The Dare County Water Department

Report on the Construction and Testing of an Upper-Yorktown Aquifer Test Well at the Stumpy Point Community, Dare County, North Carolina

January 2001

REPORT

MISSIMER INTERNATIONAL INC.

January 15, 2001

Mr. Bob Oreskovich
Dare County Water Department
600 Mustian Street
Kill Devil Hills, NC 27948

Re: Stumpy Point
Test Well Report

Dear Bob:

Please find enclosed 4 copies of the document entitled "Report on the Construction and Testing of an Upper-Yorktown Aquifer Test Well at the Stumpy Point Community, Dare County, North Carolina." The report describes the procedures used to install and test a well at the proposed water treatment plant site in Stumpy Point. Results of the investigation indicate that raw water supply development for a small membrane treatment facility at the site is feasible. The test well, Stumpy-1, has adequate yield for use as a permanent supply well for the proposed treatment plant.

We appreciate having the opportunity to offer our services to the county on this project and are available to assist with implementation of the report recommendations. Please contact me if you have any questions or comments regarding the report.

Sincerely,

Wm. Scott Manahan, P.E.
Water Resource Engineer

WSM:ll
Enclosures

pc: Ian Watson
Eric Weatherly

FH00-1111.LTR
8140 College Parkway, Suite 202
Fort Myers, Florida 33919

(941) 432-9494
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1. CONCLUSIONS AND RECOMMENDATIONS

A test well was constructed on property owned by Dare County in the community of Stumpy Point, North Carolina to identify a source of raw water for a proposed small public supply water treatment facility. The conclusions and recommendations presented below are based on the results of the test well construction project.

1.1 Conclusions

- A 4-inch diameter test well (Stumpy-1) was installed at the proposed water treatment plant site near the intersection of NC Hwy. 264 and S.R. 1100 in Stumpy Point. The well was completed within the Upper-Yorktown (Principal) Aquifer with a screened interval between 170 and 190 feet below land surface.
- A pumping test was conducted on well Stumpy-1 after drilling and development were completed. A specific capacity value of 2.5 gpm/ft was calculated for the well at a pumping rate of 97 gpm. The proposed water treatment plant maximum raw water demand is projected to be 65 gpm. The test well has adequate yield for use as a permanent supply well for the proposed treatment facility.
- The transmissivity of the Upper-Yorktown Aquifer is estimated to be approximately 5500 gpd/ft at the test well site based on analyses of data collected while testing well Stumpy-1. The aquifer transmissivity is low; however, individual wells tapping this unit can be pumped at rates adequate to meet the projected demand of the proposed small community water system.
- Water quality samples were obtained from well Stumpy-1 near the end of pump testing and sent to a laboratory for analyses. A dissolved chloride concentration of 270 mg/l and total dissolved solids of 1030 mg/l were determined for the Upper-Yorktown Aquifer at the test well location. The water has a low iron concentration (< 1.0 mg/l), but high color (> 150 color units). A membrane type treatment process will need to be utilized in order to produce water that meets state and federal drinking water standards.

- One additional production well will need to be installed on the county property to supply raw water to the proposed treatment plant. The construction cost for one additional supply well and two 5-hp submersible pumps is estimated to be approximately $50,000.00.

1.2 Recommendations

- Pilot testing of membranes proposed for use in the water treatment facility should be conducted to insure the produced water meets applicable drinking water standards. Test well Stumpy-1 can be used to supply the pilot plant at the design pumping rate of 65 gpm.
- One additional production well should be constructed at the proposed water treatment plant site. The well will provide additional raw water supply capacity to the proposed water treatment facility and is required by state law since more than 50 users will be served by the community water system.
- The production well should be constructed with 6-inch diameter Schedule 80 PVC casing to a depth of approximately 170 feet below land surface. The well should be screened with 6-inch diameter 0.025-inch continuous slot PVC screen from the casing bottom to approximately 190 feet below land surface. A coarse sand filter pack (Morie #2) should be placed around the screen. A hydrogeologist should supervise construction of the well and select final cased and total depths based on lithologic analysis of formation samples obtained during drilling. The well should be thoroughly developed after drilling is complete.
- A step-drawdown test should be conducted on the new production well. The specific capacity value calculated based on the test results can be used to assess the well yield and confirm the proposed pump setting depth and withdrawal rate. Constant rate pump tests should be conducted for a minimum of 24 hours on both the new production well and well Stumpy-1 in order to meet state well testing requirements. The wells should be disinfected following pump testing.
- Submersible well pumps should be installed in the existing and proposed supply wells. Piping from the wells should be connected to a PVC raw water transmission main going to the treatment facility.

- The proposed 6-inch diameter well should be used as the primary production well to supply the water treatment plant. Existing test well Stumpy-1 should be used as a back-up source of supply.
- Water quality and water levels should be monitored in the production wells. The data collected will enable an evaluation of the performance of the wells and help to identify potential problems. Monitoring of test well Stumpy-1 should begin immediately to obtain baseline data prior to placing the water treatment facility on line.

2. INTRODUCTION

The Dare County Water Department supplies potable water for public supply purposes to several communities on the Outer Banks in eastern Dare County. Stumpy Point is a small unincorporated community located on the Dare County mainland on the north side of Stumpy Point Bay. Stumpy Point is not currently served by a public water supply system. A water supply feasibility study for Stumpy Point was performed for Dare County previously (Hobbs Upchurch, 1998). The results of the study indicated that development of a potable water supply system for the community is feasible.

Test drilling conducted as part of the feasibility study identified two aquifer units that showed potential for use as a raw water supply source for the proposed treatment facility. That initial test drilling site is located over a mile from the proposed water treatment plant site. The construction of a test well at the proposed treatment plant location was recommended to obtain site specific information regarding aquifer yield and water quality conditions. CDM/Missimer was authorized by the Dare County Water Department in September 2000 to construct a test well at the proposed water plant site (Figure 1).

The scope of the project included a background data review, well construction, pump testing, water quality sampling, data analyses, and preparation of this summary report. The methods and procedures used during the investigation and the results obtained are presented herein.

