.89	
	40	68.82	40.36	
	60	69.08	40.62	
	80	69.47	41.01	
	100	69.58	41.12	
	120	69.91	41.45	2.2

*Measuring point is top of casing approximately 3 feet above land surface.

Step-Drawdown Test Results for Test Well 13 at the Future Production Well Site 13

Test well 13 Test Date: 24 March 2003 Recorded by: M. Colone Static Water Level: 29.35 feet Below Top of Casing (btoc)				
Pumping Rate (GPM)	Time (Minutes)	Water Level (btoc)	Drawdown (feet)	Specific Capacity (gpm/ft)
60	0	29.35	0	
	5	44.64	15.29	
	10	44.86	15.51	
	20	45.23	15.88	
	30	45.56	16.21	
	40	45.50	16.15	
	50	45.68	16.33	
	60	45.72	16.37	3.7
80	0	45.72	16.37	
	5	51.90	22.55	
	10	52.14	22.79	
	20	52.60	23.25	
	30	52.72	23.37	
	40	52.87	23.52	
	50	52.99	23.64	
	60	53.06	23.71	3.4
100	0	53.06	23.71	
	5	56.68	27.33	
	10	56.80	27.45	
	20	56.95	27.60	
	30	57.04	27.69	
	40	57.13	27.78	
	50	57.18	27.83	
	60	57.25	27.90	3.6

*Measuring point is top of casing approximately 3 feet above land surface.

Step-Drawdown Test Results for Test Well 14 at the Future Production Well Site 14

Test well 14 Test Date: 13 February 2003 Recorded by: M. Colone Static Water Level: 20.81 feet Below Top of Casing (btoc)				
Pumping Rate (GPM)	Time (Minutes)	Water Level (btoc)	Drawdown (feet)	Specific Capacity (gpm/ft)
60	0	20.81	0	
	5	34.09	13.28	
	10	35.88	15.07	
	20	36.01	15.20	
	30	36.42	15.61	
	40	36.54	15.73	
	50	36.62	15.81	
	60	36.68	15.87	3.8
80	0	36.68	15.87	
	5	36.66	15.85	
	10	41.95	21.14	
	20	41.96	21.15	
	30	42.09	21.28	
	40	42.26	21.45	
	50	42.31	21.50	
	60	42.33	21.52	3.7
95	0	42.33	21.52	
	5	47.03	26.22	
	10	47.01	26.20	
	20	47.01	26.20	
	30	46.98	26.17	
	40	47.02	26.21	
	50	47.02	26.21	
	60	47.12	26.31	3.6

*Measuring point is top of casing approximately 3 feet above land surface.

Step-Drawdown Test Results for Test Well 15 at the Future Production Well Site 15

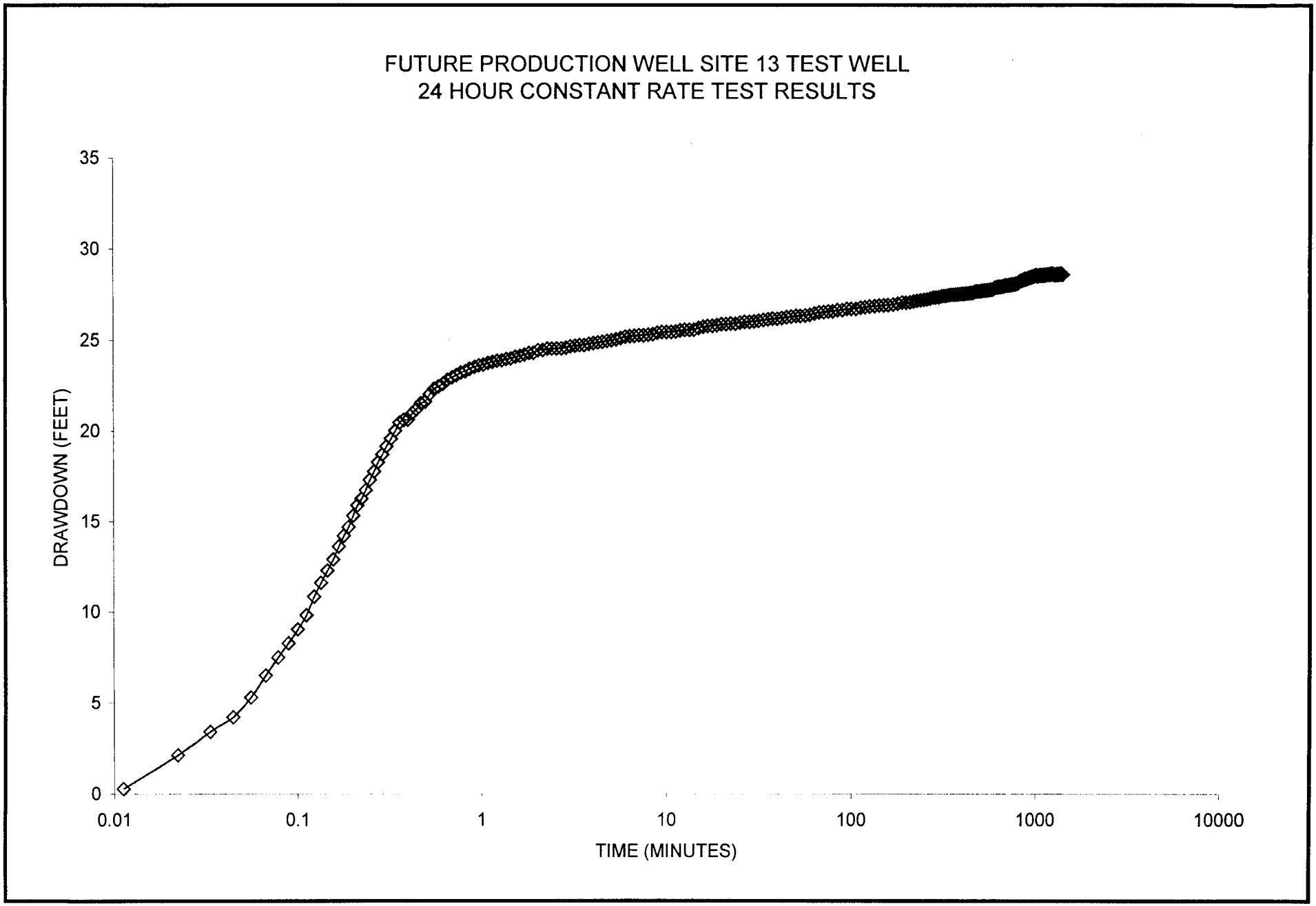
Test well 15 Test Date: 4 February 2003 Recorded by: M. Colone Static Water Level: 18.24 feet Below Top of Casing (btoc)				
Pumping Rate (GPM)	Time (Minutes)	Water Level (btoc)	Drawdown (feet)	Specific Capacity (gpm/ft)
60	0	18.24	0	
	10	29.06	10.82	
	20	30.09	11.85	
	40	30.35	12.11	
	60	30.69	12.45	
	80	30.87	12.63	
	100	31.40	13.16	
	120	30.30	12.06	5.0
80	0	30.30	12.06	
	10	34.49	16.25	
	20	35.85	17.61	
	30	35.91	17.67	
	40	36.06	17.82	
	50	36.29	18.05	
	70	36.24	18.00	
	80	35.88	17.64	4.5
95	0	35.88	17.64	
	5	40.20	21.96	
	10	40.36	22.12	
	20	40.83	22.59	
	30	40.99	22.75	
	40	41.39	23.15	
	50	41.17	22.93	
	60	40.98	22.74	4.2

*Measuring point is top of casing approximately 3 feet above land surface.

Step-Drawdown Test Results for Test Well 16 at the Future Production Well Site 16

