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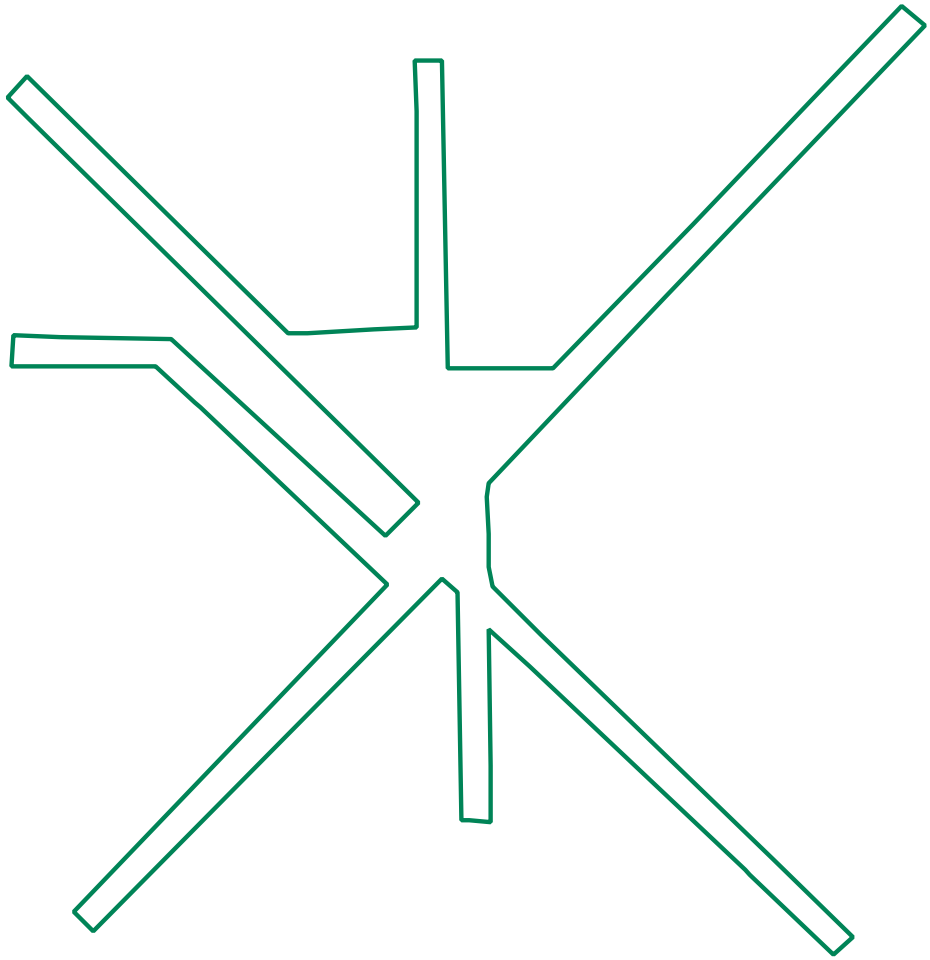
Data from Stratigraphic Test Holes Drilled at the U.S. Marine Corps Air Station, Cherry Point, North Carolina, 1994–2001, and Periodic Water Levels, 2000–2003



Open-File Report 2004–1434

U.S. Department of the Interior
U.S. Geological Survey

Data from Stratigraphic Test Holes Drilled at the U.S. Marine Corps Air Station, Cherry Point, North Carolina, 1994–2001, and Periodic Water Levels, 2000–2003

By Beth M. Wrege and Philip S. Jen

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U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
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U.S. Geological Survey, Reston, Virginia: 2004

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Contents

Abstract. 1
Introduction 1
Purpose and Scope 1
Description of the Study Area 2
Previous Investigations. 3
Hydrogeologic Setting. 3
Acknowledgments. 3
Data-Collection Methods. 4
Stratigraphic Test Hole Descriptions and Data. 6
Strat-1. 6
Strat-2. 13
Strat-3. 19
Strat-4. 25
Strat-5. 31
Strat-6. 40
Strat-7. 47
Strat-8. 53
Strat-9. 57
Seismic Data 60
Marine Seismic Data. 60
Land Seismic Data 60
Summary. 63
Selected References. 64
Appendix. 65

Figures

1. Map showing location of the U.S. Marine Corps Air Station, Cherry Point, North Carolina 2
2. Stratigraphic units beneath the U.S. Marine Corps Air Station, Cherry Point, North Carolina 3
3. Map showing locations of stratigraphic test wells, vertical seismic profile wells, and seismic surveys at the U.S. Marine Corps Air Station, Cherry Point, North Carolina. 5
4. Map showing location of Strat-1 well. 7
5. Selected borehole geophysical logs collected in Strat-1 test hole. 10
6. Strat-1 monitoring-well construction report. 11
7. Hydrograph showing ground-water levels in Strat-1 monitoring well, September 2000–August 2002 12
8. Map showing location of Strat-2 well. 13
9. Selected borehole geophysical logs collected in Strat-2 test hole. 16
10. Strat-2 monitoring-well construction report. 17
11. Hydrograph showing ground-water levels in Strat-2 monitoring well, September 2000–August 2002 18
12. Map showing location of Strat-3 well. 19

13. Selected borehole geophysical logs collected in Strat-3 test hole 22
14. Strat-3 monitoring-well construction report 23
15. Hydrograph showing ground-water levels in Strat-3 monitoring well, February 2001–August 2002 24
16. Map showing location of Strat-4 well 25
17. Selected borehole geophysical logs collected in Strat-4 test hole 28
18. Strat-4 monitoring-well construction report 29
19. Hydrograph showing ground-water levels in Strat-4 monitoring well, September 2000–May 2002 30
20. Map showing location of Strat-5 well 31
21. Photographs of the mud-rotary wire-line core rig used to drill the Strat-5 borehole 32
22. Selected borehole geophysical logs collected in Strat-5 test hole 34
23. Strat-5 monitoring-well construction report 35
24. Hydrograph showing ground-water levels in Strat-5 monitoring well, September 2000–May 2002 36
25. Hydrograph showing continuous daily mean ground-water levels in Strat-5 monitoring well for water year 2002 39
26. Hydrograph showing continuous daily mean ground-water levels in Strat-5 monitoring well for the period of record 39
27. Map showing location of Strat-6 well 40
28. Selected borehole geophysical logs collected in Strat-6 test hole 43
29. Strat-6 monitoring-well construction report 45
30. Hydrograph showing ground-water levels in Strat-6 monitoring well, September 2000–August 2002 46
31. Map showing location of Strat-7 well 47
32. Selected borehole geophysical logs collected in Strat-7 test hole 50
33. Strat-7 monitoring-well construction report 51
34. Hydrograph showing ground-water levels in Strat-7 monitoring well, September 2000–May 2002 52
35. Map showing location of Strat-8 well 53
36. Selected borehole geophysical logs collected in Strat-8 test hole 55
37. Strat-8 monitoring-well construction report 56
38. Map showing location of Strat-9 test hole 57
39. Selected borehole geophysical logs collected in Strat-9 test hole 59
40. Section of seismic data collected along the Slocum line, U.S. Marine Corps Air Station, Cherry Point, North Carolina 63

Tables

1. Selected records and borehole geophysical logs collected in stratigraphic test holes at the U.S. Marine Corps Air Station, Cherry Point, North Carolina, 1994–2001 4
2. Well-construction records for stratigraphic test holes at the U.S. Marine Corps Air Station, Cherry Point, North Carolina, 1994–2001 6
3. Lithologic log for Strat-1 test hole 8
4. Periodic water levels in Strat-1 monitoring well 12
5. Lithologic log for Strat-2 test hole 14
6. Periodic water levels in Strat-2 monitoring well 18
7. Core interval and recovery from Strat-3 test hole 20

8. Lithologic log for Strat-3 test hole 20
9. Periodic water levels in Strat-3 monitoring well 24
10. Core interval and recovery from Strat-4 test hole. 26
11. Lithologic log for Strat-4 test hole 27
12. Periodic water levels in Strat-4 monitoring well 30
13. Lithologic log for Strat-5 test hole 33
14. Periodic water levels in Strat-5 monitoring well 36
15. Continuous ground-water levels recorded for water year 2001 in the Strat-5 monitoring well 37
16. Continuous ground-water levels recorded for water year 2002 in the Strat-5 monitoring well 38
17. Lithologic log for Strat-6 test hole 41
18. Periodic water levels in Strat-6 monitoring well 46
19. Lithologic log for Strat-7 test hole 48
20. Periodic water levels in Strat-7 monitoring well 52
21. Lithologic log for Strat-8 test hole 54
22. Lithologic log for Strat-9 test hole 58
23. Field surveys conducted to collect land seismic data at the U.S. Marine Corps Air Station, Cherry Point, North Carolina, 1994–2000 60
24. Surveyed station location data and elevation inflection points for seismic surveys at the U.S. Marine Corps Air Station, Cherry Point, North Carolina 61

Appendix Table

1-1. Previous reports and investigations prepared by the U.S. Geological Survey in cooperation with the U.S. Marine Corps Air Station, Cherry Point, North Carolina 65

Conversion Factors, Datum, and Acronyms

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow	
gallon per minute (gal/min)	0.06309	liter per second (L/s)
	Mass	
pound, avoirdupois (lb)	0.4536	kilogram (kg)

SEISMIC DATA are in metric units.

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)

Temperature in degrees Celsius (° C) can be converted to degrees Fahrenheit (° F) as follows:

$$° F = (1.8 \times ° C) + 32$$

Temperature in degrees Fahrenheit (° F) can be converted to degrees Celsius (° C) as follows:

$$° C = (° F - 32) / 1.8$$

Horizontal (latitude and longitude) coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29). For the purpose of this publication, the term sea level is used to represent the 0-foot altitude as referenced to NGVD 29.

Acronyms

CMP	common midpoint
DCP	data-collection platform
KGS	Kansas Geological Survey
MCAS	Marine Corps Air Station
MMHOS/M	millimhos per meter
NWIS	National Water Information System
PVC	polyvinyl chloride
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
VSP	vertical seismic profile

Data from Stratigraphic Test Holes Drilled at the U.S. Marine Corps Air Station, Cherry Point, North Carolina, 1994–2001, and Periodic Water Levels, 2000–2003

By Beth M. Wrege and Philip S. Jen

Abstract

Nine stratigraphic test holes, from 158 to 305 feet deep, were drilled at the U.S. Marine Corps Air Station at Cherry Point, North Carolina, between 1994 and 2001 by the U.S. Geological Survey. These test holes and subsequent wells provide information about the lithology, stratigraphy, and geology at the Marine Corps Air Station. In addition, ground-water-level data were collected at the Air Station through 2003. The U.S. Geological Survey also conducted high-resolution marine and land seismic surveys during this investigation. The ground-water-level data and locations of the seismic survey lines are included in this report. The stratigraphic data combined with the seismic data provide a basis for the delineation of paleochannels beneath the Air Station as well as information for the management of water resources at the Air Station.

Introduction

The water supply for the U.S. Marine Corps Air Station (MCAS) at Cherry Point, North Carolina, has been derived from the Castle Hayne aquifer since the Air station was established in 1941 (Grossnick and Armstrong, 1997). The MCAS, which is in the Coastal Plain Physiographic Province (fig. 1), is underlain by five freshwater-bearing aquifers—the surficial, Yorktown, Pungo River, and the upper and lower Castle Hayne aquifers (Daniel and others, 1996). The upper Castle Hayne aquifer is composed of sand and sandy shell beds of the Pungo River Formation and limestone of the River Bend Formation. In localized areas, the lower part of the Pungo River Formation is not the confining unit between the Yorktown and underlying aquifers, as is the case in other areas of the Coastal Plain. This lack of hydrologic separation is attributed to the development of paleochannels. Locating these paleochannels will better define the hydrogeologic framework beneath the MCAS.