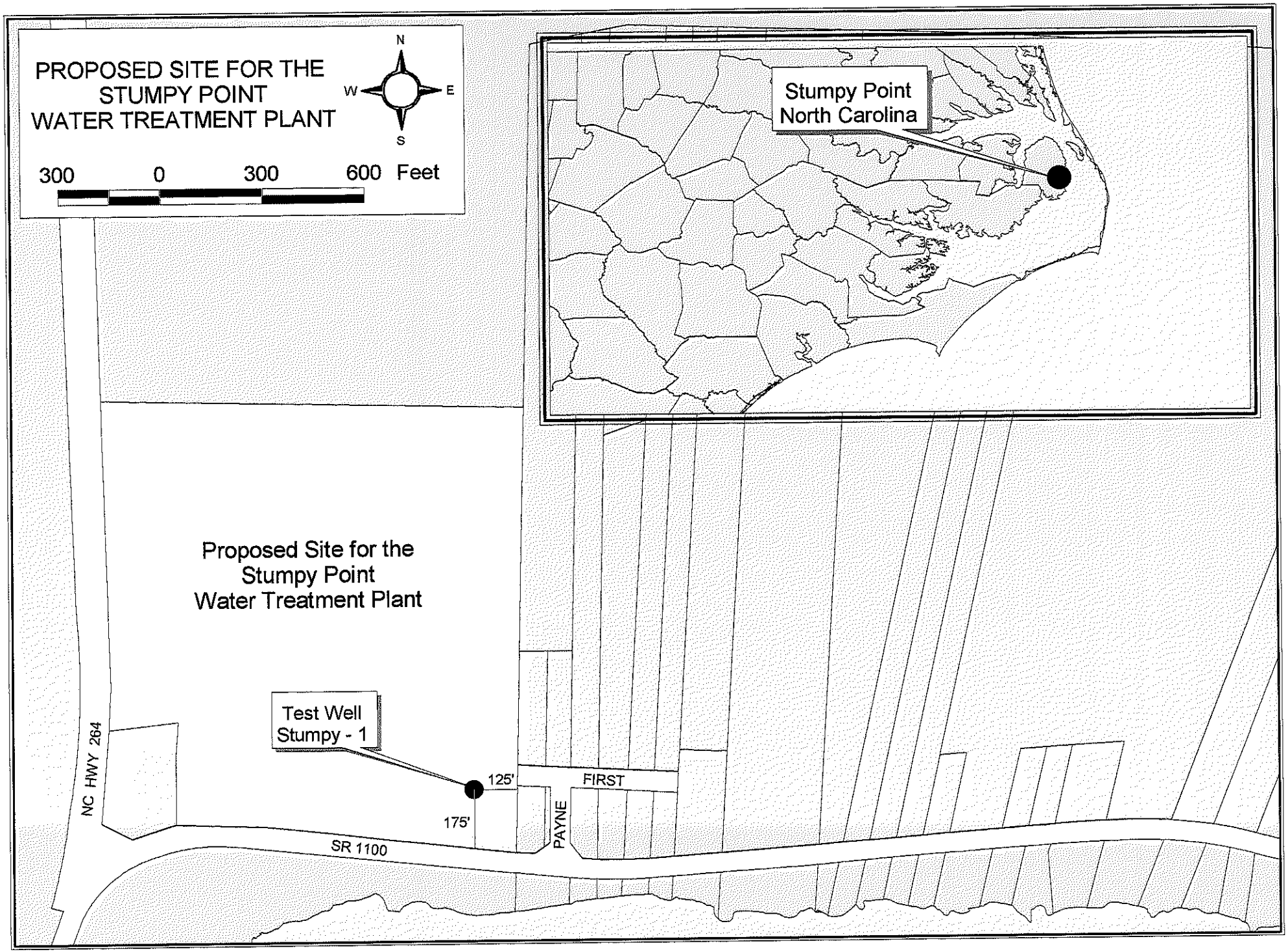


FIGURE 1. SITE MAP SHOWING TEST WELL STUMPY-1 and PROPOSED WATER TREATMENT PLANT LOCATIONS.

3. FIELD INVESTIGATION METHODS

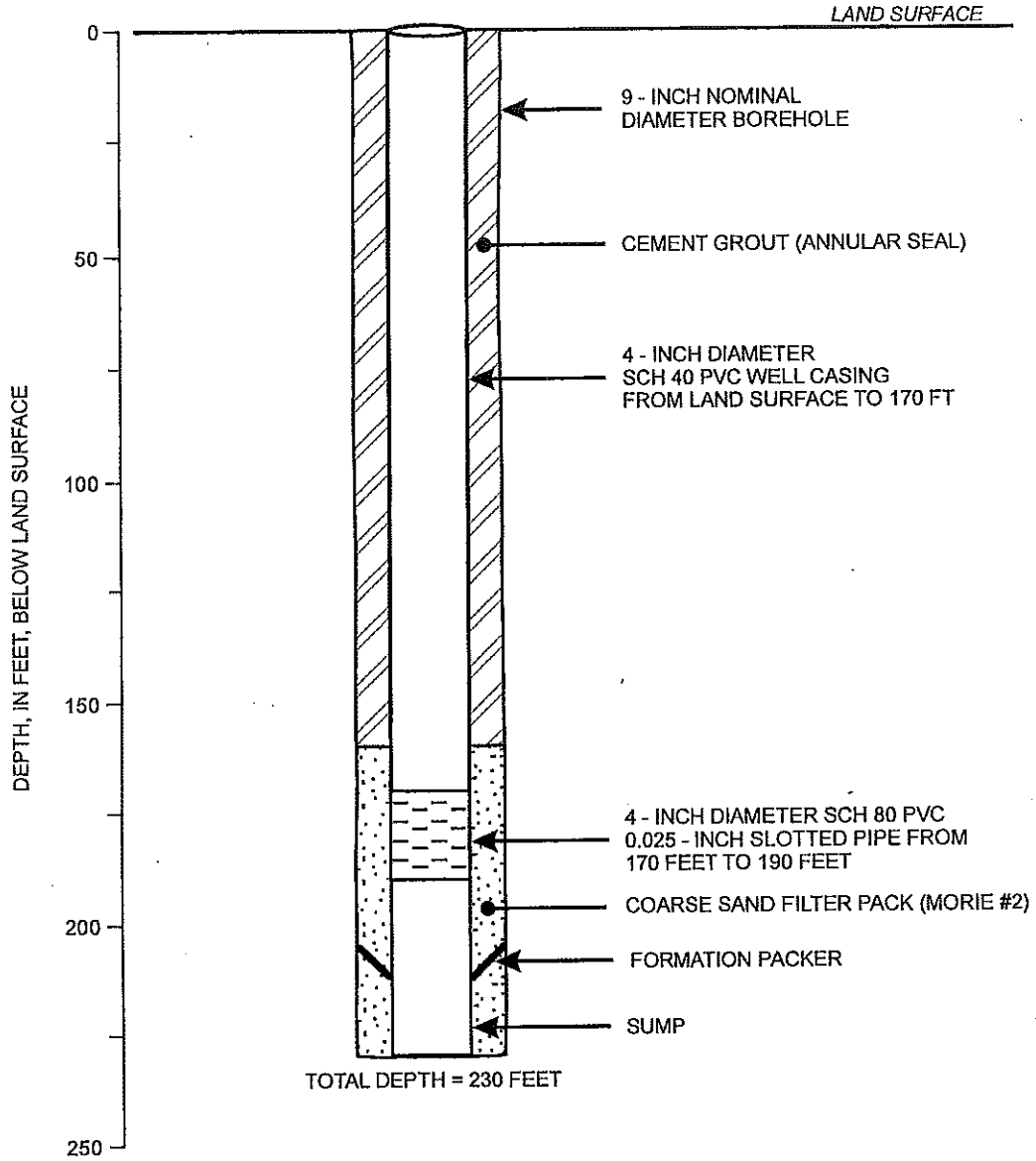
3.1 Drilling

The Stumpy Point test well (Stumpy-1) was installed near the southeast corner of the proposed water treatment plant site on property owned by Dare County at the location shown on Figure 1. Skipper's Well Drilling from Leland, North Carolina was subcontracted to construct the well and perform a pumping test. CDM/Missimer provided on-site supervision during drilling and collected formation samples for lithologic analyses.