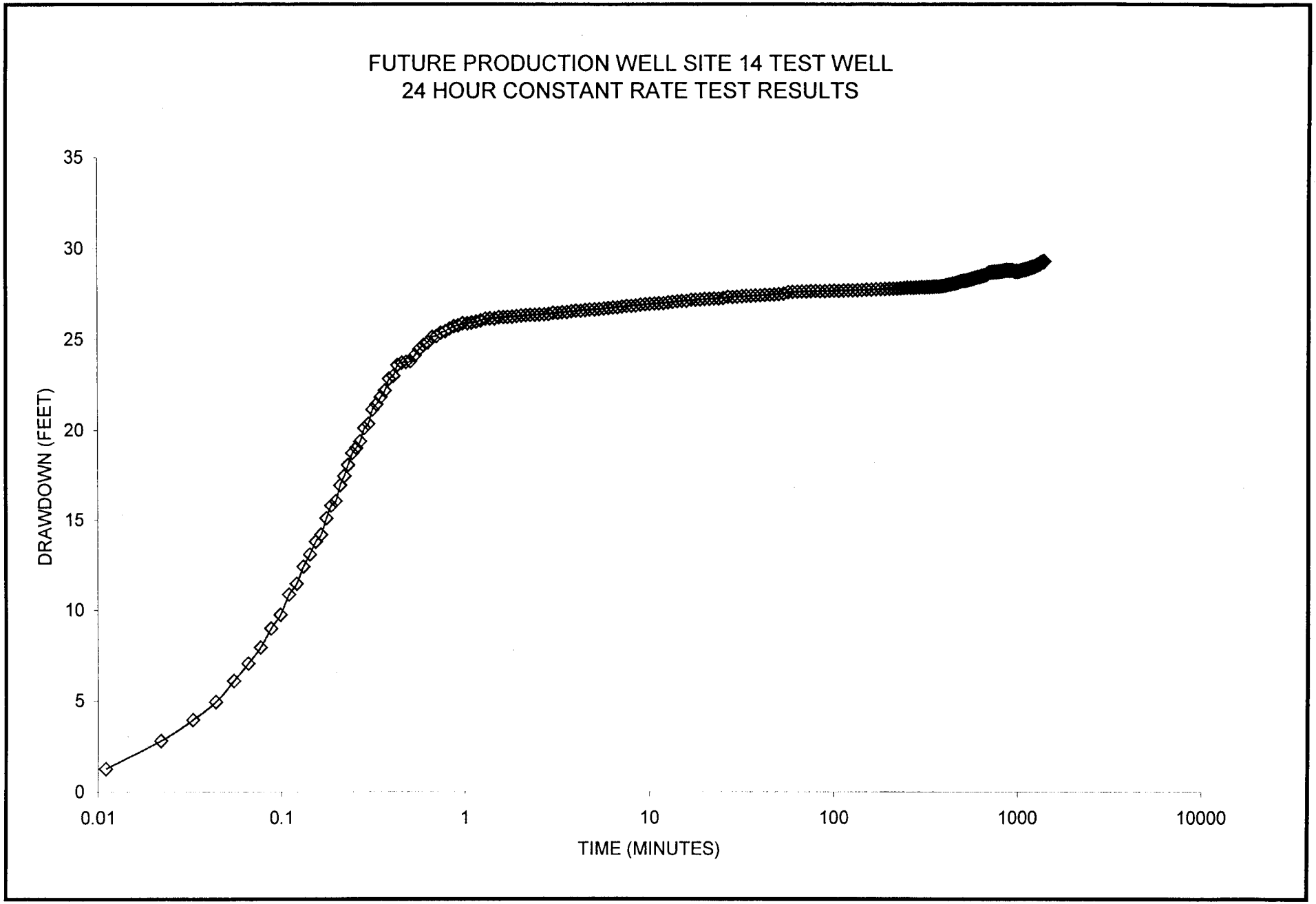
Test well 16 Test Date: 2 April 2003 Recorded by: M. Colone Static Water Level: 16.15 feet Below Top of Casing (btoc)				
Pumping Rate (GPM)	Time (Minutes)	Water Level (btoc)	Drawdown (feet)	Specific Capacity (gpm/ft)
60	0	16.15	0	
	5	29.10	12.95	
	10	29.45	13.30	
	20	29.49	13.34	
	30	29.51	13.36	
	40	29.57	13.42	
	50	29.59	13.44	
	60	29.57	13.42	4.5
80	0	29.57	13.42	
	5	33.58	17.43	
	10	33.58	17.43	
	20	33.52	17.37	
	30	33.61	17.46	
	40	33.65	17.50	
	50	33.64	17.49	
	60	33.67	17.52	4.6
100	0	33.67	17.52	
	5	37.33	21.18	
	10	37.38	21.23	
	20	37.45	21.30	
	30	37.52	21.37	
	40	37.54	21.39	
	50	37.55	21.40	
	60	37.57	21.42	4.7

*Measuring point is top of casing approximately 3.15 feet above land surface.



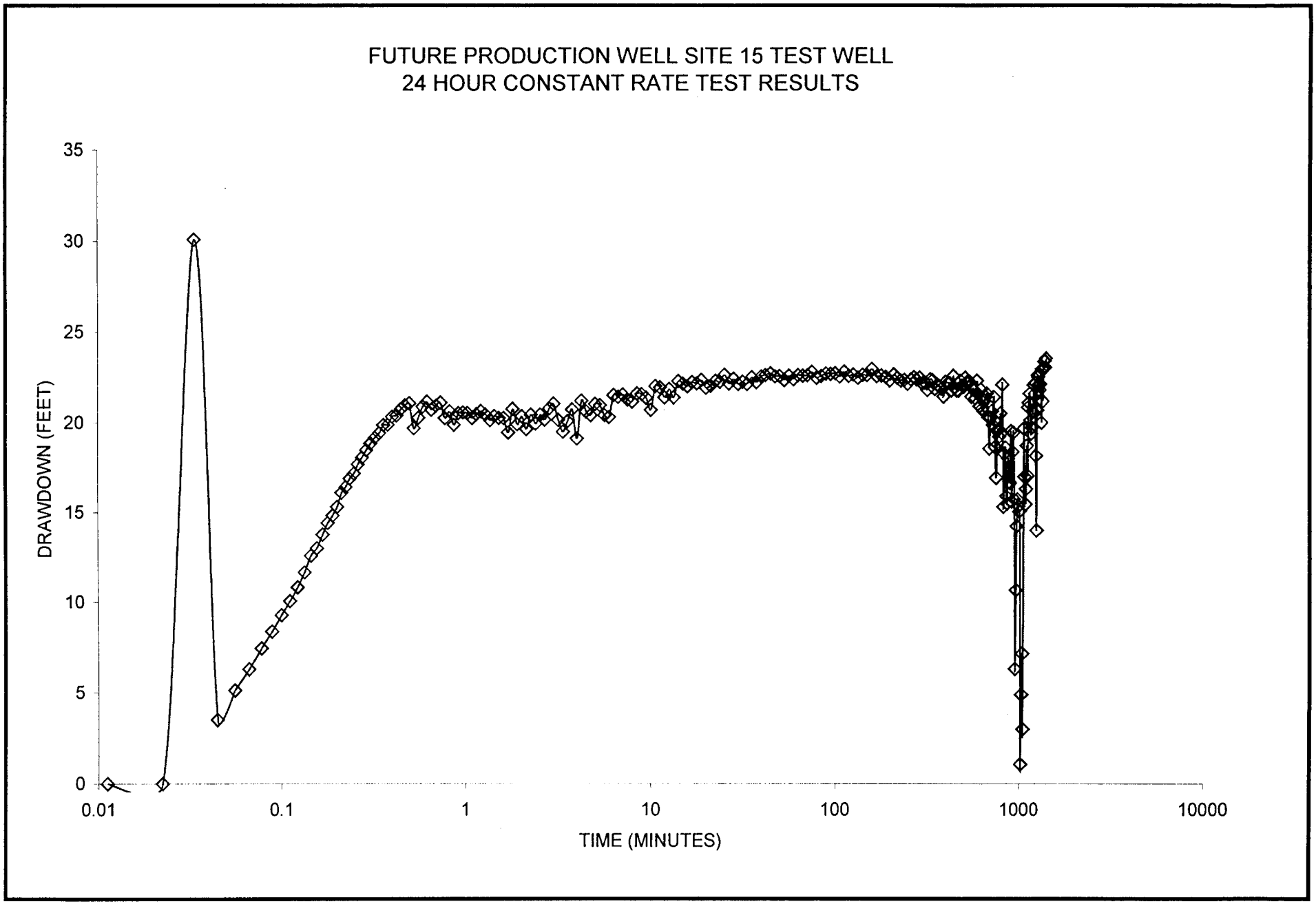
Dare County Test Wells
Semi-log Graph Showing Drawdown vs. time in Test Well 13
While Pumping at 100 GPM

CDM Missimer



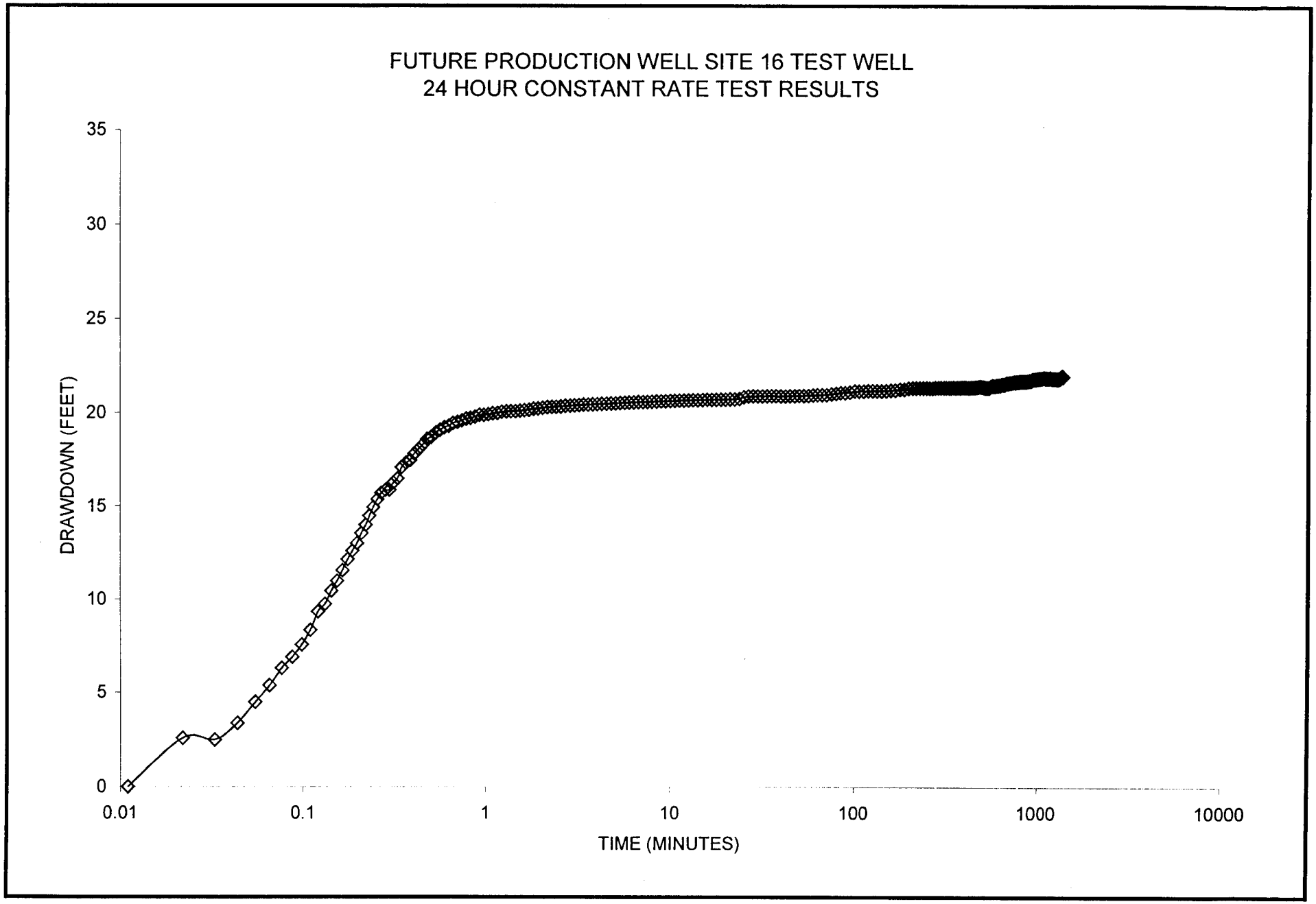
Dare County Test Wells
Semi-log Graph Showing Drawdown vs. Time in Test Well 14
While Pumping at 93 GPM