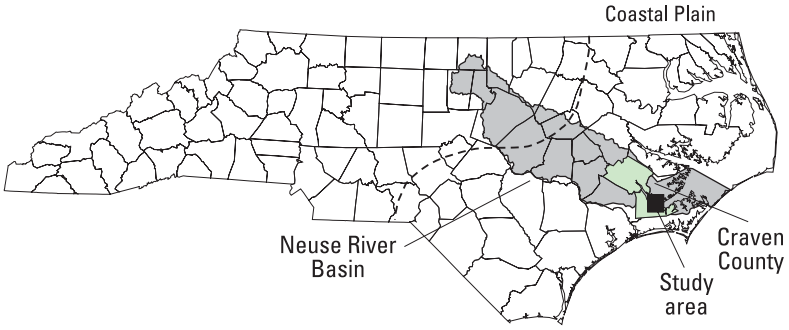
Purpose and Scope

This report presents hydrogeologic and ground-water-level data collected by the U.S. Geological Survey (USGS) at the request of the MCAS, Cherry Point, North Carolina, from 1994 to 2003. The report includes lithologic data from stratigraphic test-hole drilling, borehole geophysical data, well-construction data, and the locations of marine seismic surveys and high-resolution land seismic surveys. The purpose of this report is to provide data to aid in locating paleochannels beneath the MCAS. The existence of paleochannels may affect the ground-water supply by providing a conduit for contaminant movement at the Air Station.

Nine stratigraphic test holes, designated Strat-1 through Strat-9, were drilled at the MCAS, Cherry Point. The first four test holes, Strat-1 through Strat-4, were drilled in 1994 and 1995. Interpretations and data analysis of these four test holes are presented in Daniel and others (1996). The Strat-5 through Strat-9 test holes were drilled in 2000 and 2001.

The hydrogeologic data presented in this report include summarized data from Daniel and others (1996) for Strat-1 through Strat-4 and the data collected during this investigation for Strat-5 through Strat-9. The data are organized sequentially from Strat-1 through Strat-9. Descriptions of the stratigraphic test holes include the following:

- Background data for each test-hole drilling site,
- Location maps, including directions to the drilling sites,
- Borehole geophysical logs prepared at identical scales for comparison purposes,
- Well-construction reports for monitoring wells installed in the stratigraphic test holes,
- Water-level data,
- Hydrographs of periodic water-level measurements, and



LOCATION OF STUDY AREA, CRAVEN COUNTY, AND COASTAL PLAIN PHYSIOGRAPHIC PROVINCE IN NORTH CAROLINA

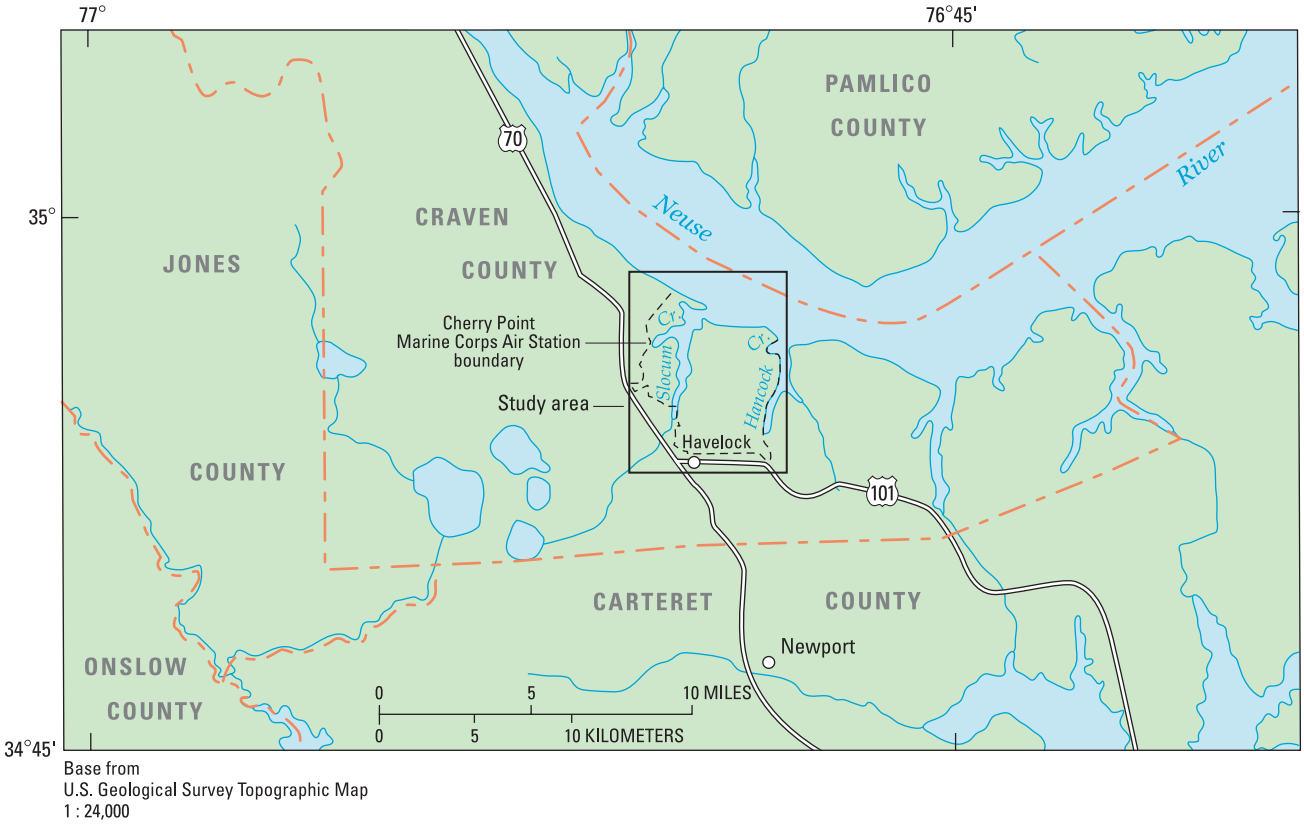


Figure 1. Location of the U.S. Marine Corps Air Station, Cherry Point, North Carolina.

- Photographs of selected data-collection methods and core samples.

Continuous water-level monitoring data were archived and can be accessed at http://waterdata.usgs.gov/nc/nwis/.

High-resolution seismic data were collected at the MCAS during four separate field surveys between September 1994 and March 2000. A map showing the line locations for these investigations is presented in this report.

Description of the Study Area

The MCAS at Cherry Point is located in Craven County, North Carolina, in the Neuse River basin (fig. 1). The study area is just north of the town of Havelock in the southeastern part of the county. The area is bounded to the north by the Neuse River, to the east by Hancock Creek, to the south by State Highway 101, and to the west by an irregular boundary about 1 mile west of Slocum Creek (fig. 1). The MCAS encompasses an area of about 19 square miles (mi^2).

Previous Investigations

The USGS has conducted several hydrogeological investigations at the MCAS, Cherry Point, since 1986. This investigation is a continuation of the work begun by Daniel and others (1996). Reports of previous investigations by the USGS in cooperation with the MCAS, Cherry Point, are listed in Appendix table 1-1.

Hydrogeologic Setting

The hydrogeologic framework underlying the MCAS at Cherry Point consists of five freshwater aquifers and associated confining units—the surficial, Yorktown, Pungo River, and upper and lower Castle Hayne. These aquifers are recognized as geologically separate units ranging in age from Quaternary-Holocene to Tertiary-Eocene (fig. 2; Daniel and others, 1996). The aquifers, however, may not be hydrologically distinct near the MCAS because of erosional truncations and paleochannels beneath the Air Station. Most municipal water-supply wells in the study area tap the Castle Hayne aquifer of Tertiary age and are completed in either the River Bend-Oligocene or the Castle Hayne-Eocene Formations.

The sedimentary deposits that form the upper three aquifers—the surficial, Yorktown, and Pungo River—range in age from Holocene through Miocene (Daniel and others, 1996, fig. 3). These deposits are composed mostly of sand with lesser amounts of gravel and limestone that are separated by locally discontinuous clay layers and lenses. The deeper Castle Hayne aquifer primarily consists of limestone with substantial thicknesses of interbedded sands.

Paleochannels are remnants of river and stream channels that have been filled with sediment and are overlain by younger units. The existence of paleochannels that breach one or more of the confining units above the Castle Hayne aquifer could provide a conduit for contaminants to penetrate from the land surface to the water supply.

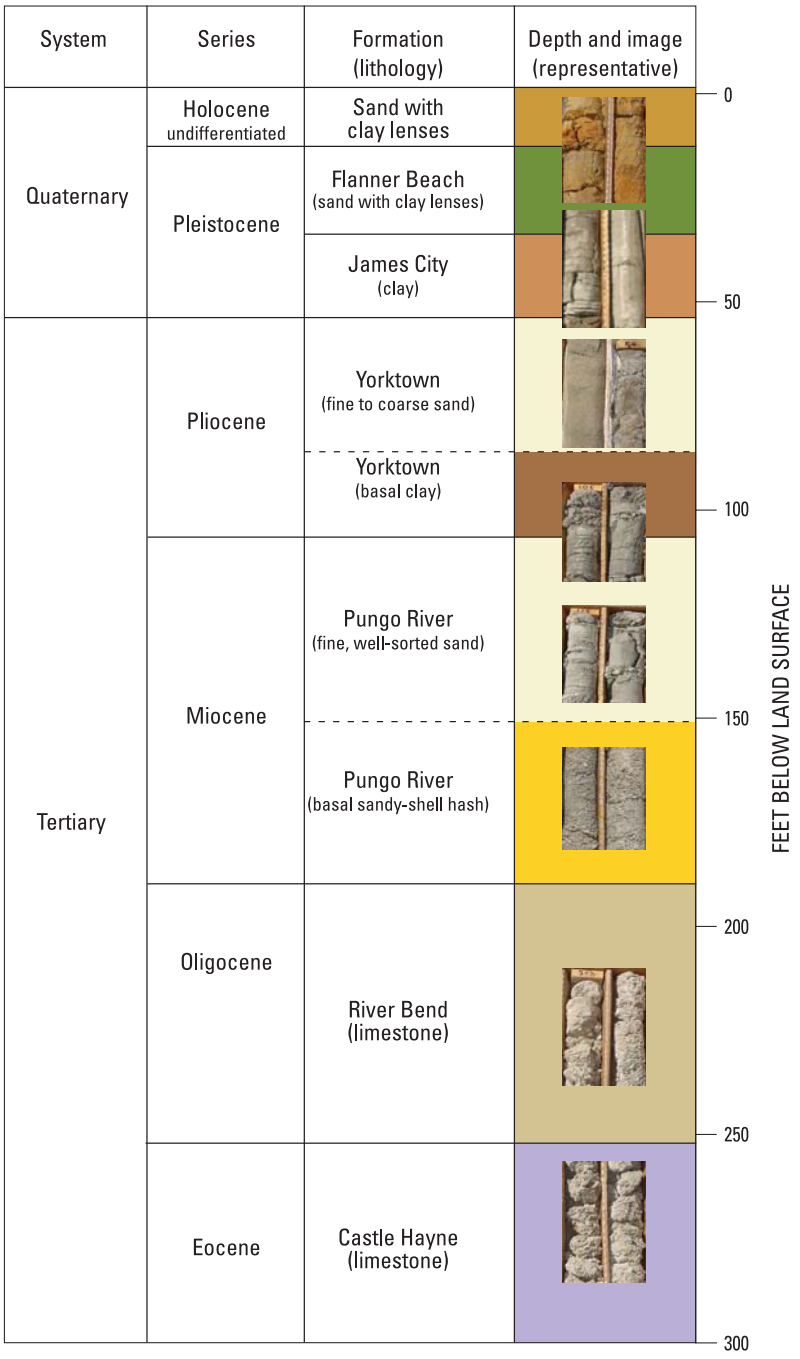


Figure 2. Stratigraphic units beneath the U.S. Marine Corps Air Station, Cherry Point, North Carolina (Wrege and Daniel, 2001).