Drilling commenced on the morning of November 11, 2000. A nominal 9-inch diameter borehole was drilled using the mud rotary method to a depth of 390 feet below land surface. Electric and natural gamma ray geophysical logs were conducted on the bentonite mud filled borehole after the drill pipe had been removed. The on-site hydrologist selected the screen interval and determined final well design based on analysis of the formation samples and geophysical logs. Copies of the geologist's log and geophysical logs are included in the appendix. Two units that appeared to be capable of yielding significant volumes of water were identified. A fine to coarse grained sand unit was encountered during drilling within the interval between approximately 170 and 190 feet below land surface. A unit consisting of sandstone, sand, shell, and clay was present between the approximate depths of 240 and 290 feet below land surface. The upper unit was selected for development based on the lithology and the general trend of poorer water quality with increasing depth in the area.

A well ~~string~~ screen consisting of 20 feet of 4-inch diameter, 0.025-inch slotted Schedule 80 PVC pipe was placed in the borehole followed by 170 feet of 4-inch diameter Schedule 40 PVC casing to land surface. A blank section of pipe 40 feet long was placed below the screen with a cap to act as a sump. Construction details for the well are shown on Figure 2. A coarse sand gravel pack (Morie #2) was placed around the screen through a tremie pipe to a height of approximately 10 feet above the

STUMPY POINT
TEST WELL STUMPY-1



MISSIMER INTERNATIONAL, INC.

Pr. Name:	DARE COUNTY - STUMPY POINT
Pr. No.	FH00-1111
Date:	11/14/00
DWG No.	STUMPY.CDR
Rev. No.	

GROUNDWATER AND ENVIRONMENTAL SERVICES

FIGURE 2. SCHEMATIC DIAGRAM SHOWING CONSTRUCTION DETAILS OF TEST WELL STUMPY-1.

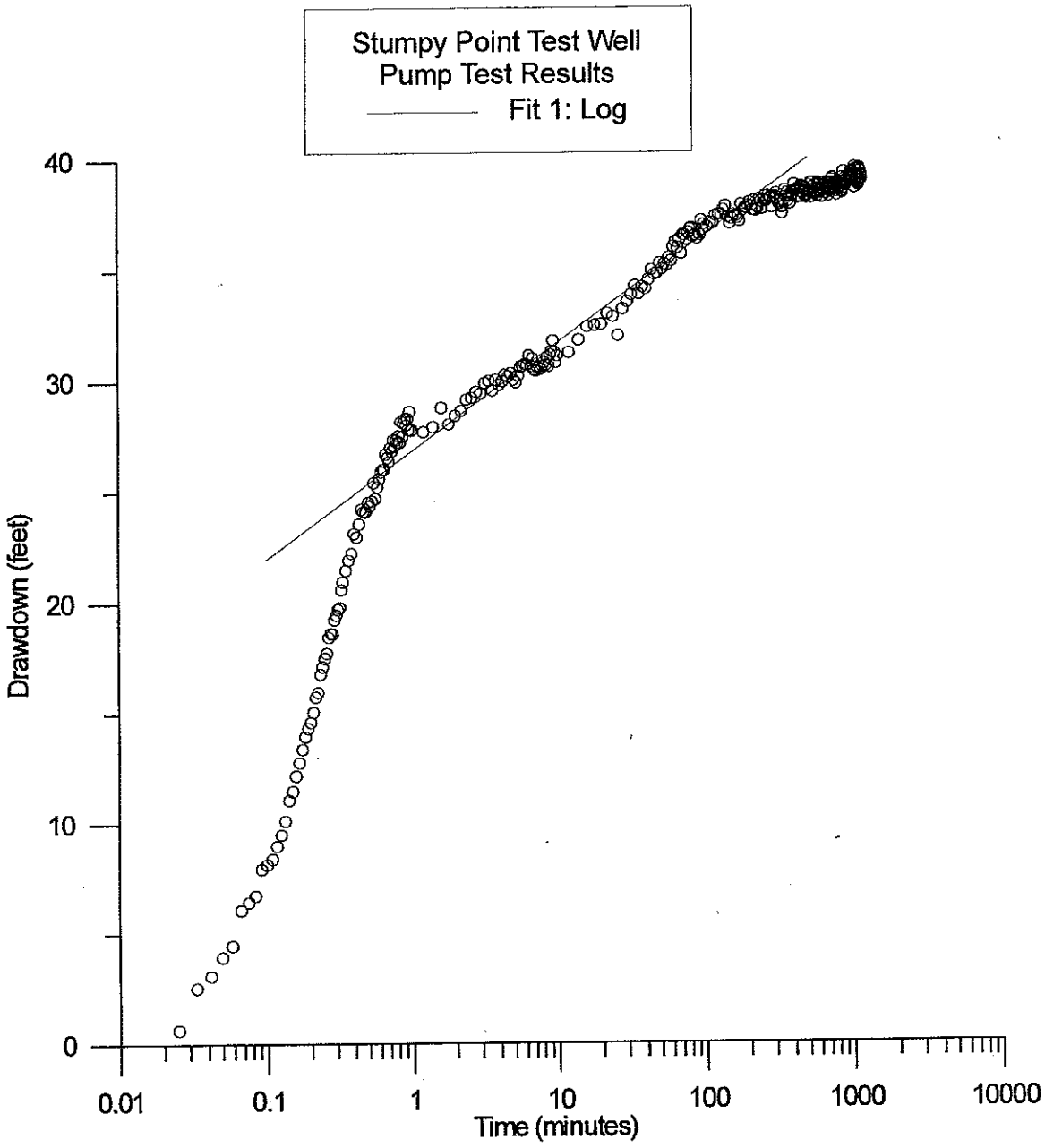
screen and the well was then developed with compressed air. The well was developed for approximately five hours and subsequently grouted with neat Portland cement from the top of the gravel pack to land surface.

3.2 Pump Testing

A 5-hp electric submersible pump was placed in well Stumpy-1 with the intake set at 60 feet below land surface. The static water level in the well measured before starting the pump test was approximately 2 feet below land surface. The well was pumped at a constant rate of 97 gpm for 19.5 hours. Drawdown in the well was measured with a pressure transducer coupled to an electronic data logger. A specific capacity value of 2.5 gpm/ft was determined at a pumping rate of 97 gpm indicating the yield potential of the Upper-Yorktown Aquifer at this location is relatively low. Recovery data were collected for approximately one hour following the pump test. Drawdown and recovery in the well were measured at closely spaced time intervals and semi-log plots of drawdown vs. time and recovery vs. time were constructed for analysis purposes (Figures 3 and 4).