CDM Missimer



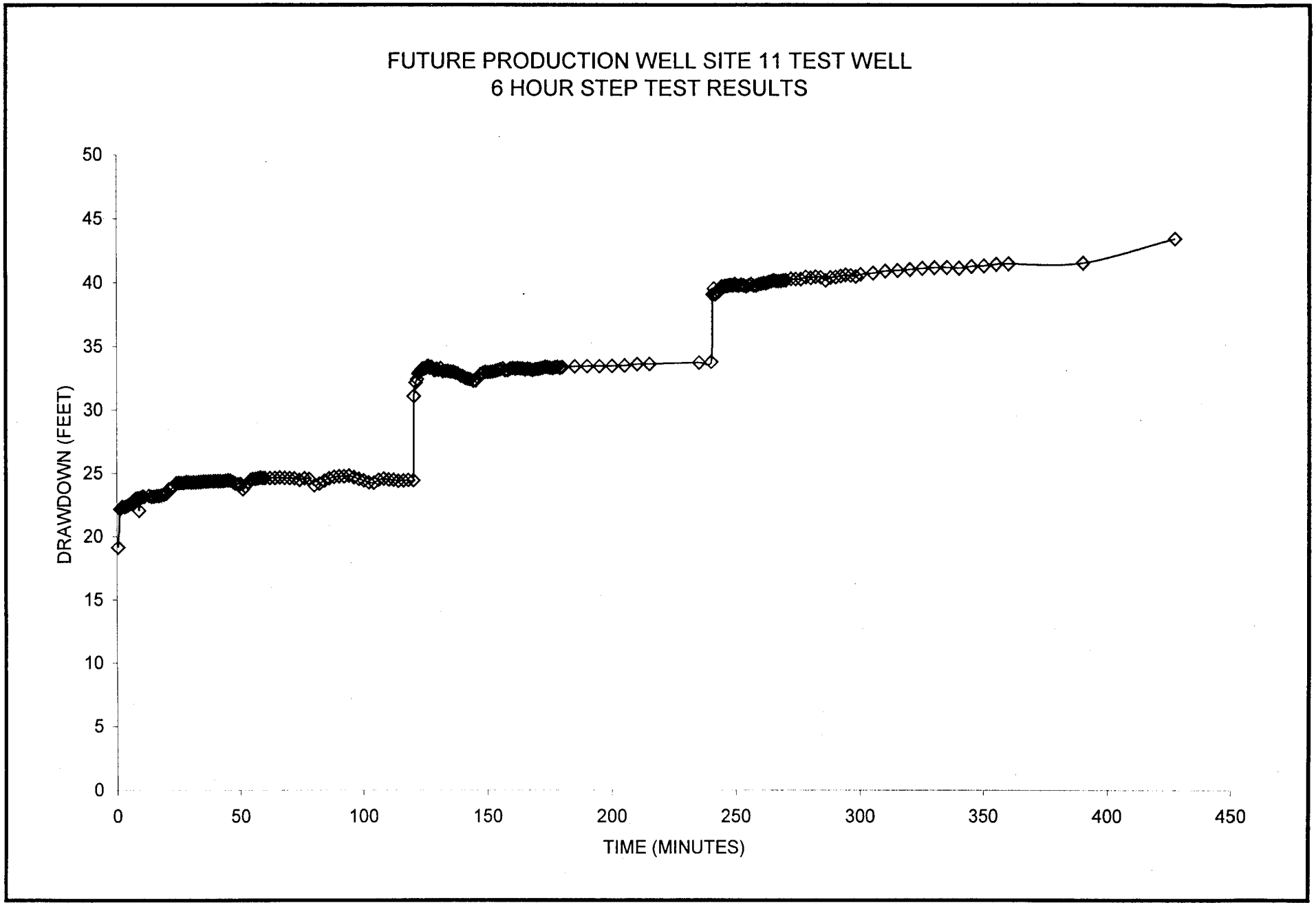
Dare County Test Wells
Semi-log Graph Showing Drawdown vs. Time in Test Well 15
While Pumping at 95 GPM

CDM Missimer



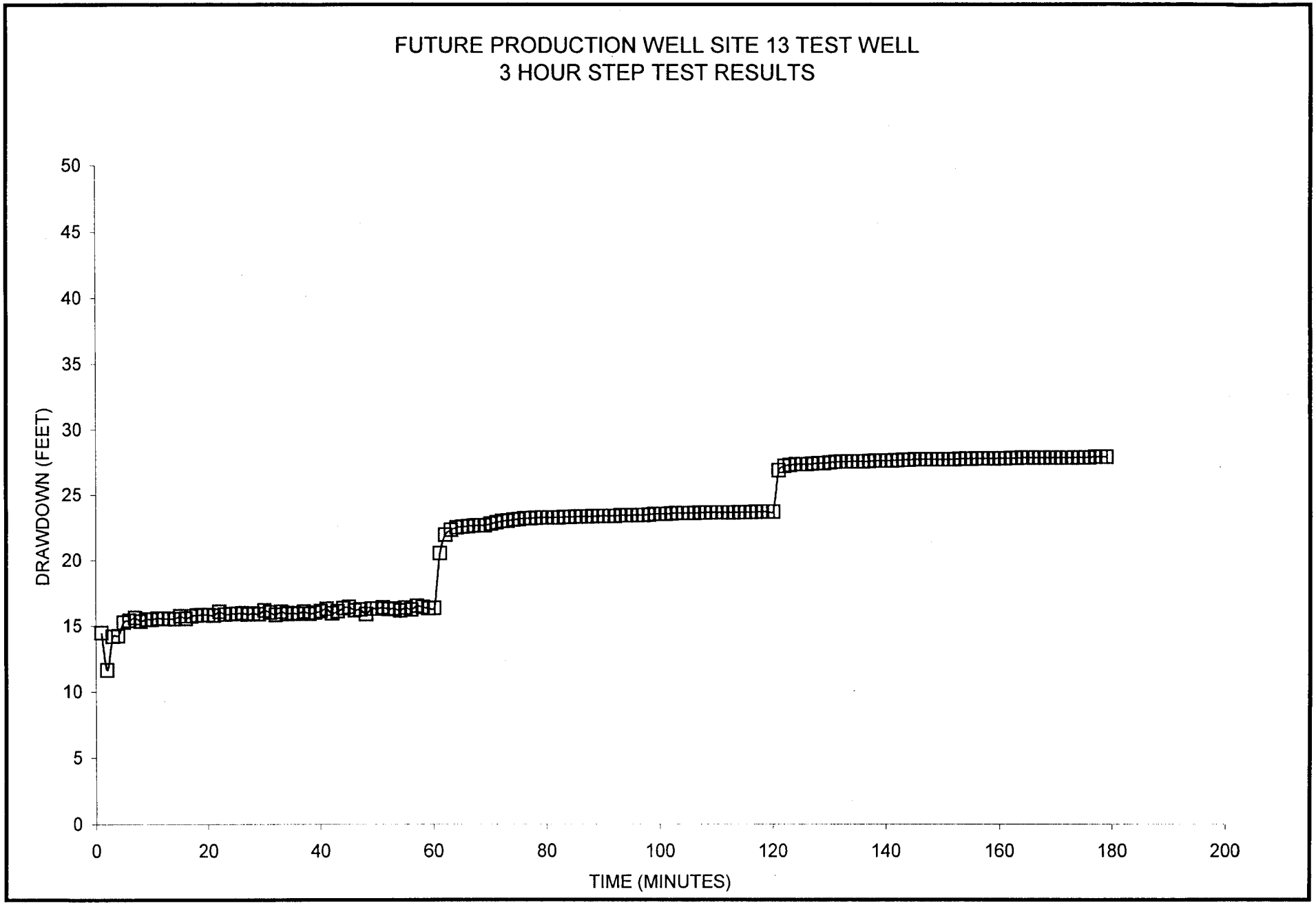
Dare County Test Wells
Semi-log Graph Showing Drawdown vs. Time in Test Well 16
While Pumping at 100 GPM