Acknowledgments

High-resolution land seismic data for this investigation were collected by Richard D. Miller, Joe M. Anderson, David R. Laflen, Choon B. Park, and Dr. Jianghai Xia of the Kansas Geological Survey, Lawrence, Kansas. Lithologic descriptions of the core samples for three wells were prepared by Dr. Charles C. Daniel, III (retired), USGS, Raleigh, North Carolina, who was the project chief during much of the investigation. The USGS borehole and well-drilling crew, Eugene Cobbs, II (retired), and Eugene Cobbs, III, from Reston, Virginia, provided excellent technical and professional support under adverse conditions. Geophysical logs for Strat-1 through Strat-4 were collected by Gerry Idler (retired), USGS, Atlanta, Georgia. Logistical support was provided by Ken Cobb of the MCAS, Cherry Point.

Data-Collection Methods

Geological and geophysical methods were used to locate paleochannels that breach one or more of the confining units above the Castle Hayne aquifer. Stratigraphic test holes were drilled for the collection of core material and the installation of observation wells (Wrege and Daniel, 2001). Drilling of these test holes began with Strat-1 in 1994 and concluded with Strat-9 in 2001. The test holes range in depth from about 158 to 305 feet (ft) below land surface. The mean depth of the nine test holes is about 222 ft below land surface. The target depth of the test holes was the top of the Castle Hayne aquifer. Observation wells were installed in selected test holes. Strat-1, 2, 3, 4, and 6 are located on the east side of the MCAS (fig. 3). Strat-5, 7, 8, and 9 are located west of Slocum Creek on the west side of the MCAS (fig. 3). Selected records and borehole geophysical logs for each stratigraphic test hole are listed in table 1. Well-construction information for the eight installed monitoring wells is presented in table 2.

Samples from Strat-1 through Strat-4 were collected by using a 2-inch diameter split-spoon sampler. Collection of cores was limited to targeted intervals. Using this drilling method, a 2-ft section of core was collected at regular intervals or when facies change was anticipated. Core-collection intervals initially were set for 10 sections, 2-ft each, per 100 ft drilled. The remaining test holes, Strat-5 through Strat-9, were drilled by using a wire-line core rig and were continuously cored. Detailed information on this method is given in the description for Strat-5.

Observation wells were installed in eight of the nine stratigraphic test holes to monitor ground-water levels (table 2). The Strat-4 well, however, was not suitable for monitoring because of a bulge in the polyvinyl chloride (PVC) pipe. A well was not installed in the Strat-9 test hole. One well, Strat-5, was equipped with a hydrologic data-collection platform (DCP) to collect and transmit near real-time water-level data.

Data collected from each of the stratigraphic test holes include lithologic descriptions (cuttings and core samples), vertical seismic profiles (VSPs), and borehole geophysical logs. Of the nearly 1,995 ft drilled, about 1,245 ft were continuously cored, and 750 ft were intermittently cored. The core material was analyzed for information on geologic contacts, age,

Table 1. Selected records and borehole geophysical logs collected in stratigraphic test holes at the U.S. Marine Corps Air Station, Cherry Point, North Carolina, 1994–2001.

[USGS, U.S. Geological Survey; CR, Craven County; L, lithologic log; C, core log; P, penetration log; G, natural gamma log; E, electric log—single-point and resistivity; A, acoustic velocity log; S, caliper (size in inches); T, temperature; VSP, vertical seismic profile; NA, not applicable]

Stratigraphic test hole identification and county number	USGS station number	Latitude[a]	Longitude[a]	Latitude (decimal degrees)	Longitude (decimal degrees)	Total depth, in feet below land surface	Measuring point, in inches above land surface	Borehole geo-physical logs	Remarks
Strat-1, CR-617	345318076541001	34°53'01.84"	76°54'00.74"	34.883900	-076.900299	163	2.52	L,C,P,G,E, A,S	VSP run in test hole.
Strat-2, CR-618	345335076530701	34°53'34.98"	76°53'06.75"	34.893101	-076.885300	158	2.94	L,C,P,G,E, A,S,T	VSP run in test hole.
Strat-3, CR-623	345312076540701	34°53'11.76"	76°54'06.98"	34.886600	-076.901939	204	1.96	L,C,P,G,E, A,S,T	VSP run in test hole.
Strat-4, CR-619	345539076524201	34°55'18.70"	76°52'42.90"	34.921864	-076.878585	225	2.61	L,C,G,E,S	Not suitable for monitoring.
Strat-5, CR-616	345504076562801	34°55'04.08"	76°56'27.96"	34.917801	-076.941101	235.5	2.79	L,C,G,E,S,	VSP run in test hole.
Strat-6, CR-620	345613076513701	34°56'37.64"	76°51'37.86"	34.937131	-076.860457	305	- 0.1	L,C,G,E,S	Flush mount.
Strat-7, CR-621	345510076544901	34°55'09.83"	76°54'48.94"	34.919399	-076.913597	265	2.34	L,C,G,E	None.
Strat-8, CR-622	345707076553501	34°57'06.84"	76°55'34.68"	34.951900	-076.926300	219.5	2.77	L,C,G,E	Secured area.
Strat-9, CR-625	345707076553502	34°53'18.10"	76°54'35.50"	34.888362	-076.909863	220	NA	L,C,G,E	No well installed.

[a] Point locations were determined using a digital elevation model.

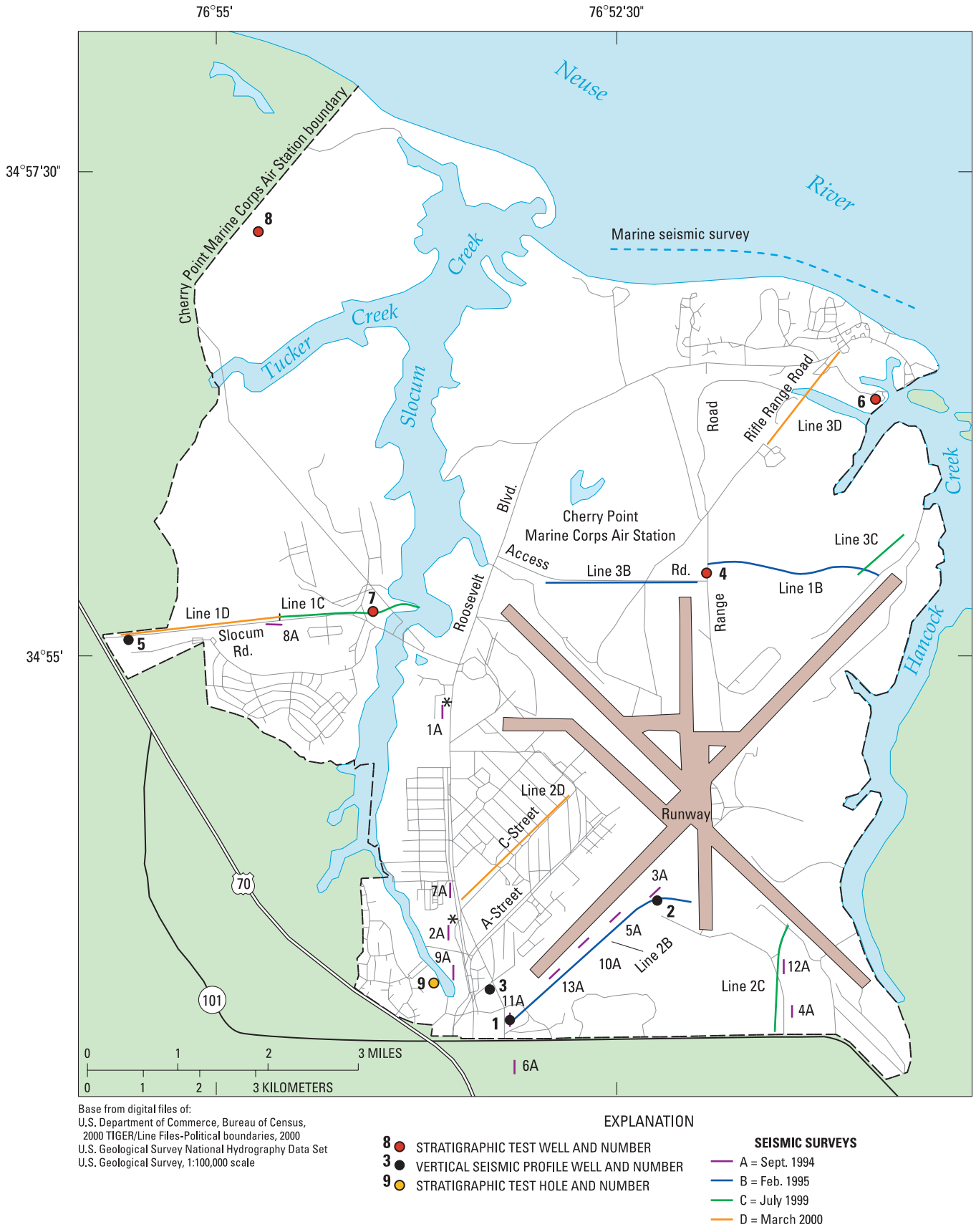


Figure 3. Locations of stratigraphic test wells, vertical seismic profile wells, and seismic surveys at the U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 2. Well-construction records for stratigraphic test holes at the U.S. Marine Corps Air Station, Cherry Point, North Carolina, 1994–2001.

[CR, Craven County; PVC, polyvinyl chloride]

Stratigraphic test hole identification and county number	Date completed	Total depth, in feet	Borehole diameter, in inches	Aquifer	Casing length, in feet	Casing material	Casing diameter, in inches	Screen interval, in feet	Screen diameter, in inches	Screen slot number	Land surface altitude
Strat-1, CR–617	11-04-1994	163	8	Pungo River	150	PVC	4	150–160	4	10	23.59
Strat-2, CR–618	11-15-1994	158	8	Pungo River	145	PVC	4	145–160	4	10	23.66
Strat-3, CR–623	11-25-1994	204	8	Castle Hayne	190	PVC	4	190–200	4	10	23.78
Strat-4, CR–619	3-27-1995	225	8	Castle Hayne	180	PVC	4	180–205	4	10	28
Strat-5, CR–616	3-9-2000	235	4.5	Castle Hayne	212	PVC	2	210–220	2	10	25.43
Strat-6, CR–620	8-19-2000	305	4.5	Castle Hayne	212.79	PVC	2	210–220	2	12	10
Strat-7, CR–621	8-2-2000	265	4.5	Pungo River	200	PVC	2	200–210	2	12	26.0
Strat-8, CR–622	2-12-2001	219.5	4.5	Castle Hayne	199.5	PVC	2	200–210	2	10	28.0

lithology, relative hydrologic properties, and to correlate stratigraphic relations with those of the other test holes.

Borehole geophysical well logs were collected by USGS personnel using Century, Mount Sopris, and Geometrics equipment. The VSPs were collected by the Kansas Geological Survey (KGS). Seismic study design and identification of hydrogeologic units were a combined effort of the USGS and the KGS.

Stratigraphic Test Hole Descriptions and Data

Information about the nine stratigraphic test holes drilled at the MCAS, Cherry Point (fig. 3), is presented in this section. Descriptions include available background data, location maps, lithologic logs, borehole geophysical well logs, monitoring-well construction diagrams, and ground-water-level data and hydrographs. Water-level data for some of the wells were published previously in USGS annual data reports (Howe and others, 2002, 2003).