3.3 Water Quality Sampling

Water samples were obtained from test well Stumpy-1 near the end of constant rate testing after the well had been pumped at a rate of 97 gpm for approximately 19 hours. Detailed analyses of the samples were conducted by the Dare County Water Department staff and also by STL Savannah Laboratories in Tampa, Florida. Laboratory analytical reports are included in the appendix. A discussion of the water quality analyses results is included in the following section of this report.



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Pr. Name: STUMPY POINT TEST WELL	
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GROUNDWATER
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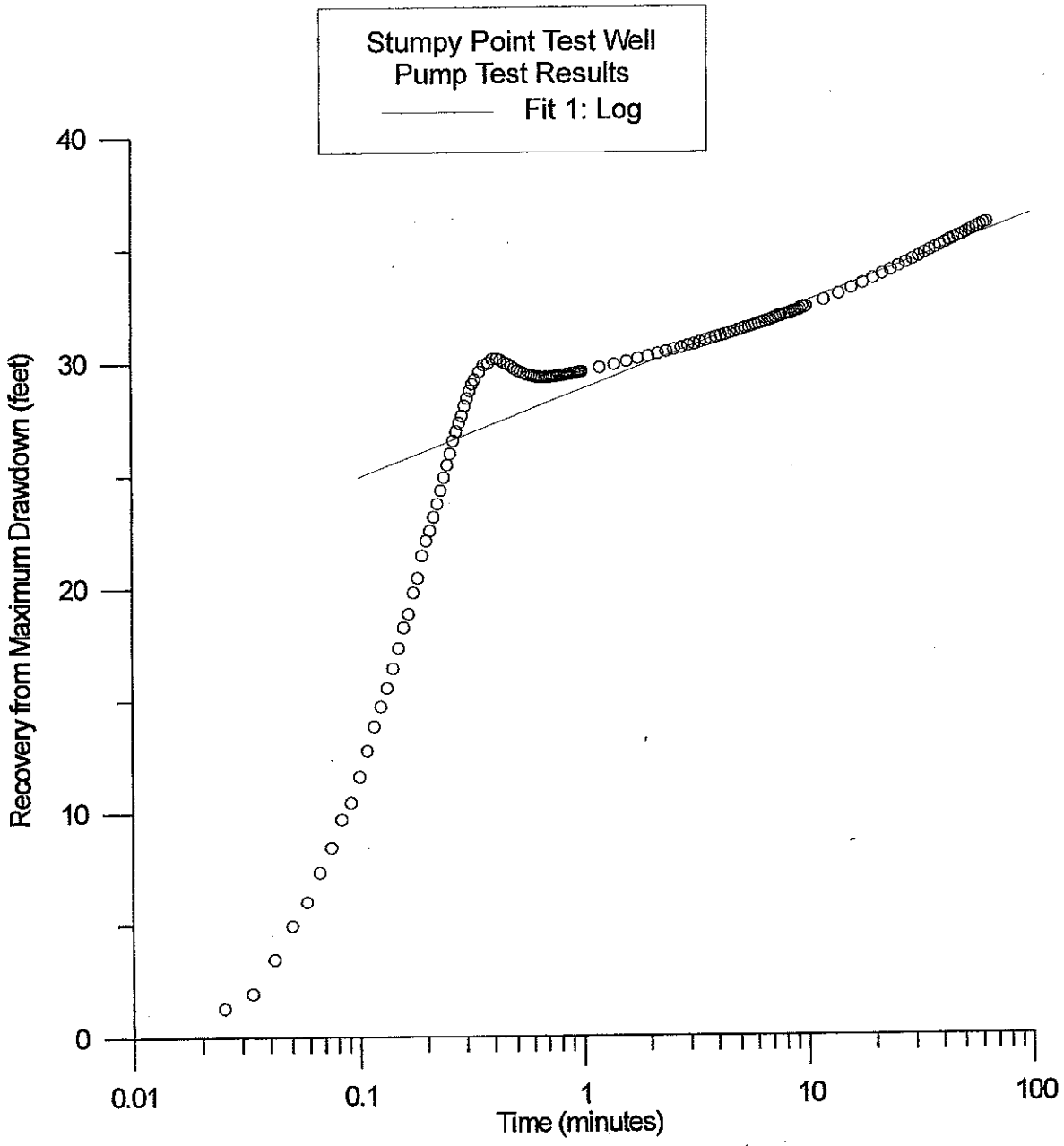
FIGURE 3. SEMI-LOG GRAPH SHOWING DRAWDOWN IN THE TEST WELL STUMPY-1 WHILE PUMPING AT 97 GPM.



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Pr. Name: STUMPY POINT TEST WELL	
Pr. No. FH00-1111	Date: 11/17/00
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FIGURE 4. SEMI-LOG GRAPH SHOWING RECOVERY IN THE TEST WELL STUMPY-1 AFTER PUMPING AT 97 GPM.

4. HYDROGEOLOGY

4.1 Geology

The geology of Dare County has been investigated by various government agencies and private consultants including CDM/Missimer. A brief description of the sediments underlying Stumpy Point is provided herein. Detailed discussions of the geologic conditions throughout Dare County are provided in the reports included in the reference section of this report.

The uppermost strata encountered at the Stumpy Point test well location include undifferentiated fine to coarse grained sand units with common shell beds and minor amounts of interbedded clay. A large percentage of the upper 10 feet was comprised of dark organic peat. Permeable sediments within these deposits form the water-table aquifer, which is approximately 100 feet thick at the Stumpy Point test well site.

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. At Stumpy Point, the upper part of the Yorktown Formation includes interbedded sand and clay units with varying amounts of shell and phosphate material. The clay beds have a very low hydraulic conductivity and provide confinement between the surficial sands and the Upper-Yorktown (Principal) Aquifer.

The Upper-Yorktown (Principal) Aquifer was encountered at a depth of approximately 170 feet below land surface in test well Stumpy-1. The aquifer consists primarily of fine to coarse grain quartz sand with only trace amounts of clay. The thickness of the unit is approximately 20 feet at the test well site. A low permeability dense marine clay layer that contains minor amounts of silt, sand, and shell lies beneath the Principal aquifer and separates it from the underlying Mid-Yorktown Aquifer. The thickness of this unit is approximately 50 feet at the Stumpy Point test well site.