CDM Missimer



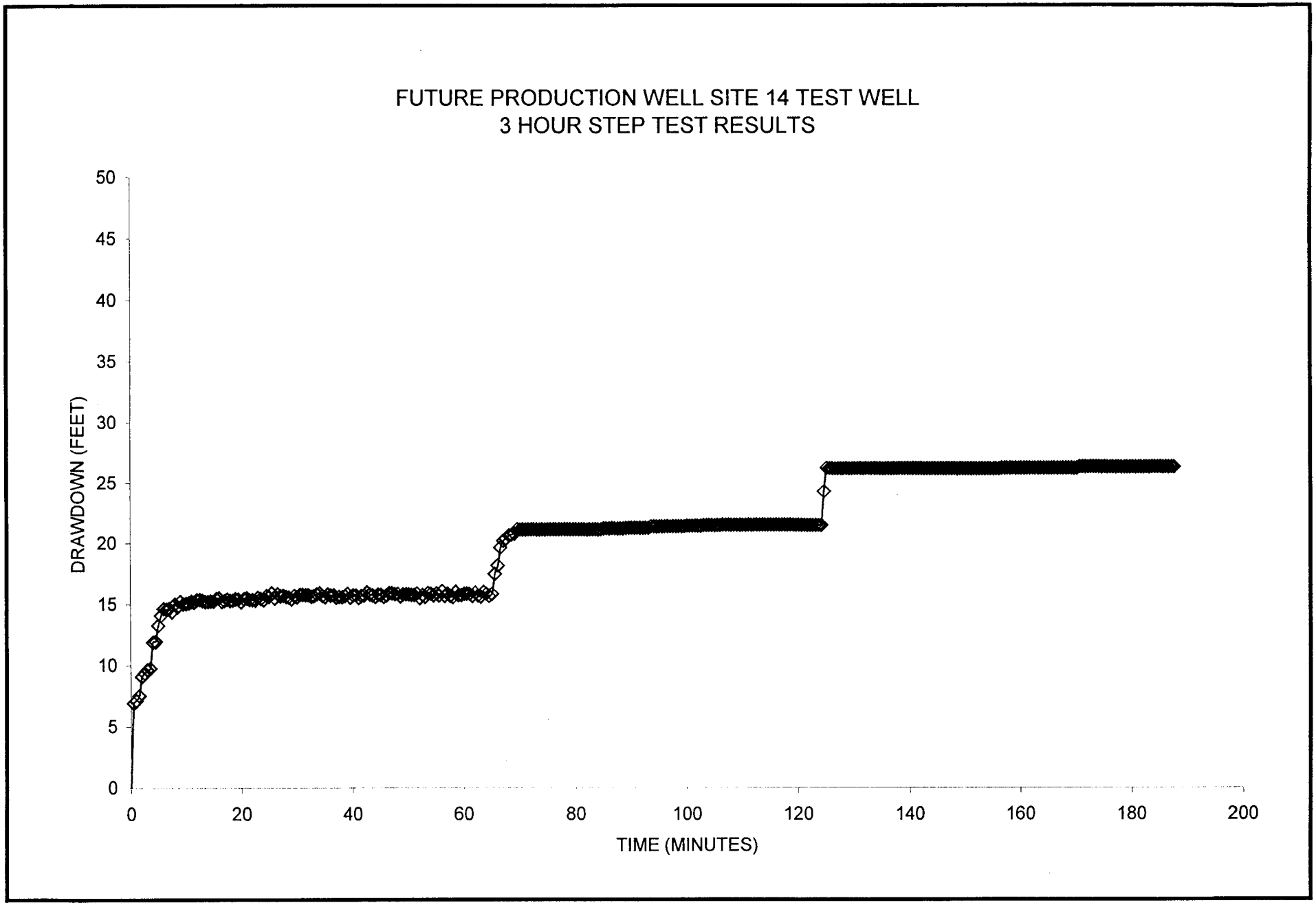
Dare County Test Wells
Graph Showing Drawdown in Test Well 11s
While Pumping at rates of 60, 80, and 90 GPM

CDM Missimer



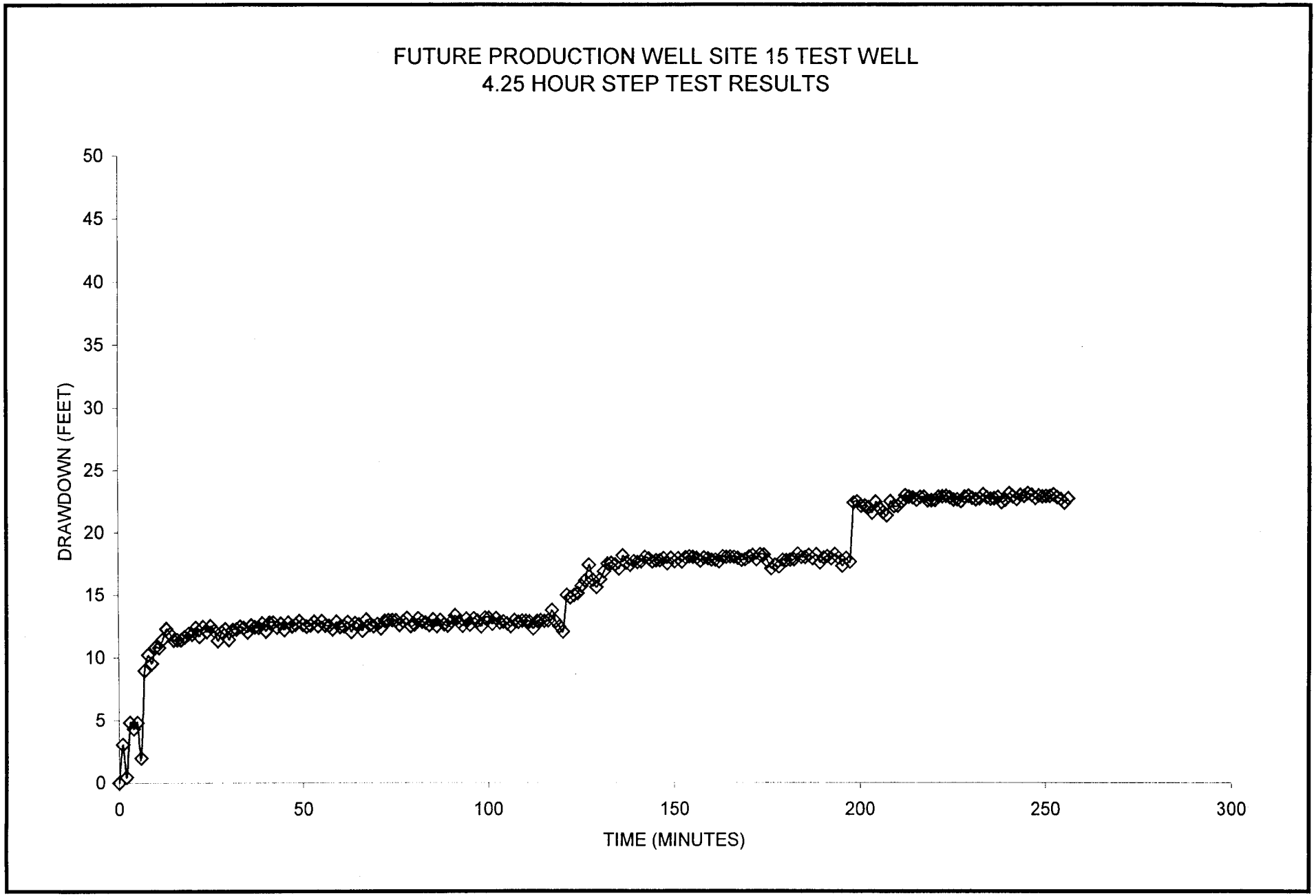
Dare County Test Wells
Graph Showing Drawdown in Test Well 13
While Pumping at rates of 60, 80, and 100 GPM

CDM Missimer



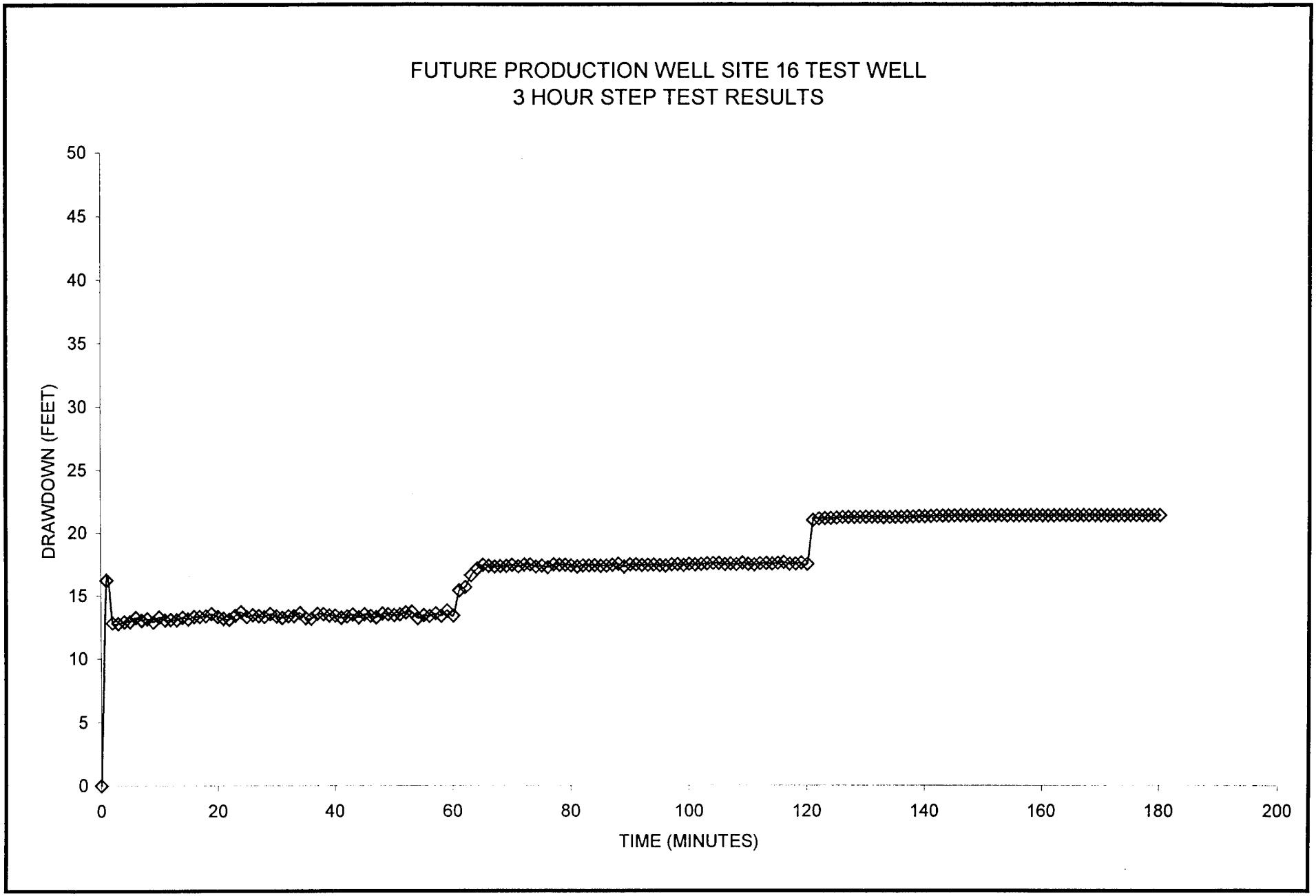
Dare County Test Wells
Graph Showing Drawdown in Test Well 14
While Pumping at rates of 60, 80, and 95 GPM