Strat-1

The Strat-1 well is located north of State Highway 101 and east of Cunningham Boulevard (fig. 4). The well is on the east side of the road behind the tree line. A detailed location map is provided in figure 4.

The Strat-1 test hole was drilled by the U.S. Army Corps of Engineers (USACE) drilling crew. Drilling began on November 1, 1994, and was completed on November 4, 1994. A reverse mud-rotary drilling method was used to reach a total depth of 163 ft. The cored intervals for this stratigraphic test hole totaled 76 ft, of which 78.2 percent was recovered. Forty separate split-spoon core runs were made, and each sample was collected in a 2-ft long tube. Lithologic descriptions were recorded from the cuttings and core samples (table 3). A general lithologic description of the core is included in this report.

Strat-1 was geophysically logged on November 16, 1994. The abbreviated lithology and digitized borehole geophysical logs are shown in figure 5. Logs collected at Strat-1 include the driller's penetration log (blow counts), a lithologic log, a hydrologic log, natural gamma radiation, and acoustic velocity. A monitoring well was installed in the borehole, and installation was completed on November 4, 1994. A diagram of the well construction, including placement of the well screen, is shown in the monitoring-well construction report (fig. 6).

The Strat-1 well was assigned North Carolina (NC) county number CR-617 and USGS station number 345318076541001. Periodic water-level measurements were made in the monitoring well between September 2000 and August 2002. Water levels ranged from 13.83 to 16.74 ft below land surface (table 4; fig. 7).

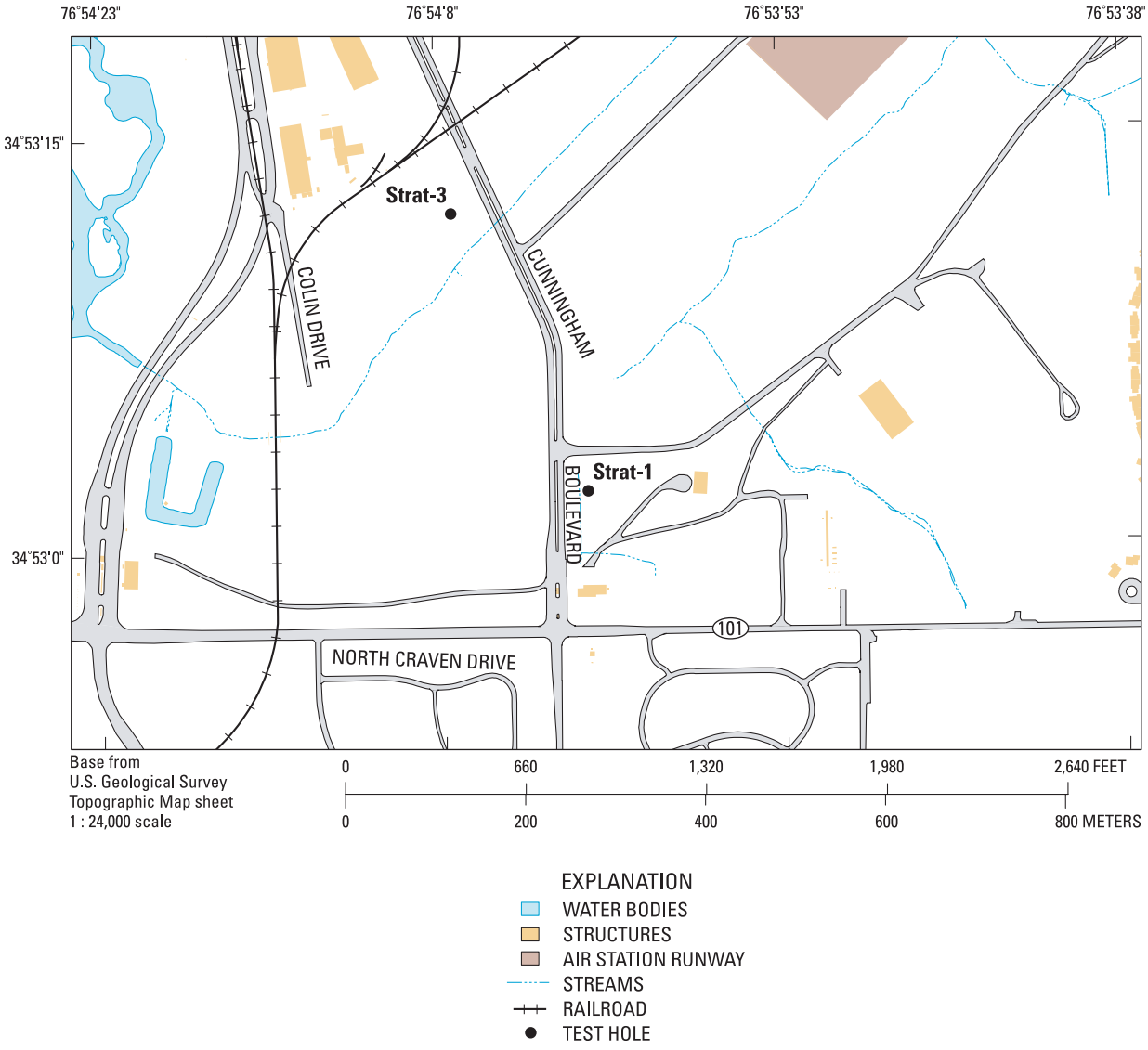


Figure 4. Location of Strat-1 well at U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 3. Lithologic log for Strat-1 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

[mm, millimeter]

Depth below land surface (in feet)	Description (compiled by B.M. Wrege)
0.0 – 3.0	SOIL.
3.0 – 4.0	Silty CLAY.
4.0 – 5.0	Silty, sandy CLAY.
5.0 – 6.0	Fine SAND.
6.0 – 8.0	No sample.
8.0 – 10.0	SAND.
10.0 – 12.0	Gray silty CLAY.
12.0 – 14.0	Gray SAND, some silt.
14.0 – 15.0	Well-sorted fine SAND–light gray.
15.0 – 18.0	Fine–medium SAND, clay ball.
18.0 – 20.0	Fine silty, clayey SAND–light gray.
20.0 – 22.0	CLAY stringers, coarse sand.
22.0 – 24.0	Silty CLAY, coarse sand stringer.
24.0 – 26.0	Medium-coarse SAND.
26.0 – 28.0	Medium SAND, gray, well sorted, some silt.
28.0 – 30.0	Fine–medium SAND, gray, well sorted, some silt.
30.0 – 32.0	SAND, moderately indurated with silt and clay, light gray.
32.0 – 34.0	SAND, gray clay and shell hash.
34.0 – 36.0	Green-gray CLAY and shell fragments.
36.0 – 38.0	Green-gray CLAY and shell fragments.
38.0 – 40.0	Green-gray CLAY.
40.0 – 42.0	Green CLAY–abundant shell hash.
42.0 – 44.0	Bluish-gray SAND, medium to fine sand, phosphate grains, fine shell fragments, minor clay.
44.0 – 46.0	Fine SAND, shell bits, modest clay, bluish gray.
46.0 – 48.0	Fine SAND, fine shell bits, bluish gray.
48.0 – 50.0	Fine SAND, bluish gray.
50.0 – 52.0	Green silty CLAY, hard, some fine sand, fine shell fragments.
52.0. – 54.0	Dense green silty CLAY, some fine sand, a few shell fragments.
54.0 – 56.0	Dense green silty CLAY, few quartz grains.
56.0 – 58.0	Green silty CLAY, hard, some fine sand, fine shell fragments.
58.0 – 59.5	Green silty CLAY with a few coarse quartz pebbles, 3–6 mm, color changes to gray.
59.5 – 60.9	No sample, hard at bottom of interval, bit sizes, changed from drag bit to roller cone bit.
60.9 – 61.7	No sample, very hard.
61.7 – 62.0	No sample, soft, drills easy.
62.0 – 63.3	Dense green silty sandy CLAY.
63.3 – 64.0	SAND, clean fine gray.
64.0 – 66.0	No sample.
66.0 – 67.0	Fine (sugar) SAND, clean, well sorted, no fossils.
67.0 – 70.0	No sample.
70.0 – 71.5	Fine SAND, clean, well sorted.
71.5 – 74.0	No sample.
74.0 – 75.5	Fine SAND, clean, well sorted.

Table 3. Lithologic log for Strat-1 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.—Continued

[mm, millimeter]

Depth below land surface (in feet)	Description (compiled by B.M. Wrege)
75.5 – 78.0	No sample.
78.0 – 80.0	Fine SAND, greenish-gray color.
80.0 – 82.0	No sample.
82.0 – 83.4	Very fine greenish-gray SAND.
83.4 – 86.0	No sample.
86.0 – 86.8	Very fine gray SAND, a few shell fragments.
86.8 – 90.0	No sample.
90.0 – 91.2	Medium to coarse SAND, phosphate grains.
91.2 – 94.0	No sample.
94.0 – 95.0	Medium to coarse SAND, large phosphate and quartz pebbles, 4–8 mm in diameter, abundant shell fragments.
95.0 – 96.0	Lime-cemented medium to medium-coarse SAND.
96.0 – 98.0	No sample.
98.0 – 99.2	Fine SAND with a few shell fragments.
99.2 – 102.0	No sample.
102.0 – 104.0	Fine to medium limey SAND, with a few shell fragments, phosphate grains.
104.0 – 106.0	No sample.
106.0 – 106.8	SAND to coarse SAND, with limey phosphate grains.
106.8 – 119.6	No sample.
119.6 – 120.5	Fine silty SAND, gray shell fragments.
120.5 – 135.0	No sample.
135.0 – 140.0	Shell hash, about 50 percent of cuttings.
140.0 – 150.0	No sample.
150.0 – 163.0	Abundant shell fragments with limey brown clay, trace of limestone.