The Mid-Yorktown aquifer lies beneath the Yorktown Formation confining beds in eastern Dare County. In most areas, the aquifer consists primarily of medium to fine grain quartz sand with occasional shell, phosphatic material, and coarse sand layers. However, the aquifer is comprised of sandstone, sand, shell, and interbedded clay at Stumpy Point. The permeability of the Mid-Yorktown aquifer sediments appears to be relatively low at the Stumpy Point test site. Low permeability sediments within the Mid-Yorktown aquitard separates the Mid-Yorktown aquifer from underlying units.

4.2 Aquifer Hydraulic Characteristics

The method developed by Jacob (1952) was used to analyze the drawdown and recovery data collected during testing of well Stumpy-1. A straight line segment is selected from the semi-log plots of drawdown vs. time (Figure 3) and recovery vs. time (Figure 4). The change in drawdown/recovery 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)

A transmissivity value of 5500 gpd/ft was calculated for the Upper-Yorktown Aquifer using both the drawdown and recovery data obtained during testing. The transmissivity of the aquifer is relatively low. The low transmissivity of the aquifer at the Stumpy Point test site is attributed to the fact that the aquifer is only 20 feet thick at this location. Although the aquifer transmissivity is relatively low, the site does have the potential for raw water supply development adequate to meet the projected needs of the small community water system proposed for installation at Stumpy Point.

Water supply development at the site is discussed in more detail in the following section of this report.

4.3 Water Quality

The laboratory analyses results for the samples obtained from well Stumpy-1 indicate that water quality in the Upper-Yorktown (Principal) Aquifer at the test site is slightly brackish. Salinity parameters are summarized in the table below. Copies of the full laboratory analyses are included in the appendix.

TABLE 1. UPPER-YORKTOWN (PRINCIPAL) AQUIFER WELL STUMPY-1 WATER QUALITY
(November 2000)

Dissolved Chloride Concentration (mg/l)		**Total Dissolved Solids (mg/l)**	
Dare County Lab	STL Savannah Lab	Dare County Lab	STL Savannah Lab
270	230	1030	1000

The water has a relatively low iron concentration (< 1 mg/l), but is high in color (> 150 PCU). The elevated color level is likely due to the presence of tannins or other organic acids in the water. Treatment of the water will be required in order to meet applicable state and federal drinking water standards. Membrane softening or ultra low pressure reverse osmosis treatment methods may be appropriate.

5. WATER SUPPLY EVALUATION

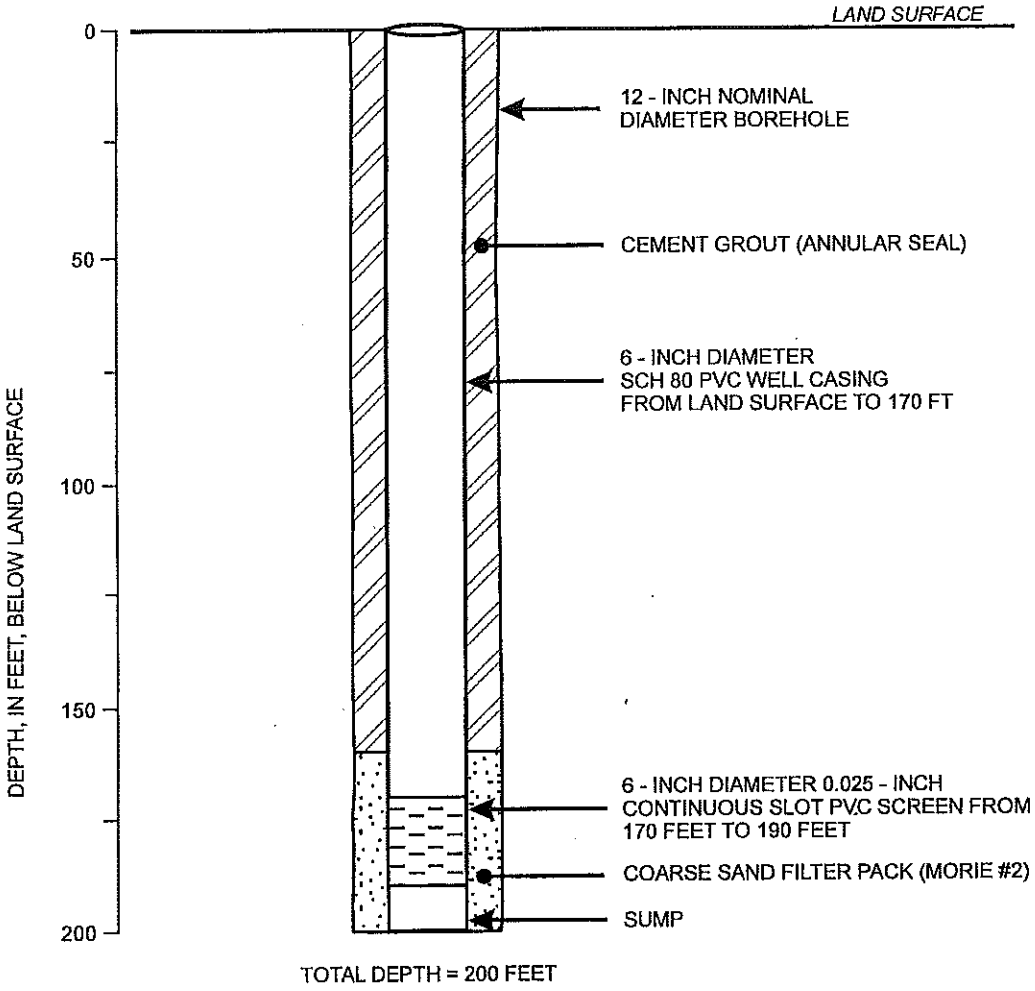
5.1 Production Wells

Data collected during the installation and testing of well Stumpy-1 indicate that the county owned property near the intersection of NC Hwy. 264 and S.R. 1100 has the potential for public water supply development. A transmissivity value of approximately 5500 gpd/ft was calculated for the Upper-Yorktown Aquifer at the site based on data collected during pump testing. The aquifer transmissivity is low, but this unit should be able to meet the projected demands of 65 gpm for the proposed water treatment facility. Well Stumpy-1 was pumped at a constant rate of 97 gpm for 19.5 hours and drawdown in the well had stabilized. Well Stumpy-1 has adequate yield for use as a permanent supply well and is capable of meeting the anticipated water treatment plant demands. Community water systems that supply over 50 users must have a minimum of two wells per state law. An additional production well will need to be constructed.

The additional production well (Stumpy-2) should be constructed with 6-inch diameter Schedule 80 PVC casing and continuous slot PVC screen. A schematic diagram showing the proposed construction details for the well is provided as Figure 5. The larger casing and screen diameter should provide better well hydraulics and therefore, less drawdown than test well Stumpy-1 at similar production rates. The well should be placed near the proposed treatment facility. The exact location of the well and distance from well Stumpy-1 is not critical as only one well will be required to supply the plant so interference drawdown is not an issue. The proposed production well Stumpy-2 should be utilized as the primary source of raw water for the treatment plant. Well Stumpy-1 was drilled as a test well. The design and construction methods specified for well Stumpy-2 were selected with the knowledge that the well would be used as a long-term source of supply.