CDM Missimer



Dare County Test Wells
Graph Showing Drawdown in Test Well 15
While Pumping at rates of 60, 80, and 95 GPM

CDM Missimer



Dare County Test Wells
Graph Showing Drawdown in Test Well 16
While Pumping at rates of 60, 80, and 100 GPM

CDM Missimer

APPENDIX E

Water Quality Analyses

SEVERN TRENT STL

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Analytical Report

TW-13

Report To: Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Ft. Myers, FL 33919

Project Number: 17952-37587
Project Name: Dare County Test Wells
STL Log Number: B351084
Report Date: April 4, 2003

Results Pages 1 through 6 (excluding cover page)

Michael F. Valder, Project Manager
mvalder@stl-inc.com

SEVERN TRENT STL

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LOG NO: B3-51084
Received: 26 MAR 03
Reported: 04 APR 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE COUNTY TEST WELLS
Sampled By: Client
Code: 16493047

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
51084-1	TP-13	03-25-03/15:00

PARAMETER	51084-1
Alkalinity (to pH 4.5) as CaCO3 (310.1), mg/l	580
Analysis Date	03.27.03
Bicarbonate Alkalinity as CaCO3 (SM2320B), mg/l	560
Analysis Date	03.31.03
Chloride (325.3), mg/l	1000
Analysis Date	03.27.03
Color (110.2), PCU	40
Analysis Date	03.27.03
Fluoride (340.2), mg/l	0.59
Analysis Date	03.31.03
Sulfate as SO4 (375.4), mg/l	<5.0
Analysis Date	03.27.03
Solids, Total Dissolved (160.1), mg/l	2000
Analysis Date	03.28.03
Turbidity (180.1), NTU	0.58
Analysis Date	03.27.03

SEVERN TRENT STL

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LOG NO: B3-51084
Received: 26 MAR 03
Reported: 04 APR 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE COUNTY TEST WELLS
Sampled By: Client
Code: 16493047

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
51084-1	TP-13	03-25-03/15:00

PARAMETER	51084-1
ICP Metals (6010)	
Arsenic, mg/l	<0.010
Boron, mg/l	1.7
Calcium, mg/l	12
Copper, mg/l	<0.020
Iron, mg/l	<0.050
Magnesium, mg/l	22
Nickel, mg/l	<0.040
Sodium, mg/l	730
Strontium, mg/l	0.38
Zinc, mg/l	<0.020
Manganese, mg/l	<0.010
Prep Date	03.26.03
Analysis Date	03.27.03
Hardness as CaCO3 (2340B), mg/l	120
Prep Date	03.26.03
Analysis Date	03.27.03
Noncarbonate Hardness as CaCO3 (2340B)	
Hardness as CaCO3, mg/l	30
Prep Date	03.26.03
Analysis Date	03.27.03

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LOG NO: B3-51084
Received: 26 MAR 03
Reported: 04 APR 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE COUNTY TEST WELLS
Sampled By: Client
Code: 16493047

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
51084-1	TP-13	03-25-03/15:00

PARAMETER	51084-1
Bromide (300.0), mg/l	3.8
Prep Date	03.31.03
Analysis Date	03.31.03
Sulfide (376.1), mg/l	<1.0
Analysis Date	03.29.03
Silica as SiO2 (6010), mg/l	18
Prep Date	04.02.03
Analysis Date	04.02.03

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Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE COUNTY TEST WELLS
Sampled By: Client
Code: 16493047

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
51084-2	Method Blank	
51084-3	Accuracy (%Rec)	
51084-4	LCS Accuracy Control Limit (%R)	
51084-5	Precision (%RPD)	
51084-6	LCS Precision Control Limit (Advisory) %RPD	

PARAMETER	51084-2	51084-3	51084-4	51084-5	51084-6
Alkalinity (to pH 4.5) as CaCO3 (310.1), mg/l	<1.0	105 %	80-120 %	0 %	<30 %
Analysis Date	03.27.03	03.27.03	---	03.27.03	---
Bicarbonate Alkalinity as CaCO3 (SM2320B), mg/l	<1.0	104 %	80-120 %	0.82 %	<30 %
Analysis Date	03.31.03	03.31.03	---	03.31.03	---
Chloride (325.3), mg/l	<1.0	102 %	75-125 %	0.89 %	<30 %
Analysis Date	03.27.03	03.27.03	---	03.27.03	---
Color (110.2), PCU	<5	100 %	NA	0 %	<40 %
Analysis Date	03.27.03	03.27.03	---	03.27.03	---
Fluoride (340.2), mg/l	<0.20	108 %	85-115 %	3.7 %	<30 %
Analysis Date	03.31.03	03.31.03	---	03.31.03	---
Sulfate as SO4 (375.4), mg/l	<5.0	91 %	75-125 %	2.9 %	<30 %
Analysis Date	03.27.03	03.27.03	---	03.27.03	---
Solids, Total Dissolved (160.1), mg/l	<5.0	101 %	80-120 %	0.10 %	<25 %
Analysis Date	03.28.03	03.28.03	---	03.28.03	---

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LOG NO: B3-51084
Received: 26 MAR 03
Reported: 04 APR 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE COUNTY TEST WELLS
Sampled By: Client
Code: 16493047

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
51084-2	Method Blank	
51084-3	Accuracy (%Rec)	
51084-4	LCS Accuracy Control Limit (%R)	
51084-5	Precision (%RPD)	
51084-6	LCS Precision Control Limit (Advisory) %RPD	

PARAMETER	51084-2	51084-3	51084-4	51084-5	51084-6
Turbidity (180.1), NTU	<0.10	97 %	90-110 %	1.6 %	<30 %
Analysis Date	03.27.03	03.27.03	---	03.27.03	---
ICP Metals (6010)					
Arsenic, mg/l	<0.010	103 %	75-125 %	2.5 %	<20 %
Boron, mg/l	<0.050	101 %	75-125 %	1.2 %	<20 %
Calcium, mg/l	<0.50	103 %	75-125 %	2.3 %	<20 %
Copper, mg/l	<0.020	98 %	75-125 %	1.2 %	<20 %
Iron, mg/l	<0.050	110 %	75-125 %	2.2 %	<20 %
Magnesium, mg/l	<0.50	112 %	75-125 %	2.2 %	<20 %
Nickel, mg/l	<0.040	102 %	75-125 %	2.0 %	<20 %
Sodium, mg/l	<0.50	96 %	75-125 %	2.0 %	<20 %
Strontium, mg/l	<0.010	97 %	75-125 %	1.4 %	<20 %
Zinc, mg/l	<0.020	105 %	75-125 %	2.1 %	<20 %
Manganese, mg/l	<0.010	101 %	75-125 %	2.0 %	<20 %
Prep Date	03.26.03	03.26.03	---	03.26.03	---
Analysis Date	03.27.03	03.27.03	---	03.27.03	---
Bromide (300.0), mg/l	<1.0	100 %	90-110 %	1.2 %	<30 %
Prep Date	03.31.03	03.31.03	---	03.31.03	---
Analysis Date	03.31.03	03.31.03	---	03.31.03	---

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LOG NO: B3-51084
Received: 26 MAR 03
Reported: 04 APR 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE COUNTY TEST WELLS
Sampled By: Client
Code: 16493047

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
51084-2	Method Blank	
51084-3	Accuracy (%Rec)	
51084-4	LCS Accuracy Control Limit (%R)	
51084-5	Precision (%RPD)	
51084-6	LCS Precision Control Limit (Advisory) %RPD	

PARAMETER	51084-2	51084-3	51084-4	51084-5	51084-6
Sulfide (376.1), mg/l	<1.0	96 %	75-125 %	0 %	<30 %
Analysis Date	03.29.03	03.29.03	---	03.29.03	---
Silica as SiO2 (6010), mg/l	<0.50	94 %	75-125 %	0.35 %	<20 %
Prep Date	04.02.03	04.02.03	---	04.02.03	---
Analysis Date	04.02.03	04.02.03	---	04.02.03	---

These test results meet all the requirements of NELAC. All questions regarding this test report should be directed to the STL Project Manager who signed this test report.
Method: EPA SW-846
DOH Certifiaction #: E84282

Michael F. Valder, Project Manager

SEVERN TRENT STL

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Analytical Report

Report To: Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Ft. Myers, FL 33919

TW-14

Project Number: 17952-37587
Project Name: DARE TEST WELLS
STL Log Number: B350626
Report Date: February 28, 2003

Results Pages 1 through 6 (excluding cover page)

Michael F. Valder, Project Manager
mvalder@stl-inc.com

SEVERN TRENT STL

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LOG NO: B3-50626
Received: 20 FEB 03
Reported: 28 FEB 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE TEST WELLS
Sampled By: Client
Code: 161730228

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
50626-1	Test Well #14	02-19-03/15:00

PARAMETER	50626-1
Fluoride (340.2), mg/l	0.65
Analysis Date	02.24.03
Sulfate as SO4 (375.4), mg/l	<5.0
Analysis Date	02.24.03
Solids, Total Dissolved (160.1), mg/l	2600
Analysis Date	02.21.03
Alkalinity (to pH 4.5) as CaCO3 (310.1), mg/l	540
Analysis Date	02.24.03
Turbidity (180.1), NTU	0.77
Analysis Date	02.20.03
Sulfide (376.1), mg/l	<1.0
Analysis Date	02.22.03
Silica as SiO2 (6010), mg/l	21
Prep Date	02.27.03
Analysis Date	02.27.03

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LOG NO: B3-50626
Received: 20 FEB 03
Reported: 28 FEB 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE TEST WELLS
Sampled By: Client
Code: 161730228

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
50626-1	Test Well #14	02-19-03/15:00