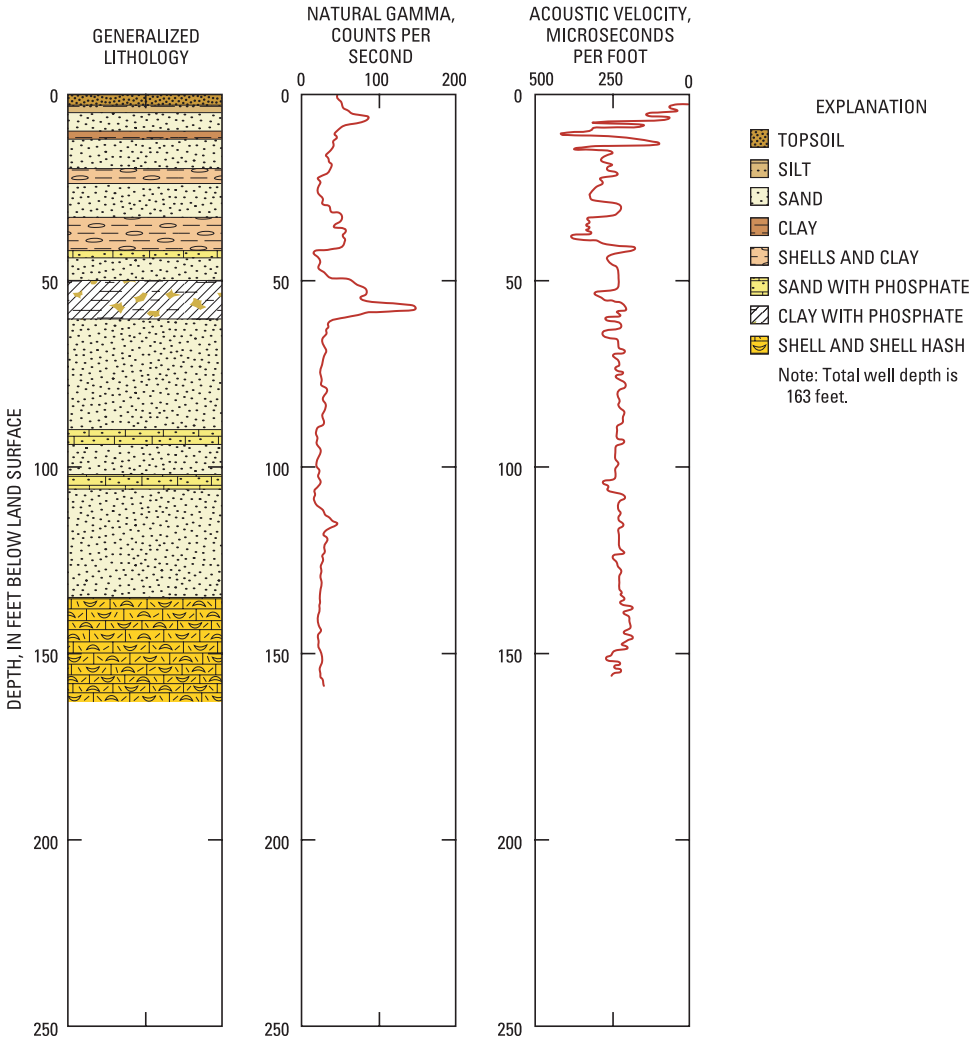
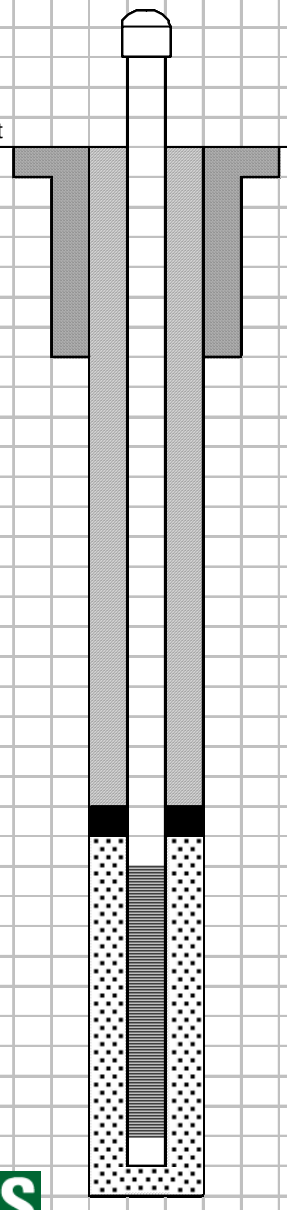


Figure 5. Selected borehole geophysical logs collected in Strat-1 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

MONITORING WELL CONSTRUCTION REPORT

U.S. Geological Survey
Water Resources Division
3916 Sunset Ridge Road
Raleigh, North Carolina 27607
(919) 571-4000

SITE:	CR-617 STRAT HOLE 1 AT CHERRY POINT MCAS				
WELL NUMBER:	345318076541001	LATITUDE:	34° 53' 18"	DATUM:	
DATE STARTED:	11-1-1994	LONGITUDE:	76° 54' 10"	NAD83	
DATE COMPLETED:	11-4-1994	AQUIFER:	PUNGO RIVER		
USGS REPRESENTATIVE:	Beth Wrege	PROJECT NUMBER:	13800		



LAND SURFACE
ALTITUDE: 23.78 feet
DATUM: NGVD29

ALTITUDE OF MEASURING POINT	26.30 feet
HEIGHT OF MEASURING POINT ABOVE LAND SURFACE	2.52 feet
BOREHOLE DIAMETER	8 inches
CASING DIAMETER / TYPE	4 inches / PVC
SURFACE CASING DEPTH	20 feet
TYPE OF GROUT	Type I Portland Cement*
DEPTH OF GROUT	25 feet
TOP OF FILTER PACK DEPTH	63 feet
TYPE OF FILTER PACK	Sand
SCREEN SLOT NUMBER	#2
SCREEN DIAMETER	4 inches
SCREEN INTERVAL TOP	147.48 feet
SCREEN INTERVAL BOTTOM	157.48 feet
WELL DEPTH	163 feet
HOLE DEPTH	163 feet

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Figure 6. Strat-1 monitoring-well construction report, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 4. Periodic water levels in Strat-1 monitoring well, U.S. Marine Corps Air Station, Cherry Point, North Carolina

Date	Water Level, feet below land surface
9/21/2000	14.53
2/9/2001	14.65
5/3/2001	15.55
8/9/2001	13.83
3/29/2002	15.16
5/15/2002	16.05
8/16/2002	16.74

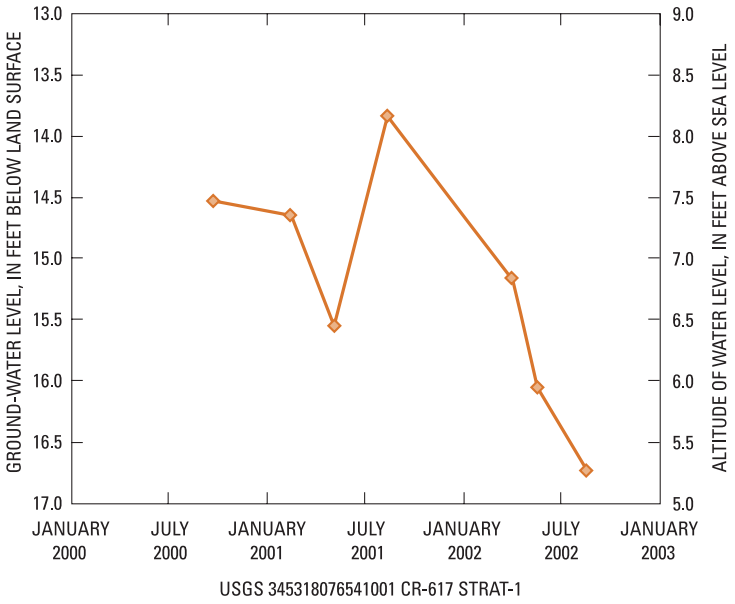


Figure 7. Hydrograph of ground-water levels in Strat-1 monitoring well, U.S. Marine Corps Air Station, Cherry Point, North Carolina, September 2000–August 2002.

Strat-2

The Strat-2 well is located between runways on the south side of the MCAS and on the north side of an unimproved road (fig. 3). Although access to this location is limited, a detailed location map is provided in figure 8.

The Strat-2 test hole was drilled by the USACE drilling crew. Drilling began on November 5, 1994, and a total depth of 158 ft was reached on November 15, 1994. A reverse mud-rotary drilling method was used. The cored intervals of this stratigraphic test hole totaled 91 ft, of which 92.7 percent was recovered. The core was collected in 2-ft long tubes. Lithologic determinations were made from the cuttings and core samples, and are described in table 5. For a more detailed analysis, see Daniel and others (1996).

After the test was drilled, geophysical logs were run in the open borehole, which was logged on November 15, 1994. Logs collected at Strat-2 include the driller's penetration log (blow counts), a lithologic log, a hydrologic log, natural gamma radiation, acoustic velocity, single-point resistance, spontaneous potential, guard log (focused resistivity), caliper, and temperature. Vertical seismic profiling (VSP) included a hydrophone log and aholelock geophysical log. The VSP survey was completed November 23, 1994, in the Strat-2 borehole. The abbreviated lithology and borehole geophysical logs are shown in figure 9. A monitoring well was installed in the borehole to a depth of 152.06 ft. A diagram of the well construction, including placement of the well screen, is shown in the monitoring-well construction report (fig. 10).

The Strat-2 well was assigned NC county number CR-618 and USGS station number 345335076530701. Periodic water-level measurements were made in the monitoring well between September 2000 and August 2002. Water-level data ranged from 11.51 to 16.53 ft below land surface (table 6; fig. 11).

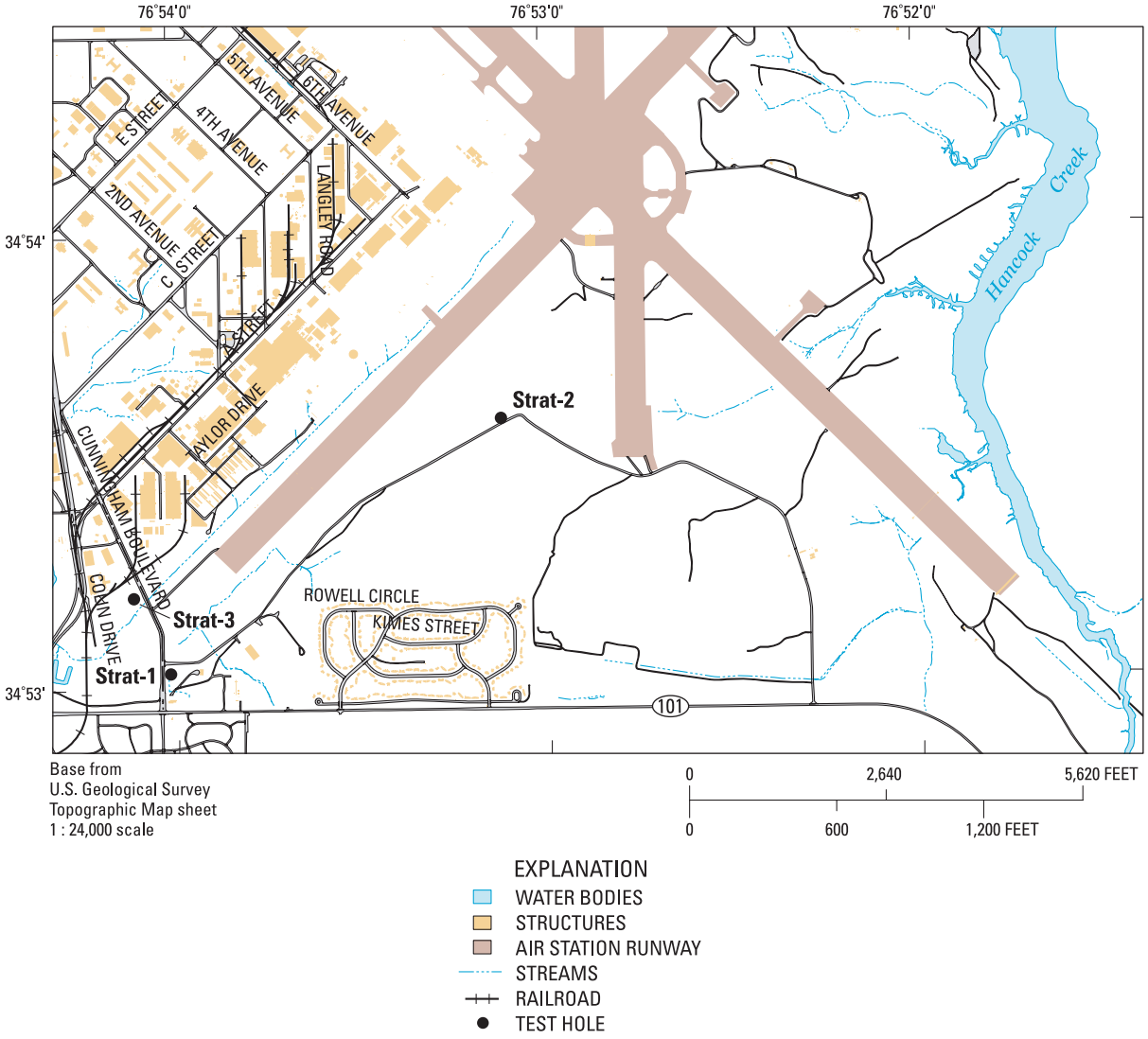


Figure 8. Location of Strat-2 well at U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 5. Lithologic log for Strat-2 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