It should be noted that the water supply evaluation presented herein is based on short-term testing of well Stumpy-1 and data collected by others during test drilling conducted in the vicinity of the proposed water treatment plant site. Multiple well aquifer performance testing and computer

STUMPY POINT
PROPOSED PRODUCTION WELL STUMPY-2



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Pr. Name: DARE COUNTY - STUMPY POINT		
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FIGURE 5. SCHEMATIC DIAGRAM SHOWING PROPOSED CONSTRUCTION DETAILS FOR PRODUCTION WELL STUMPY-2.

modeling to more fully evaluate the long-term impacts due to the proposed withdrawals were beyond the scope of this investigation. However, the Upper-Yorktown Aquifer should be capable of meeting the relatively low water treatment plant demands based on the available data.

5.2 Construction Cost Estimate

The results of testing conducted on the county property at Stumpy Point indicate that the construction of one additional production well to supply the proposed water treatment plant is feasible. Submersible pumps and transmission piping would be required to complete the installation. A pumping rate of 65 gpm from a single well would be adequate to meet the needs of the water plant. The estimated cost for installing the additional well and two 5-hp submersible pumps is $50,000.00. The cost estimate includes a flowmeter and gate valve on each well. Installation of the transmission piping and connection to a SCADA system or other telemetry are not included.

6. SELECTED REFERENCES

Hobbs, Upchurch & Associates, P.A., 1998, Water Feasibility Study for the Stumpy Point Community: Report to Dare County, Kill Devil Hills, North Carolina.

Jacob, C. E., and Lohman, S. W., 1952, Nonsteady flow to a well of constant drawdown in an extensive aquifer: A Geophysical Union Trans., v. 33, p. 559-569.

Missimer & Associates, Inc., 1987, Modeling of pumping induced groundwater quality changes at the Dare County, North Carolina wellfield (Kill Devil Hills site): Rept. To Black & Veatch, Inc., Asheboro, North Carolina, 177 p.

Missimer & Associates, Inc., Investigation and predictive modeling of water quality changes within the Yorktown Aquifer, Dare County, North Carolina, V. 1: Rept. to the County of Dare Water Production Department, Kill Devil Hills, North Carolina, 129 p.

Missimer International, Inc., 1998, Dare County-Wide Hydrogeological Study and Groundwater Resource Evaluation: Rept. to the Dare County Water Department, Kill Devil Hills, North Carolina, 98 p.

North Carolina Department of Natural Resources and Community Development, Division of Environmental Management (Well Records 1983).

Peek, H. M., Register, L. A., and Nelson, P. F., 1972, Potential Ground-Water Supplies for Roanoke Island and the Dare County Beaches, North Carolina: Rept. of investigations No. 9, Ground Water Division Office of Water and Air Resources, North Carolina Department of Natural and Economic Resources, Raleigh, North Carolina, 26 p.

GEGOLGIST'S LOG

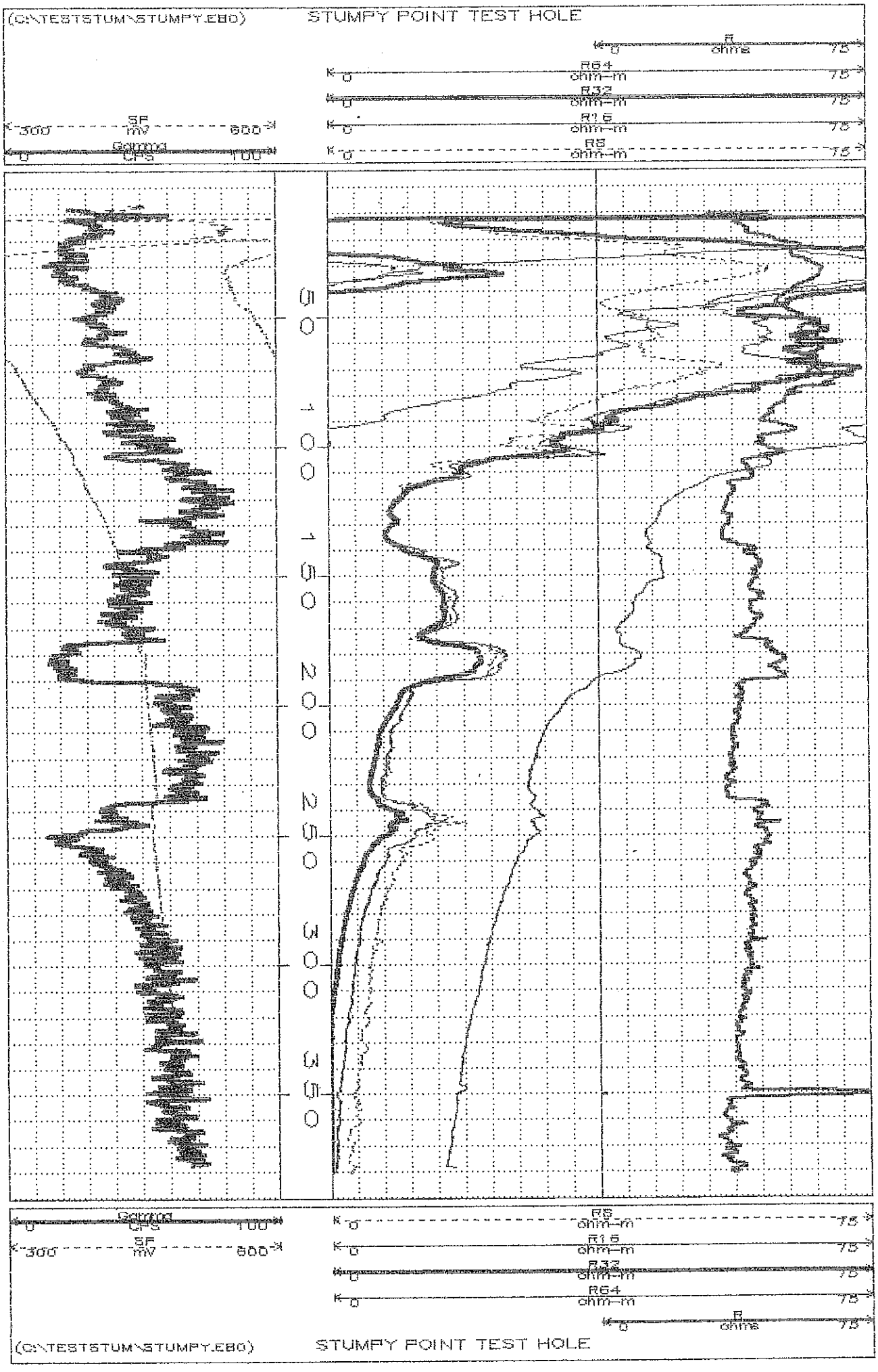
GEOLOGIST'S LOG
NC-4 STUMPY 1
November 2000