PARAMETER	50626-1
ICP Metals (6010)	
Arsenic, mg/l	<0.010
Calcium, mg/l	18
Copper, mg/l	<0.020
Iron, mg/l	0.14
Magnesium, mg/l	36
Nickel, mg/l	<0.040
Sodium, mg/l	920
Strontium, mg/l	0.66
Zinc, mg/l	<0.020
Boron, mg/l	1.8
Manganese, mg/l	<0.010
Prep Date	02.20.03
Analysis Date	02.24.03
Color (110.2), PCU	20
Analysis Date	02.20.03
Bicarbonate Alkalinity as CaCO3 (SM2320B), mg/l	540
Analysis Date	02.24.03
Bromide (300.0), mg/l	4.9
Prep Date	02.25.03
Analysis Date	02.25.03

SEVERN TRENT STL

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LOG NO: B3-50626
Received: 20 FEB 03
Reported: 28 FEB 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE TEST WELLS
Sampled By: Client
Code: 161730228

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
50626-1	Test Well #14	02-19-03/15:00

PARAMETER	50626-1
Chloride (325.3), mg/l	1200
Analysis Date	02.21.03
Hardness as CaCO3 (2340B), mg/l	130
Prep Date	02.20.03
Analysis Date	02.24.03
Noncarbonate Hardness as CaCO3 (2340B)	
Hardness as CaCO3, mg/l	0

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LOG NO: B3-50626
Received: 20 FEB 03
Reported: 28 FEB 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE TEST WELLS
Sampled By: Client
Code: 161730228

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
50626-2	Method Blank	
50626-3	Accuracy (%Rec)	
50626-4	LCS Accuracy Control Limit (%R)	
50626-5	Precision (%RPD)	
50626-6	LCS Precision Control Limit (Advisory) %RPD	

PARAMETER	50626-2	50626-3	50626-4	50626-5	50626-6
Fluoride (340.2), mg/l	<0.20	89 %	85-115 %	0.84 %	<30 %
Analysis Date	02.24.03	02.24.03	---	02.24.03	---
Sulfate as SO4 (375.4), mg/l	<5.0	101 %	75-125 %	0 %	<30 %
Analysis Date	02.24.03	02.24.03	---	02.24.03	---
Solids, Total Dissolved (160.1), mg/l	<5.0	102 %	80-120 %	1.2 %	<25 %
Analysis Date	02.21.03	02.21.03	---	02.21.03	---
Alkalinity (to pH 4.5) as CaCO3 (310.1), mg/l	<1.0	103 %	80-120 %	0 %	<40 %
Analysis Date	02.24.03	02.24.03	---	02.24.03	---
Turbidity (180.1), NTU	<0.10	102 %	90-110 %	0.79 %	<30 %
Analysis Date	02.20.03	02.20.03	---	02.20.03	---
Sulfide (376.1), mg/l	<1.0	99 %	75-125 %	0.81 %	<30 %
Analysis Date	02.22.03	02.22.03	---	02.22.03	---

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LOG NO: B3-50626
Received: 20 FEB 03
Reported: 28 FEB 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE TEST WELLS
Sampled By: Client
Code: 161730228

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
50626-2	Method Blank	
50626-3	Accuracy (%Rec)	
50626-4	LCS Accuracy Control Limit (%R)	
50626-5	Precision (%RPD)	
50626-6	LCS Precision Control Limit (Advisory) %RPD	

PARAMETER	50626-2	50626-3	50626-4	50626-5	50626-6
Silica as SiO2 (6010), mg/l	<0.50	95 %	75-125 %	1.2 %	<20 %
Prep Date	02.27.03	02.27.03	---	02.27.03	---
Analysis Date	02.27.03	02.27.03	---	02.27.03	---
ICP Metals (6010)					
Arsenic, mg/l	<0.010	103 %	75-125 %	1.3 %	<20 %
Calcium, mg/l	<0.50	82 %	75-125 %	0.12 %	<20 %
Copper, mg/l	<0.020	103 %	75-125 %	0.40 %	<20 %
Iron, mg/l	<0.050	106 %	75-125 %	0.64 %	<20 %
Magnesium, mg/l	<0.50	100 %	75-125 %	3.5 %	<20 %
Nickel, mg/l	<0.040	103 %	75-125 %	1.2 %	<20 %
Sodium, mg/l	<0.50	101 %	75-125 %	0.83 %	<20 %
Strontium, mg/l	<0.010	94 %	75-125 %	0.12 %	<20 %
Zinc, mg/l	<0.020	103 %	75-125 %	1.5 %	<20 %
Boron, mg/l	<0.050	102 %	75-125 %	0.43 %	<20 %
Manganese, mg/l	<0.010	103 %	75-125 %	0.70 %	<20 %
Prep Date	02.20.03	02.20.03	---	02.20.03	---
Analysis Date	02.24.03	02.24.03	---	02.24.03	---
Color (110.2), PCU	<5	100 %	NA	0 %	<40 %
Analysis Date	02.20.03	02.20.03	---	02.20.03	---

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LOG NO: B3-50626
Received: 20 FEB 03
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Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE TEST WELLS
Sampled By: Client
Code: 161730228

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
50626-2	Method Blank	
50626-3	Accuracy (%Rec)	
50626-4	LCS Accuracy Control Limit (%R)	
50626-5	Precision (%RPD)	
50626-6	LCS Precision Control Limit (Advisory) %RPD	

PARAMETER	50626-2	50626-3	50626-4	50626-5	50626-6
Bicarbonate Alkalinity as CaCO3 (SM2320B), mg/l	<1.0	103 %	80-120 %	0 %	<30 %
Analysis Date	02.24.03	02.24.03	---	02.24.03	---
Bromide (300.0), mg/l	<1.0	100 %	90-110 %	4.9 %	<30 %
Prep Date	02.25.03	02.25.03	---	02.25.03	---
Analysis Date	02.25.03	02.25.03	---	02.25.03	---
Chloride (325.3), mg/l	<1.0	100 %	75-125 %	1.0 %	<30 %
Analysis Date	02.21.03	02.21.03	---	02.21.03	---

Methods: EPA SW-846, EPA 600/4-79-020
DOH Certification #: E84282

These test results meet all the requirements of NELAC. All questions regarding this test report should be directed to the STL project manager who signed this test report. The estimated uncertainty associated with these reported results is available upon request.

STL Savannah, 5102 LaRoche Ave., Savannah, GA 31404
Certification #E87052.

Michael F. Valder, Project Manager

Final Page Of Report

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Analytical Report

Report To: Mr. Scott Manahan
CDM Missimer
8140 Coleege Pkwy Suite 202
Ft. Myers, FL 33919

TW-15

Project Number: 17952-37587
Project Name: Dare Test Wells
STL Log Number: B350450
Report Date: February 18, 2003

Results Pages 1 through 6 (excluding cover page)

Michael F. Valder, Project Manager
mvalder@stl-inc.com

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LOG NO: B3-50450
Received: 06 FEB 03
Reported: 18 FEB 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE TEST WELLS
Sampled By: Client
Code: 104630218

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
50450-1	TP-15	02-05-03/14:00

PARAMETER	50450-1
Fluoride (340.2), mg/l	0.65
Analysis Date	02.12.03
Sulfate as SO4 (375.4), mg/l	<5.0
Analysis Date	02.10.03
Solids, Total Dissolved (160.1), mg/l	2500
Analysis Date	02.07.03
Alkalinity (to pH 4.5) as CaCO3 (310.1), mg/l	560
Analysis Date	02.10.03
Turbidity (180.1), NTU	0.51
Analysis Date	02.07.03
Sulfide (376.1), mg/l	<1.0
Analysis Date	02.07.03
Silica as SiO2 (6010), mg/l	22
Prep Date	02.10.03
Analysis Date	02.10.03

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LOG NO: B3-50450
Received: 06 FEB 03
Reported: 18 FEB 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE TEST WELLS
Sampled By: Client
Code: 104630218

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
50450-1	TP-15	02-05-03/14:00

PARAMETER	50450-1
ICP Metals (6010)	
Calcium, mg/l	17
Copper, mg/l	<0.020
Iron, mg/l	0.14
Magnesium, mg/l	34
Nickel, mg/l	<0.040
Sodium, mg/l	1000
Strontium, mg/l	0.63
Zinc, mg/l	<0.020
Boron, mg/l	1.8
Manganese, mg/l	<0.010
Prep Date	02.06.03
Analysis Date	02.07.03
Color (110.2), PCU	30
Analysis Date	02.07.03
Bicarbonate Alkalinity as CaCO3 (SM2320B), mg/l	560
Analysis Date	02.10.03
Bromide (300.0), mg/l	5.1
Prep Date	02.10.03
Analysis Date	02.11.03
Chloride (325.3), mg/l	1300
Analysis Date	02.10.03

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LOG NO: B3-50450
Received: 06 FEB 03
Reported: 18 FEB 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE TEST WELLS
Sampled By: Client
Code: 104630218

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
50450-1	TP-15	02-05-03/14:00

PARAMETER	50450-1
Hardness as CaCO3 (2340B), mg/l	180
Prep Date	02.06.03
Analysis Date	02.07.03
Noncarbonate Hardness as CaCO3 (2340B)	
Hardness as CaCO3, mg/l	0

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LOG NO: B3-50450
Received: 06 FEB 03
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Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE TEST WELLS
Sampled By: Client
Code: 104630218

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
50450-2	Method Blank	
50450-3	Accuracy (%Rec)	
50450-4	LCS Accuracy Control Limit (%R)	
50450-5	Precision (%RPD)	
50450-6	LCS Precision Control Limit (Advisory) %RPD	

PARAMETER	50450-2	50450-3	50450-4	50450-5	50450-6
Fluoride (340.2), mg/l	<0.20	107 %	85-115 %	0 %	<30 %
Analysis Date	02.12.03	02.12.03	---	02.12.03	---
Sulfate as SO4 (375.4), mg/l	<5.0	102 %	75-125 %	2.9 %	<30 %
Analysis Date	02.10.03	02.10.03	---	02.10.03	---
Solids, Total Dissolved (160.1), mg/l	<5.0	103 %	80-120 %	0.29 %	<25 %
Analysis Date	02.07.03	02.07.03	---	02.07.03	---
Alkalinity (to pH 4.5) as CaCO3 (310.1), mg/l	<1.0	106 %	80-120 %	0 %	<30 %
Analysis Date	02.10.03	02.10.03	---	02.10.03	---
Turbidity (180.1), NTU	<0.10	102 %	90-110 %	0.99 %	<30 %
Analysis Date	02.07.03	02.07.03	---	02.07.03	---
Sulfide (376.1), mg/l	<1.0	98 %	75-125 %	0 %	<30 %
Analysis Date	02.07.03	02.07.03	---	02.07.03	---