[mm, millimeter; cm, centimeter; ft, feet]

Depth below land surface (in feet)	Description (compiled by B.M. Wrege)
0.0 – 1.0	Organic SOIL with clay.
1.0 – 2.0	CLAY with fine sand, yellow.
2.0 – 3.0	Stiff CLAY with medium sand, 20-percent sand.
3.0 – 4.0	CLAY with fine sand, 40-percent sand.
4.0 – 5.0	Dry SAND, fine with clay, well sorted.
5.0 – 7.0	SAND, light brown.
7.0 – 8.0	Clean SAND, grading to more clays.
8.0 – 10.0	SAND, fine with clay, uniform.
10.0 – 12.0	SAND, fine to very fine, uniform.
12.0 – 14.0	SAND, fine, silty.
14.0 – 16.0	SAND, very fine to fine, clean.
16.0 – 18.0	SAND, fine, uniform, clean with trace medium.
18.0 – 20.0	SAND, fine to very fine, uniform, clean.
20.0 – 22.0	SAND, clean, fine, uniform.
22.0 – 23.0	Fine SAND, uniform, clean.
23.0 – 24.0	Clean, well graded, light gray quartz SAND.
24.0 – 26.0	Very fine SAND.
26.0 – 28.0	Very fine SAND.
28.0 – 30.0	Fine SAND, color change at bottom of interval.
30.0 – 31.0	Clack, organic SAND.
31.0 – 32.0	SAND, coarse, well sorted.
32.0 – 34.0	Coarse SAND.
34.0 – 38.0	SAND, medium gray, with wood fragments.
38.0 – 39.0	SAND, medium, clean, subrounded, 30-percent white clack and gray shell fragments.
39.0 – 40.0	Shell fragments to 2 mm, clean, sandy, no clay.
40.0 – 42.0	Shells, pelecypods, whole to 14 mm, fragments to 2 cm, with fine, clean sand and gravel, no more wood.
42.0 – 44.0	Shells and sand, fine, grading to coarse.
44.0 – 46.0	No sample.
46.0 – 48.0	Slick green CLAY.
48.0 – 50.0	CLAY, dense, tight with shells and sand.
50.0 – 52.0	SAND, medium to fine.
52.0. – 54.0	SAND and shells, trace clay.
54.0 – 56.0	Clayey SAND, trace shells.
56.0 – 58.0	CLAY.
58.0 – 59.5	CLAY.
59.5 – 60.0	SILT.
60.0 – 62.0	Green CLAY, silty with coarse shells, gastropods and pelecypods, 1- to 3-mm phosphate pebbles.
62.0 – 64.0	Green silty CLAY, a few shells, finer than above.
64.0 – 64.8	Green clayey silt.
64.8 – 66.0	Gray, time-cemented SAND.
66.0 – 68.0	Limey SAND, hard with small shells, some coarse sand.

Table 5. Lithologic log for Strat-2 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.—Continued

[mm, millimeter; cm, centimeter; ft, feet]

Depth below land surface (in feet)	Description (compiled by B.M. Wrege)
68.0 – 70.0	Quartz and phosphate PEBBLES, well rounded, 2–10 mm, with shell fragments, sandy silt and green clay in last 0.5 ft.
70.0 – 72.0	Green clayey SILT with small 1- to 3-mm quartz pebbles and shells.
72.0 – 73.8	Coarse limey SAND with a few pebbles and shell fragments, gray with greenish tint, hard.
73.8 – 76.0	Abundant shell fragments, 1–3 mm, with greenish-gray sand and minor clay.
76.0 – 78.0	Coarse sand and shell fragments, gray limey matrix, hard at top 0.8 ft of interval.
78.0 – 78.9	Gray, coarse, limey sand and shell fragments, hard; changed to roller bit.
78.9 – 82.0	Shell fragments, possible coquina layer.
82.0 – 84.0	Same as above, with few phosphate grains.
84.0 – 84.5	Same as above, very hard.
84.5 – 88.0	Same as above, softer.
88.0 – 90.0	Green CLAY, no sand.
90.0 – 92.0	Green sandy CLAY to green clay, no sand.
92.0 – 92.8	Greenish-gray orthoquartzite (chert cement).
92.8 – 93.8	Cemented SAND.
93.8 – 96.0	CLAY.
96.0 – 98.0	SAND, fine, well-sorted, trace clay (split spoon).
98.0 – 100.0	SAND, fine with clay, green-gray.
100.0 – 102.0	Sandy CLAY, fine sand.
102.0 – 104.0	Same as above.
104.0 – 106.0	CLAY with sand, green, tight.
106.0 – 108.0	CLAY with very fine sand, green.
108.0 – 110.0	Same as above.
110.0 – 112.0	CLAY with very fine sand.
112.0 – 113.8	Green silty CLAY, with sand stringers, hard at 113.8.
113.8 – 116.0	Green silty CLAY, with thin sand layers, quartz pebble 1–2 mm, small 1- to 1.5-mm plant fragment.
116.0 – 118.0	Same as above, with shells.
118.0 – 120.0	Same as above, with phosphate pebbles, 1–3 mm and 4- to 6-mm tan shale clast.
120.0 – 122.0	Green silty CLAY with abundant quartz and phosphate pebbles 1–4 mm, well-rounded, shell fragments.
122.0 – 124.0	No sample.
124.0 – 125.2	Fine SAND with hard, gray, clay balls.
125.2 – 128.0	No sample.
128.0 – 129.0	Very fine, gray, silty SAND.
129.0 – 132.0	No sample.
132.0 – 133.3	Shell fragments, soft limestone (loss of drilling fluid to formation).
133.3 – 158.0	Shell fragments, rounded quartz and phosphate grains to 2 mm.

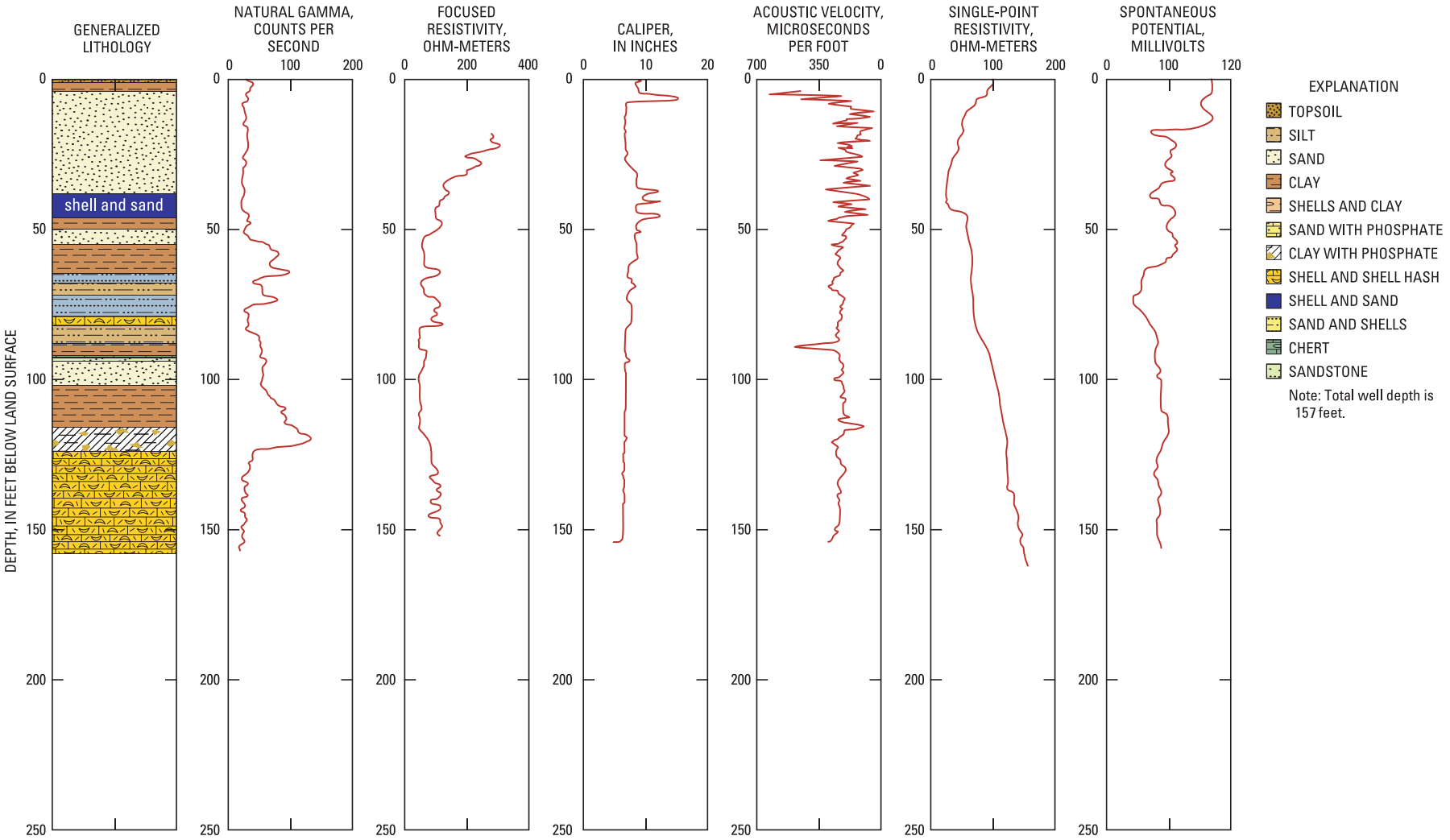


Figure 9. Selected borehole geophysical logs collected in Strat-2 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