Depth (feet)	Lithology
0 – 2	Sand, light brownish gray (5YR 6/1), very fine to fine-grained, quartz, well-sorted, shell fragments.
2 – 7	Peat, dusky brown (5YR 2/2), very organic, sticky.
7 – 16	Clay, light gray (N7), sandy, soft, sticky, minor shell fragments.
16 – 20	Shell and sand, medium to very coarse-grained, quartz, poorly-sorted, well-rounded.
20 – 30	Shell and sand, clear to frosted, coarse to very coarse-grained, quartz, well-sorted.
30 – 40	Shell, mostly bivalves and sand, medium to coarse-grained, quartz, poorly-sorted.
40 – 50	Interbedded shell and minor clay. Clay, light gray (N7).
50 – 60	Interbedded shell and clay.
60 – 70	Interbedded sand, clay and shell. Sand, light gray (N7), fine-grained, quartz, well-sorted.
70 – 80	Sand, light gray (N7), very fine to fine-grained, quartz, well-sorted, minor shell.
80 – 90	Interbedded sand, shell and trace clay. Sand, light gray (N7), fine-grained, quartz, well-sorted, subrounded. Shell, very pale orange (10YR 8/2), fragmented.
90 – 100	Interbedded sand, shell and trace clay. Sand, fine to medium-grained, quartz, well-sorted.
100 – 106	Interbedded sand, shell and trace clay. Sand, light gray (N7), fine-grained, quartz, well-sorted, subrounded. Shell, very pale orange (10YR 8/2), fragmented.
106 – 135	Clay, olive gray (5Y 4/1), stiff, sticky, finely phosphatic, minor shell.
135 – 150	Clay, as above with only trace shell.
150 – 170	Clay, olive gray (5Y 4/1), soft, sticky, trace shell, trace sand.
170 – 190	Sand, light gray (N7), fine to coarse-grained, quartz, poorly-sorted.

GEOLOGIST'S LOG
NC-4 STUMPY 1
November 2000

Depth (feet)	Lithology
190 – 240	Clay, light gray (N7), very soft, silty, finely phosphatic.
240 – 241	Sandstone, very hard.
241 – 250	Interbedded sandstone, sand, shell and clay. Clay, highly phosphatic.
250 – 270	Interbedded sandstone, sand, clay and shell. Sandstone, very hard.
270 – 290	Interbedded shell, sandstone, sand and clay. Shell, black. Sandstone, hard. Sand, coarse-grained, quartz, well-sorted, phosphatic.
290 – 310	Interbedded clay, sandstone, shell and sand. Clay, phosphatic.
310 – 330	Clay, light gray (N7), soft, sticky, occasional sand and sandstone, minor shell.
330 – 390	Clay, light gray (N7), soft, phosphatic, trace shell.

GEOPHYSICAL LOG


(C:\TEST\STUM\STUMPY.EBO)
STUMPY POINT TEST HOLE
R
ohms
0
75
R64
ohm-m
R32
ohm-m
R16
ohm-m
R8
ohm-m
SP
mV
-300
-100
Gamma
CPS
0
100
50
100
150
200
250
300
350
(C:\TEST\STUM\STUMPY.EBO)
STUMPY POINT TEST HOLE

WATER QUALITY ANALYSES

COUNTY OF DARE
KILL DEVIL HILLS, NC 27948

Date Sample Drawn: **11/11/00**

Date Analysis Completed: **11/12/00**

By Whom: **GL, CP, RK**

Source: **Stumpy Point Test Well #1**

Water Treatment Plant: **NRO Plant**

	Water Quality	MCL
P - Alkalinity as $CaCO_3$, mg/l	0	N/A
Total Alkalinity $CaCO_3$, mg/l	600	N/A
Bicarbonate as HCO_3, mg/l	0	N/A
Carbonate as CO_3, mg/l	0	N/A
Hydroxide as OH, mg/l	0	N/A
Total Hardness as $CaCO_3$, mg/l	58	150*
Calcium Hardness as $CaCO_3$, mg/l	10	N/A
Magnesium as $CaCO_3$, mg/l	0	N/A
Calcium as Ca, mg/l	4.0	60.0*
Color, C.U. (Color Units)	170	15 *
Silica as SiO_2, mg/l	35.6	N/A
Conductivity as µmho/cm	2020	N/A
Iron, Fe, mg/l	0.198	0.300 ¤
Potassium, K, mg/l	14.8	N/A
Copper, Cu, mg/l	<0.070	1.300 ¤
Manganese, Mn, mg/l	0.031	0.050 ¤

	Water Quality	MCL
Phosphate as PO_4, mg/l	2.67	5.00 *
Chloride as Cl^-, mg/l	270	250 *
Fluoride as F, mg/l	0.44	2.00 * 4.00 ¤
Nitrate as NO_3, mg/l	0	10.00 ¤
Zinc as Zn, mg/l	0.205	5.000 ¤
Chlorine (free Cl_2), mg/l	0	0.20 ★
Lead as Pb, mg/l	<0.005	0.015 ¤
Corrosiveness	-0.02	N/A
pH	8.12	6.5 - 8.5 ♦
pHs	7.83	N/A
Turbidity, N.T.U.	1.20	1.0 ¤
Total Suspended Solids, mg/l	0.70	N/A
Total Dissolved Solids, mg/l	1030	500 *
Sulfate as SO_4, mg/l	3.70	250.0 *
Sodium as Na, mg/l (est.)	0	250.0 ¤
Sulfide as S, mg/l	0	N/A

MCL – Maximum Contaminant Level
mg/l = parts per million (ppm)
N/A- Not Available; No Limit

* Recommended Maximum ★ Mandatory Minimum ¤ Mandatory Maximum ♦ Mandatory Range

SEVERN TRENT SERVICES

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

STL Tampa West

LOG NO: B0-63363
Received: 15 NOV 00
Reported: 28 NOV 00

Mr. Scott Manahan
Missimer International, Inc.
8140 College Parkway, Suite 202
Fort Myers, FL 33919

Client PO. No.: FH8-812

Project: DARE CO. WATER DEPT
Sampled By: Client
Code: 091501128

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
63363-1	DARE COUNTY	11-14-00/11:45

PARAMETER	63363-1
Fluoride (340.2), mg/l	0.50
Analysis Date	11.20.00
Sulfate as SO4 (375.4), mg/l	<5.0
Analysis Date	11.16.00
Total Dissolved Solids (160.1), mg/l	1000
Analysis Date	11.17.00
Alkalinity (to pH 4.5) as CaCO3 (310.1), mg/l	660
Analysis Date	11.21.00
Turbidity (180.1), NTU	8.5
Analysis Date	11.15.00
Sulfide (376.2), mg/l	<0.10
Prep Date	11.21.00
Analysis Date	11.21.00
Silica as SiO2, mg/l	23
Prep Date	11.17.00
Analysis Date	11.27.00
Boron, mg/l	1.3
Prep Date	11.17.00
Analysis Date	11.20.00