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LOG NO: B3-50450
Received: 06 FEB 03
Reported: 18 FEB 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE TEST WELLS
Sampled By: Client
Code: 104630218

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
50450-2	Method Blank	
50450-3	Accuracy (%Rec)	
50450-4	LCS Accuracy Control Limit (%R)	
50450-5	Precision (%RPD)	
50450-6	LCS Precision Control Limit (Advisory) %RPD	

PARAMETER	50450-2	50450-3	50450-4	50450-5	50450-6
Silica as SiO2 (6010), mg/l	<0.50	96 %	75-125 %	13 %	<20 %
Prep Date	02.10.03	02.10.03	---	02.10.03	---
Analysis Date	02.10.03	02.10.03	---	02.10.03	---
ICP Metals (6010)					
Calcium, mg/l	<0.50	102 %	75-125 %	0.66 %	<20 %
Copper, mg/l	<0.020	102 %	75-125 %	0 %	<20 %
Iron, mg/l	<0.050	109 %	75-125 %	0.90 %	<20 %
Magnesium, mg/l	<0.50	100 %	75-125 %	0 %	<20 %
Nickel, mg/l	<0.040	102 %	75-125 %	0.99 %	<20 %
Sodium, mg/l	<0.50	106 %	75-125 %	2.2 %	<20 %
Strontium, mg/l	<0.010	99 %	75-125 %	0 %	<20 %
Zinc, mg/l	<0.020	102 %	75-125 %	0.98 %	<20 %
Boron, mg/l	<0.050	103 %	75-125 %	0.84 %	<20 %
Manganese, mg/l	<0.010	102 %	75-125 %	0.97 %	<20 %
Prep Date	02.06.03	02.06.03	---	02.06.03	---
Analysis Date	02.07.03	02.07.03	---	02.07.03	---
Color (110.2), PCU	<5	100 %	NA	0 %	<40 %
Analysis Date	02.07.03	02.07.03	---	02.07.03	---

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LOG NO: B3-50450
Received: 06 FEB 03
Reported: 18 FEB 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE TEST WELLS
Sampled By: Client
Code: 140130218

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
50450-2	Method Blank	
50450-3	Accuracy (%Rec)	
50450-4	LCS Accuracy Control Limit (%R)	
50450-5	Precision (%RPD)	
50450-6	LCS Precision Control Limit (Advisory) %RPD	

PARAMETER	50450-2	50450-3	50450-4	50450-5	50450-6
Bicarbonate Alkalinity as CaCO3 (SM2320B), mg/l	<1.0	106 %	80-120 %	0 %	<30 %
Analysis Date	02.10.03	02.10.03	---	02.10.03	---
Bromide (300.0), mg/l	<1.0	101 %	90-110 %	0 %	<30 %
Prep Date	02.10.03	02.10.03	---	02.10.03	---
Analysis Date	02.11.03	02.11.03	---	02.11.03	---
Chloride (325.3), mg/l	<1.0	101 %	75-125 %	1.0 %	<30 %
Analysis Date	02.10.03	02.10.03	---	02.10.03	---

Methods: EPA SW-846, EPA 600/4-79-020
DOH Certification #: E84282

These test results meet all the requirements of NELAC. All questions regarding this test report should be directed to the STL project manager who signed this test report. The estimated uncertainty associated with these reported results is available upon request.

STL Savannah, 5102 LaRoche Ave., Savannah, GA 31404
Certification #E87052.

Michael F. Valder, Project Manager

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Analytical Report

Report To: Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Ft. Myers, FL 33919

TW-16

Project Number: 17952-37587
Project Name: Dare County Test Wells
STL Log Number: B351232
Report Date: April 17, 2003

Results Pages 1 through 6 (excluding cover page)

Michael F. Valder, Project Manager
mvalder@stl-inc.com

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LOG NO: B3-51232
Received: 04 APR 03
Reported: 17 APR 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE COUNTY TEST WELLS
Sampled By: Client
Code: 091630417

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
51232-1	TP-16	04-03-03/11:00

PARAMETER	51232-1
Alkalinity (to pH 4.5) as CaCO3 (310.1), mg/l	560
Analysis Date	04.07.03
Bicarbonate Alkalinity as CaCO3 (SM2320B), mg/l	560
Analysis Date	04.07.03
Chloride (325.3), mg/l	1200
Analysis Date	04.08.03
Color (110.2), PCU	40
Analysis Date	04.04.03
Fluoride (340.2), mg/l	0.70
Analysis Date	04.10.03
Sulfate as SO4 (375.4), mg/l	<5.0
Analysis Date	04.14.03
Solids, Total Dissolved (160.1), mg/l	2400
Analysis Date	04.08.03
Turbidity (180.1), NTU	0.18
Analysis Date	04.04.03

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LOG NO: B3-51232
Received: 04 APR 03
Reported: 17 APR 03

Mr. Scott Manahan
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8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE COUNTY TEST WELLS
Sampled By: Client
Code: 091630417

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
51232-1	TP-16	04-03-03/11:00

PARAMETER	51232-1
ICP Metals (6010)	
Arsenic, mg/l	<0.010
Boron, mg/l	2.1
Calcium, mg/l	16
Copper, mg/l	<0.020
Iron, mg/l	0.098
Magnesium, mg/l	31
Nickel, mg/l	<0.040
Sodium, mg/l	970
Strontium, mg/l	0.55
Zinc, mg/l	<0.020
Manganese, mg/l	<0.010
Prep Date	04.07.03
Analysis Date	04.07.03
Hardness as CaCO3 (2340B), mg/l	170
Prep Date	04.07.03
Analysis Date	04.07.03
Noncarbonate Hardness as CaCO3 (2340B)	
Hardness as CaCO3, mg/l	0
Bromide (300.0), mg/l	4.9
Prep Date	04.07.03
Analysis Date	04.07.03

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LOG NO: B3-51232
Received: 04 APR 03
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Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE COUNTY TEST WELLS
Sampled By: Client
Code: 091630417

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
51232-1	TP-16	04-03-03/11:00

PARAMETER	51232-1
Sulfide (376.1), mg/l	<1.0
Analysis Date	04.05.03
Silica as SiO2 (6010), mg/l	21
Prep Date	04.10.03
Analysis Date	04.10.03

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LOG NO: B3-51232
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8140 College Pkwy Suite 202
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Cl Project No: 17952-37587

Project: DARE COUNTY TEST WELLS
Sampled By: Client
Code: 091630417

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
51232-2	Method Blank	
51232-3	Accuracy (%Rec)	
51232-4	LCS Accuracy Control Limit (%R)	
51232-5	Precision (%RPD)	
51232-6	LCS Precision Control Limit (Advisory) %RPD	

PARAMETER	51232-2	51232-3	51232-4	51232-5	51232-6
Alkalinity (to pH 4.5) as CaCO3 (310.1), mg/l	<1.0	105 %	80-120 %	1.6 %	<30 %
Analysis Date	04.07.03	04.07.03	---	04.07.03	---
Bicarbonate Alkalinity as CaCO3 (SM2320B), mg/l	<1.0	105 %	80-120 %	1.6 %	<30 %
Analysis Date	04.07.03	04.07.03	---	04.07.03	---
Chloride (325.3), mg/l	<1.0	100 %	75-125 %	0.90 %	<30 %
Analysis Date	04.08.03	04.08.03	---	04.08.03	---
Color (110.2), PCU	<5	100 %	NA	0 %	<40 %
Analysis Date	04.04.03	04.04.03	---	04.04.03	---
Fluoride (340.2), mg/l	<0.20	94 %	85-115 %	0.93 %	<30 %
Analysis Date	04.10.03	04.10.03	---	04.10.03	---
Sulfate as SO4 (375.4), mg/l	<5.0	112 %	75-125 %	2.7 %	<30 %
Analysis Date	04.14.03	04.14.03	---	04.14.03	---
Solids, Total Dissolved (160.1), mg/l	<5.0	100 %	80-120 %	0.40 %	<25 %
Analysis Date	04.08.03	04.08.03	---	04.08.03	---

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LOG NO: B3-51232
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Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
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Cl Project No: 17952-37587

Project: DARE COUNTY TEST WELLS
Sampled By: Client
Code: 091630417

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
51232-2	Method Blank	
51232-3	Accuracy (%Rec)	
51232-4	LCS Accuracy Control Limit (%R)	
51232-5	Precision (%RPD)	
51232-6	LCS Precision Control Limit (Advisory) %RPD	

PARAMETER	51232-2	51232-3	51232-4	51232-5	51232-6
Turbidity (180.1), NTU	<0.10	102 %	90-110 %	1.4 %	<30 %
Analysis Date	04.04.03	04.04.03	---	04.04.03	---
ICP Metals (6010)					
Arsenic, mg/l	<0.010	110 %	75-125 %	0.82 %	<20 %
Boron, mg/l	<0.050	109 %	75-125 %	1.7 %	<20 %
Calcium, mg/l	<0.50	76 %	75-125 %	1.2 %	<20 %
Copper, mg/l	<0.020	107 %	75-125 %	1.2 %	<20 %
Iron, mg/l	<0.050	111 %	75-125 %	1.4 %	<20 %
Magnesium, mg/l	<0.50	91 %	75-125 %	1.6 %	<20 %
Nickel, mg/l	<0.040	103 %	75-125 %	1.4 %	<20 %
Sodium, mg/l	<0.50	115 %	75-125 %	1.4 %	<20 %
Strontium, mg/l	<0.010	102 %	75-125 %	0.20 %	<20 %
Zinc, mg/l	<0.020	102 %	75-125 %	2.4 %	<20 %
Manganese, mg/l	<0.010	102 %	75-125 %	1.5 %	<20 %
Prep Date	04.07.03	04.07.03	---	04.07.03	---
Analysis Date	04.07.03	04.07.03	---	04.07.03	---
Bromide (300.0), mg/l	<1.0	100 %	90-110 %	0 %	<30 %
Prep Date	04.07.03	04.07.03	---	04.07.03	---
Analysis Date	04.07.03	04.07.03	---	04.07.03	---