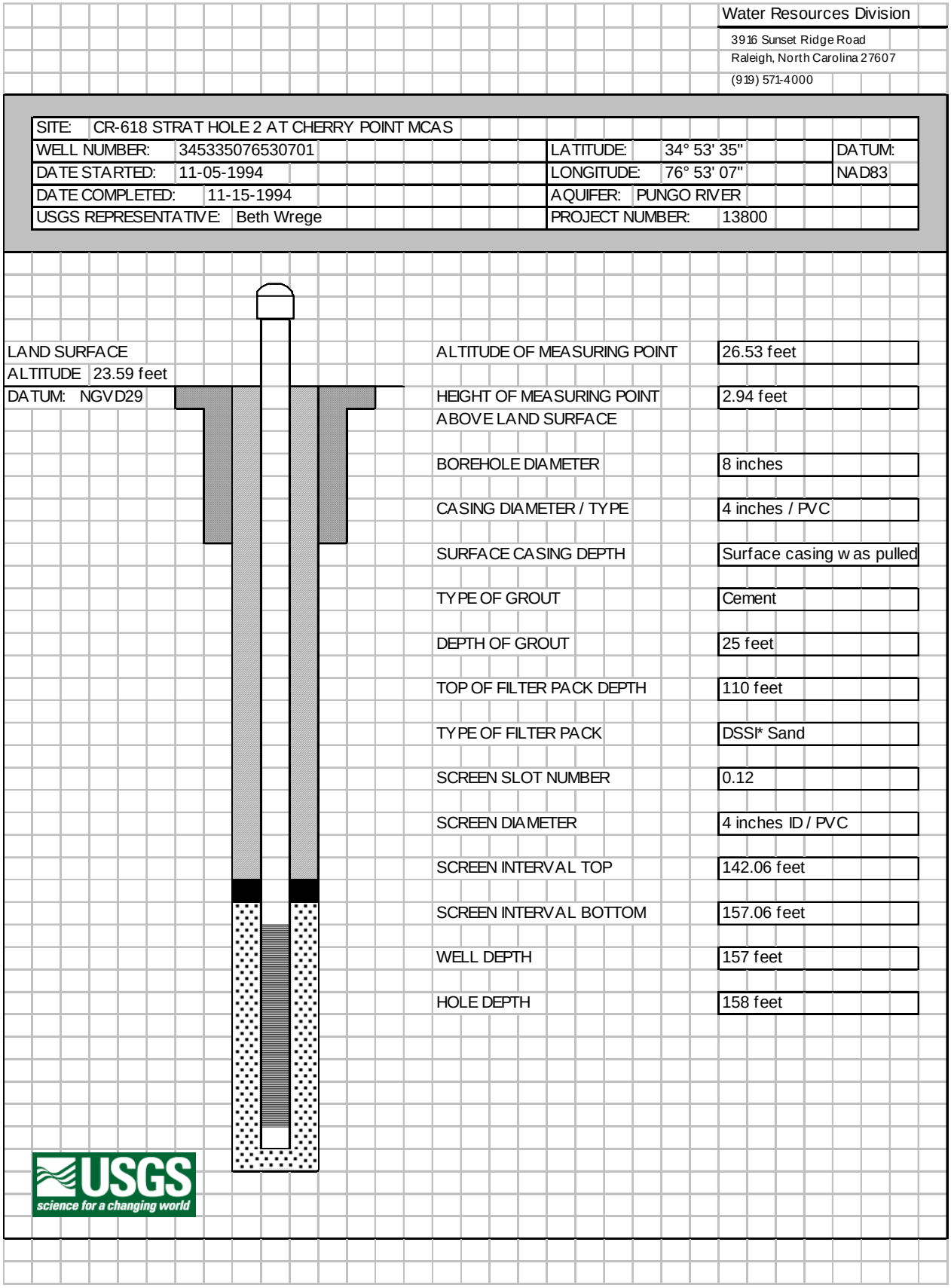


Figure 10. Strat-2 monitoring-well construction report, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 6. Periodic water levels in Strat-2 monitoring well, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Date	Water level, in feet below land surface
09-21-2000	14.23
02-09-2001	14.68
05-03-2001	14.76
08-09-2001	11.51
03-29-2002	14.62
05-15-2002	15.45
08-16-2002	16.53

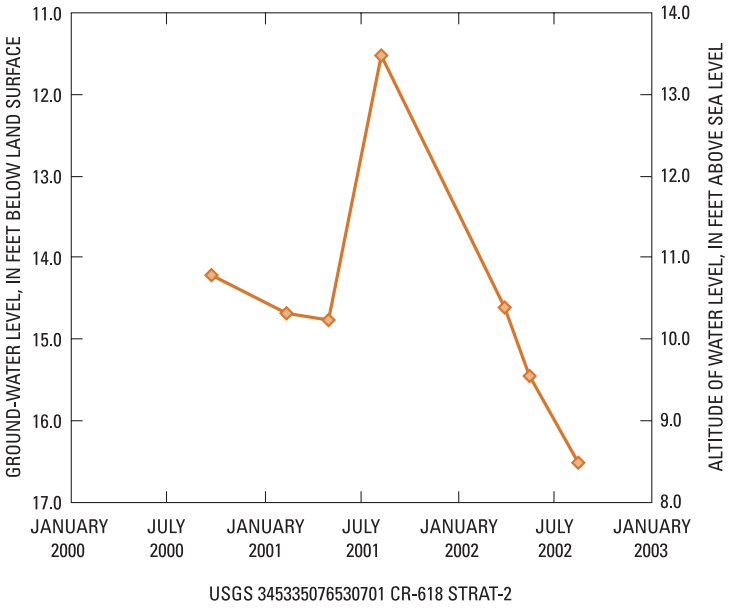


Figure 11. Hydrograph of ground-water levels in Strat-2 monitoring well, U.S. Marine Corps Air Station, Cherry Point, North Carolina, September 2000–August 2002.

Strat-3

The Strat-3 well is west of Cunningham Boulevard, north of Stte highway 101, and south of the railroad tracks at the MCAS (fig. 3). A detailed map is provided in figure 12.

The Strat-3 test hole was drilled by the USACE drilling crew. Drilling began on November 17, 1994, and reached a total depth of 204 ft on November 25, 1994. Using are reverse rotary drilling method, drilling was initiated with a 7 3/8-inch drag bit (fishtail) and a 150-pound hammer. At 174 ft, the drag bit was changed to a roller cone (tri-cone) bit. Of the total 204 ft drilled, 17 cores were collected and 80 percent were recovered. The cored intervals and amounts are listed in table 7. (Note: When clay is recovered, it can expand to a length greater than the initial interval cored, resulting in a recovery length that exceeds the drilling interval.) Lithologic determinations were made from the cuttings and core samples, and are described in table 8. A more detailed core description is given in Daniel and others (1996).

After the test hole was drilled, geophysical logs were run in the open hole. The VSP logs were collected on November 25, 1994, and included the driller's penetration log (blow counts), a lithologic log, a hydrologic log, natural gamma radiation, acoustic veolocity, single-point resistance, spontaneous potential, guard log (focused resistivity), caliper, and temperature. VSP included a hydrophone log and a holelock geophysical log. The abbreviated lithology and digitized borehole geophysical logs are shown in figure 13. A monitoring well was installed in the borehole, and a diagram of the well construction, including placement of the well screen, is shown in the monitoring-well construction report (fig. 14).

The Strat-3 well was assigned NC county number CR-623 and USGS station number 345312076540701. Periodic water-level measurements were made in the monitoring well between February 2001 and August 2002. Water-level data ranged from 14.09 to 17.11 ft below land surface (table 9; fig. 15).

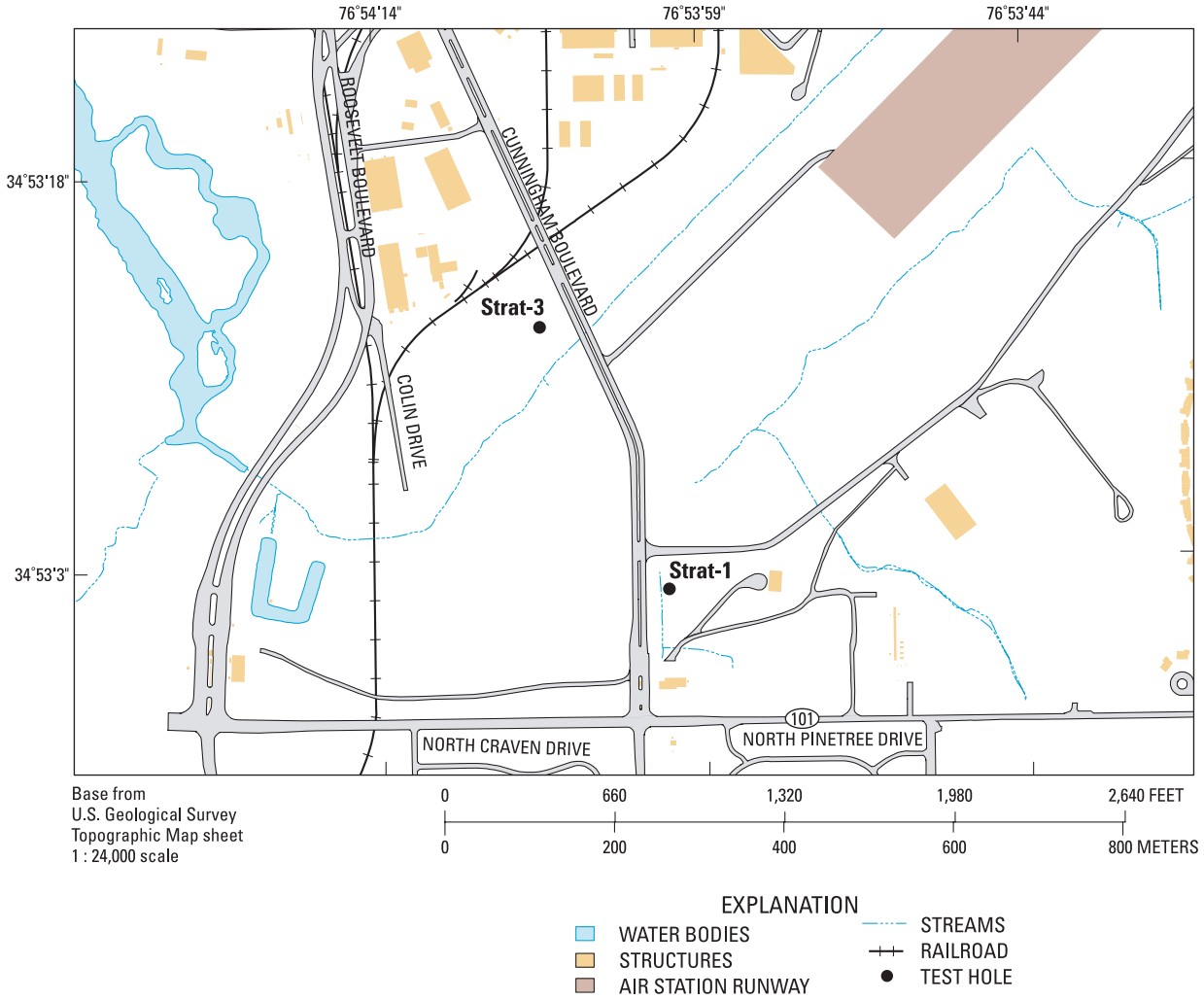


Figure 12. Location of Strat-3 well at U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 7. Core interval and recovery from Strat-3 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Cored interval, in feet	Recovery, in feet
10 – 12	1.7
20 – 22	1.2
28 – 30	1.3
40 – 42	1.2
50 – 52	1.5
60 – 62	1.7
66 – 67	2.0
70 – 72	1.3
80 – 82	2.0
90 – 92	1.3
100 – 102	1.7
110 – 111	1.1
120 – 122	1.2
130 – 131	1.1
140 – 142	2.0
150 – 151	0.5
173 – 175	1.1
Total = 30	23.9

Table 8. Lithologic log for Strat-3 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

[ft, feet; mm, millimeter]

Depth below land surface (in feet)	Description (compiled by B.M. Wrege)
0.0 – 2.0	Tan, sandy SOIL.
2.0 – 3.0	No sample.
3.0 – 10.0	Gray CLAY, alternating with thin sand layers.
10.0 – 13.0	Fine, well-sorted gray SAND.
13.0 – 20.0	No sample.
20.0 – 22.0	Dark gray CLAY and medium to coarse gray SAND layers.
22.0 – 30.0	No sample.
30.0 – 32.0	Dark gray CLAY and alternating yellow well-sorted SAND layers.
32.0 – 40.0	No sample.
40.0 – 42.0	Medium yellow SAND.
42.0 – 50.0	No sample.
50.0 – 52.0	Yellow-orange SAND, fine to medium, well-sorted with ochre stain, hard.
52.0 – 60.0	No sample.
60.0 – 62.0	Greenish-gray SAND to fine gray sand.
62.0 – 70.0	Fine to coarse SAND, phosphate pellets.