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STL Tampa West

LOG NO: B0-63363
Received: 15 NOV 00
Reported: 28 NOV 00

Mr. Scott Manahan
Missimer International, Inc.
8140 College Parkway, Suite 202
Fort Myers, FL 33919

Client PO. No.: FH8-812

Project: DARE CO. WATER DEPT
Sampled By: Client
Code: 091501128

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
63363-1	DARE COUNTY	11-14-00/11:45

PARAMETER	63363-1
Copper (6010), mg/l	<0.020
Prep Date	11.17.00
Analysis Date	11.20.00
Iron (6010), mg/l	0.71
Prep Date	11.17.00
Analysis Date	11.20.00
Nickel (6010), mg/l	<0.040
Prep Date	11.17.00
Analysis Date	11.20.00
Manganese (6010), mg/l	0.027
Prep Date	11.17.00
Analysis Date	11.20.00
Sodium (6010), mg/l	480
Prep Date	11.17.00
Analysis Date	11.22.00
Zinc (6010), mg/l	<0.020
Prep Date	11.17.00
Analysis Date	11.20.00
Strontium (6010), mg/l	0.083
Prep Date	11.17.00
Analysis Date	11.20.00

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LOG NO: B0-63363
Received: 15 NOV 00
Reported: 28 NOV 00

Mr. Scott Manahan
Missimer International, Inc.
8140 College Parkway, Suite 202
Fort Myers, FL 33919

Client PO. No.: FH8-812

Project: DARE CO. WATER DEPT
Sampled By: Client
Code: 091501128

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
63363-1	DARE COUNTY	11-14-00/11:45

PARAMETER	63363-1
Calcium (6010), mg/l	5.6
Prep Date	11.17.00
Analysis Date	11.20.00
Magnesium (6010), mg/l	7.6
Prep Date	11.17.00
Analysis Date	11.20.00
Color (110.2), PCU	160
Analysis Date	11.15.00
Bicarbonate Alkalinity as CaCO3 (2320B), mg/l	660
Analysis Date	11.21.00
Bromide (300.0), mg/l	1.1
Prep Date	11.17.00
Analysis Date	11.17.00
Chloride (325.3)	
Chloride, mg/l	230
Analysis Date	11.17.00
Hardness as CaCO3 (6010)	
Hardness as CaCO3, mg/l	45
Prep Date	11.17.00
Analysis Date	11.20.00

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE/ TIME SAMPLED
63363-1	DARE COUNTY	11-14-00/11:45

PARAMETER	63363-1
Noncarbonate Hardness as CaCO3	
Hardness as CaCO3, mg/l	<3.3
Prep Date	11.17.00
Analysis Date	11.20.00

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
63363-2	Method Blank	
63363-3	Accuracy (%Rec)	
63363-4	Precision (%RPD)	

PARAMETER	63363-2	63363-3	63363-4
Fluoride (340.2), mg/l	<0.20	98 %	3.7 %
Analysis Date	11.20.00	11.20.00	---
Sulfate as SO4 (375.4), mg/l	<5.0	90 %	6.7 %
Analysis Date	11.16.00	11.16.00	---
Total Dissolved Solids (160.1), mg/l	<5.0	100 %	0.70 %
Analysis Date	11.17.00	11.17.00	---
Alkalinity (to pH 4.5) as CaCO3 (310.1), mg/l	<1.0	96 %	1.8 %
Analysis Date	11.21.00	11.21.00	---
Turbidity (180.1), NTU	<0.10	90 %	0.44 %
Analysis Date	11.15.00	11.15.00	---
Sulfide (376.2), mg/l	<0.10	87 %	0 %
Prep Date	11.21.00	11.21.00	---
Analysis Date	11.21.00	11.21.00	---
Silica as SiO2, mg/l	<0.50	86 %	8.1 %
Prep Date	11.17.00	11.17.00	---
Analysis Date	11.27.00	11.27.00	---
Boron, mg/l	<0.050	118 %	11 %
Prep Date	11.17.00	11.17.00	---
Analysis Date	11.20.00	11.20.00	---

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
63363-2	Method Blank	
63363-3	Accuracy (%Rec)	
63363-4	Precision (%RPD)	

PARAMETER	63363-2	63363-3	63363-4
Copper (6010), mg/l	<0.020	111 %	1.8 %
Prep Date	11.17.00	11.17.00	---
Analysis Date	11.20.00	11.20.00	---
Iron (6010), mg/l	<0.050	110 %	0 %
Prep Date	11.17.00	11.17.00	---
Analysis Date	11.20.00	11.20.00	---
Nickel (6010), mg/l	<0.040	110 %	0.91 %
Prep Date	11.17.00	11.17.00	---
Analysis Date	11.20.00	11.20.00	---
Manganese (6010), mg/l	<0.010	110 %	0.91 %
Prep Date	11.17.00	11.17.00	---
Analysis Date	11.20.00	11.20.00	---
Sodium (6010), mg/l	<0.50	104 %	11 %
Prep Date	11.17.00	11.17.00	---
Analysis Date	11.20.00	11.20.00	---
Zinc (6010), mg/l	<0.020	110 %	1.8 %
Prep Date	11.17.00	11.17.00	---
Analysis Date	11.20.00	11.20.00	---
Strontium (6010), mg/l	<0.010	104 %	11 %
Prep Date	11.17.00	11.17.00	---
Analysis Date	11.20.00	11.20.00	---

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES	DATE/ TIME SAMPLED
63363-2	Method Blank	
63363-3	Accuracy (%Rec)	
63363-4	Precision (%RPD)	

PARAMETER	63363-2	63363-3	63363-4
Calcium (6010), mg/l	<0.50	106 %	11 %
Prep Date	11.17.00	11.17.00	---
Analysis Date	11.20.00	11.20.00	---
Magnesium (6010), mg/l	<0.50	106 %	10 %
Prep Date	11.17.00	11.17.00	---
Analysis Date	11.20.00	11.20.00	---
Color (110.2), PCU	<5	100 %	0 %
Analysis Date	11.15.00	11.15.00	---
Bicarbonate Alkalinity as CaCO3 (2320B), mg/l	<1.0	96 %	1.8 %
Analysis Date	11.21.00	11.21.00	---
Bromide (300.0), mg/l	<1.0	107 %	2.8 %
Prep Date	11.17.00	11.17.00	---
Analysis Date	11.17.00	11.17.00	---
Chloride (325.3)			
Chloride, mg/l	<1.0	96 %	1.0 %
Analysis Date	11.17.00	11.17.00	---

Methods: EPA SW-846, EPA 600/4-79-020
DOH Certification #'s 84385, E84282, 87279, E87052, 87375, E87089

Michael F. Valder, Project Manager

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