SEVERN TRENT STL

STL Tampa • 6712 Benjamin Road • Suite 100 • Tampa, FL 33634 • Tel 813 885 7427 • Fax 813 885 7049 • www.stl-inc.com

LOG NO: B3-51232
Received: 04 APR 03
Reported: 17 APR 03

Mr. Scott Manahan
CDM Missimer
8140 College Pkwy Suite 202
Fort Myers, FL 33919

Cl Project No: 17952-37587

Project: DARE COUNTY TEST WELLS
Sampled By: Client
Code: 091630417

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
51232-2	Method Blank	
51232-3	Accuracy (%Rec)	
51232-4	LCS Accuracy Control Limit (%R)	
51232-5	Precision (%RPD)	
51232-6	LCS Precision Control Limit (Advisory) %RPD	

PARAMETER	51232-2	51232-3	51232-4	51232-5	51232-6
Sulfide (376.1), mg/l	<1.0	95 %	75-125 %	0 %	<30 %
Analysis Date	04.05.03	04.05.03	---	04.05.03	---
Silica as SiO2 (6010), mg/l	<0.50	100 %	75-125 %	0.5 %	<20 %
Prep Date	04.10.03	04.10.03	---	04.10.03	---
Analysis Date	04.10.03	04.10.03	---	04.10.03	---

Method: EPA 600/4-79-020
DOH Certification #:E84282

These test results meet all the requirements of NELAC. All questions regarding this test report should be directed to the STL Project Manager who signed this test report.
The estimated uncertainty associated with these reported results is available upon request.

Michael F. Valder, Project Manager

Final Page Of Report

Dare County, North Carolina
Regional Water system

Date Sample Drawn: 3-25-03 Operators: PS,CP,MW

Date Analysis Completed: 3-27-03 Wells: #13

	Finished	MCL
Alkalinity as CaCO3, mg/L	0	N/A
Total Alkalinity CaCO3, mg/L	502	N/A
Bicarbonate as HCO3, mg/L	612.20	N/A
Carbonate as CO3, mg/L	0	N/A
Hydroxide as OH, mg/L	0	N/A
Total Hardness as CaCO3, mg/L	108	150*
Calcium Hardness as CaCO3, mg/L	22	N/A
Magnesium as CaCO3, mg/L	86	N/A
Calcium as Ca, mg/L	8.8	60*
Color	44	15^
Silica as SiO2, mg/L	20.2	N/A
Conductivity	3960 ~~20~~	N/A
Iron, Fe, mg/L	0.054	0.3^
Potassium K, mg/L	43.2	N/A
Copper, Cu, mg/L	< 70ug/l	1.0*
Manganese, Mn mg/L	0.16	N/A
Phosphate as PO4, mg/L	1.03	5.0*
Chloride as Cl-, mg/L	1,000	250.0*
Fluoride, F, mg/L	.75	4.0*
Nitrate as NO3, mg/L	0.5	10^
Zinc, Zn, mg/L	0.189	5.0^
Chlorine (free Cl2), mg/L	0.15	0.2@
Lead, Pb, mg/L	<5ug/l	0.05^
Corrosivity	0.928	N/A
pH	8.34	6.5-8.5*
pHs	7.62	N/A
Turbidity, N.T.U.	0.49	1.0^
Total Suspended Solids (TSS), mg/L	0.9	N/A
Total Dissolved Solids (TDS), mg/L	1,945	500.0*
Sulfate as SO4, mg/L	22.50	250.0*
Sodium, Na, mg/L	691.83	250.0^
Sulfide as S, mg/L	0	N/A

*Recommended State Maximum
@Mandatory State Minimum
^Mandatory State Maximums
N/A - Not Applicable

Dare County, North Carolina
Regional Water system

Date Sample Drawn: 2-19-03 Operators: FL,,NC,DH

Date Analysis Completed: 2-22-03 Wells: 14

	Well #14	MCL
Alkalinity as CaCO3, mg/L	0	N/A
Total Alkalinity CaCO3, mg/L	500	N/A
Bicarbonate as HCO3, mg/L	609.76	N/A
Carbonate as CO3, mg/L	0	N/A
Hydroxide as OH, mg/L	0	N/A
Total Hardness as CaCO3, mg/L	186	150*
Calcium Hardness as CaCO3, mg/L	56	N/A
Magnesium as CaCO3, mg/L	130	N/A
Calcium as Ca, mg/L	74	60*
Color	113	15^
Silica as SiO2, mg/L	26.6	N/A
Conductivity	4,890	N/A
Iron, Fe, mg/L	0.16	0.3^
Potassium K, mg/L	28	N/A
Copper, Cu, mg/L	< 70ug/l	1.0*
Manganese, Mn mg/L	0.097	N/A
Phosphate as PO4, mg/L	1.51	5.0*
Chloride as Cl-, mg/L	1,250	250.0*
Fluoride, F, mg/L	1	4.0*
Nitrate as NO3, mg/L	0.43	10^
Zinc, Zn, mg/L	0.065	5.0^
Chlorine (free Cl2), mg/L	0	0.2@
Lead, Pb, mg/L	<5ug/l	0.05^
Corrosivity	0.928	N/A
pH	8.20	6.5-8.5*
pHs	7.83	N/A
Turbidity, N.T.U.	0.4	1.0^
Total Suspended Solids (TSS), mg/L	2	N/A
Total Dissolved Solids (TDS), mg/L	2,455	500.0*
Sulfate as SO4, mg/L	0.60	250.0*
Sodium, Na, mg/L	693.40	250.0^
Sulfide as S, mg/L	0	N/A

*Recommended State Maximum
@Mandatory State Minimum
^Mandatory State Maximums
N/A - Not Applicable

Dare County, North Carolina
Regional Water system

Date Sample Drawn: 02/05/03 Operators: AB, FL

Date Analysis Completed: 02/06/03 Wells: NRO #15

	Well #15	MCL
Alkalinity as CaCO3, mg/L	0	N/A
Total Alkalinity CaCO3, mg/L	405	N/A
Bicarbonate as HCO3, mg/L	493.90	N/A
Carbonate as CO3, mg/L	0	N/A
Hydroxide as OH, mg/L	0	N/A
Total Hardness as CaCO3, mg/L	200	150*
Calcium Hardness as CaCO3, mg/L	60	N/A
Magnesium as CaCO3, mg/L	140	N/A
Calcium as Ca, mg/L	24	60*
Color	51	15^
Silica as SiO2, mg/L	4.8	N/A
Conductivity	4,980	N/A
Iron, Fe, mg/L	0.132	0.3^
Potassium K, mg/L	36	N/A
Copper, Cu, mg/L	< 70ug/l	1.0*
Manganese, Mn mg/L	0.039	N/A
Phosphate as PO4, mg/L	0.994	5.0*
Chloride as Cl-, mg/L	1,150	250.0*
Fluoride, F, mg/L	0.68	4.0*
Nitrate as NO3, mg/L	0.02	10^
Zinc, Zn, mg/L	0.095	5.0^
Chlorine (free Cl2), mg/L	0	0.2@
Lead, Pb, mg/L	<5ug/l	0.05^
Corrosivity	0.928	N/A
pH	7.97	6.5-8.5*
pHs	7.83	N/A
Turbidity, N.T.U.	0.2	1.0^
Total Suspended Solids (TSS), mg/L	0.3	N/A
Total Dissolved Solids (TDS), mg/L	2,490	500.0*
Sulfate as SO4, mg/L	2.50	250.0*
Sodium, Na, mg/L	619.78	250.0^
Sulfide as S, mg/L	0	N/A

AS 0 .101 mg/l

*Recommended State Maximum
@Mandatory State Minimum
^Mandatory State Maximums
N/A - Not Applicable

Dare County, North Carolina
Regional Water system

Date Sample Drawn: 4-3-03 Operators: MW,AB

Date Analysis Completed: 4-03-03 Wells: 16

	Well #16	MCL
Alkalinity as CaCO3, mg/L	0	N/A
Total Alkalinity CaCO3, mg/L	340	N/A
Bicarbonate as HCO3, mg/L	414.63	N/A
Carbonate as CO3, mg/L	0	N/A
Hydroxide as OH, mg/L	0	N/A
Total Hardness as CaCO3, mg/L	160	150*
Calcium Hardness as CaCO3, mg/L	60	N/A
Magnesium as CaCO3, mg/L	100	N/A
Calcium as Ca, mg/L	64	60*
Color	51	15^
Silica as SiO2, mg/L	20	N/A
Conductivity	4,610	N/A
Iron, Fe, mg/L	0.07	0.3^
Potassium K, mg/L	0.25	N/A
Copper, Cu, mg/L	< 70ug/l	1.0*
Manganese, Mn mg/L	0.395	N/A
Phosphate as PO4, mg/L	1.4	5.0*
Chloride as Cl-, mg/L	1,250	250.0*
Fluoride, F, mg/L	1	4.0*
Nitrate as NO3, mg/L	0.5	10^
Zinc, Zn, mg/L	0.25	5.0^
Chlorine (free Cl2), mg/L	0.05	0.2@
Lead, Pb, mg/L	<5ug/l	0.05^
Corrosivity	0.928	N/A
pH	8.29	6.5-8.5*
pHs	7.62	N/A
Turbidity, N.T.U.	0.16	1.0^
Total Suspended Solids (TSS), mg/L	0.7	N/A
Total Dissolved Solids (TDS), mg/L	2,290	500.0*
Sulfate as SO4, mg/L	0.50	250.0*
Sodium, Na, mg/L	704.16	250.0^
Sulfide as S, mg/L	0	N/A

*Recommended State Maximum total Arsenic - 0
@Mandatory State Minimum
^Mandatory State Maximums
N/A - Not Applicable