Table 8. Lithologic log for Strat-3 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.—Continued

[ft, feet; mm, millimeter]

Depth below land surface (in feet)	Description (compiled by B.M. Wrege)
70.0 – 71.0	Very fine, well-sorted gray SAND, very hard.
71.0 – 80.0	No sample.
80.0 – 82.0	Fine, well-sorted greenish-gray SAND.
82.0 –90.0	SAND with shell fragments.
90.0 – 91.7	Fine gray SAND to light-gray calcareous sand.
91.7 – 100.0	Gray CLAY and shell fragments from 93 to 96 ft, abundant shell fragments.
100.0 – 102.0	Light-gray medium SAND, calcareous with shell fragments.
102.0 – 110.0	Medium-to-coarse sand-sized SHELL fragments.
110.0 – 110.5	Medium-to-coarse SAND with calcareous cement, some phosphate, light gray.
110.5 – 113.7	Coarse SAND, phosphate grains and shell fragments, drills alternately hard and soft.
113.7 – 114.5	No sample, drills hard.
114.5 – 119.0	Coarse SAND, 2–3 mm, well-rounded, some phosphate grains, less shell than above.
119.0 – 120.0	No sample, drills harder.
120.0 – 121.6	Cemented SAND, hard, with shell fragments, grades to clean gray well-sorted fine sand.
121.6 – 130.0	No sample.
130.0 – 130.5	Fine, well-sorted gray SAND, no fossils.
130.5 – 140.0	Shell fragments, clay balls, phosphate grains, quartz grains, and organic fragments.
140.0 – 140.4	Fine gray well-sorted SAND with small, 3- to 6-mm pebbles, hard.
140.4 – 150.0	SHELL fragments.
150.0 – 150.3	Very fine, clean gray SAND with heavy minerals.
150.3 – 160.0	SAND, some shell fragments.
160.0 – 173.4	SHELL fragments.
173.4 – 174.7	Large SHELL fragments in greenish, silty, fine gray SAND matrix; switched to roller cone.
174.7 – 177.0	No sample.
177.0 – 180.0	Broken SHELL, balls of gray slick clay, phosphate grains.
180.0 – 183.0	No sample.
183.0 – 184.6	Fragments of phosphate and shell, quartz pebbles, 2–5 mm, a few dark-gray clay balls.
184.6 – 188.0	SHELL fragments, a few fragments of voidic limestone.
188.0 – 191.0	No sample.
191.0 – 192.0	LIMESTONE, sample from wash, almost entirely fragments of voidic limestone, a few shell fragments and a few quartz and phosphate pebbles 3–6 mm, well rounded.
192.0 – 198.0	No sample.
198.0 – 199.0	LIMESTONE, a few shell fragments.
199.0 – 202.0	No sample.
202.0 –204.0	LIMESTONE, light tan and light-gray voidic limestone.

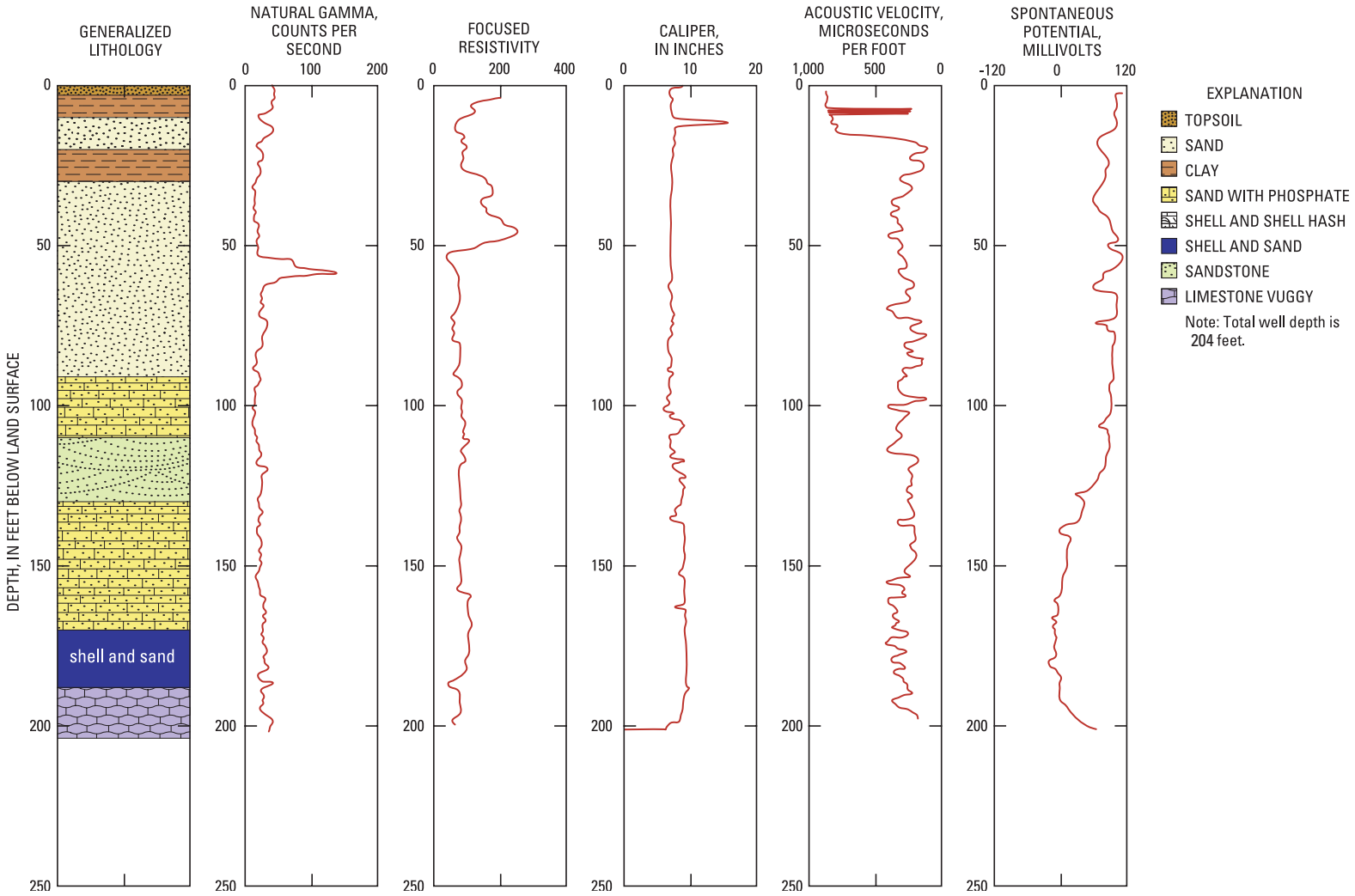
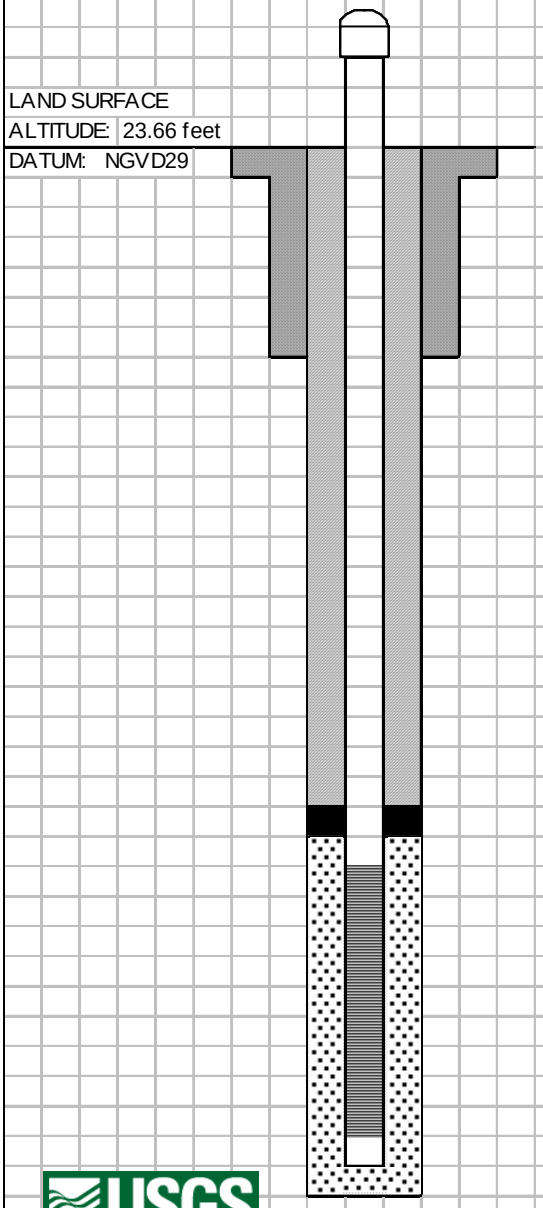


Figure 13. Selected borehole geophysical logs collected in Strat-3 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

MONITORING WELL CONSTRUCTION REPORT

U.S. Geological Survey
Water Resources Division
3916 Sunset Ridge Road
Raleigh, North Carolina 27607
(919) 571-4000

SITE:	CR-623 STRAT HOLE 3 AT CHERRY POINT MCAS				
WELL NUMBER:	345312076540701	LATITUDE:	34° 53' 12"	DATUM:	
DATE STARTED:	11-17-1994	LONGITUDE:	76° 54' 07"	NAD83	
DATE COMPLETED:	11-25-1994	AQUIFER:	CASTLE HAYNE		
USGS REPRESENTATIVE:	Beth Wrege	PROJECT NUMBER:	13800		



LAND SURFACE
ALTITUDE: 23.66 feet
DATUM: NGVD29

ALTITUDE OF MEASURING POINT	25.62 feet
HEIGHT OF MEASURING POINT ABOVE LAND SURFACE	1.96 feet
BOREHOLE DIAMETER	8 inches
CASING DIAMETER / TYPE	4 inches / PVC
SURFACE CASING DEPTH	Surface casing removed
TYPE OF GROUT	Cement
DEPTH OF GROUT	153 feet (pressure grouted)
TOP OF FILTER PACK DEPTH	153 feet
TYPE OF FILTER PACK	DSSI* Sand
SCREEN SLOT NUMBER	0.12
SCREEN DIAMETER	4-inch ID / PVC
SCREEN INTERVAL TOP	188.3 feet
SCREEN INTERVAL BOTTOM	198.3 feet
WELL DEPTH	204 feet
HOLE DEPTH	204 feet

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Figure 14. Strat-3 monitoring-well construction report, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 9. Periodic water levels in Strat-3 monitoring well, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Date	Water level, in feet below land surface
02-09-2001	14.09
05-03-2001	16.11
08-09-2001	16.14
03-29-2002	16.00
05-15-2002	16.38
08-16-2002	17.11

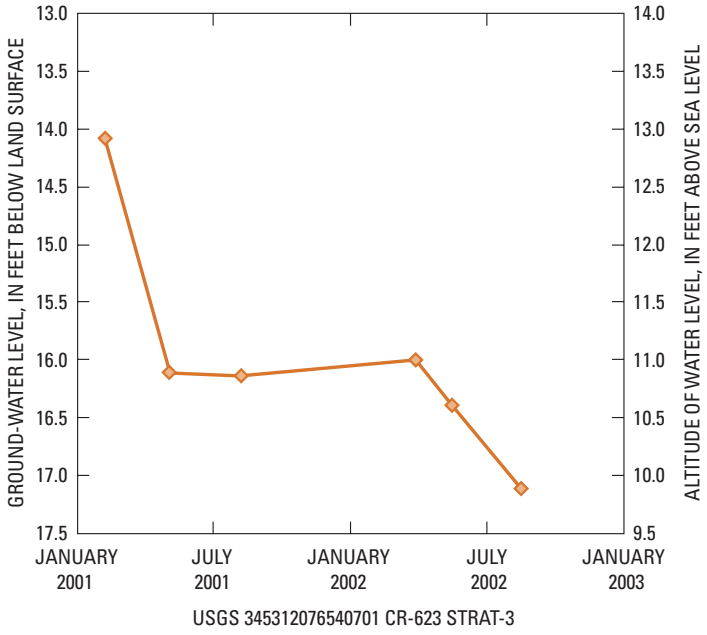


Figure 15. Hydrograph of ground-water levels in Strat-3 monitoring well, U.S. Marine Corps Air Station, Cherry Point, North Carolina, February 2001–August 2002.

Strat-4

The Strat-4 well is on the northwest side of the intersection of Access Road and Range Road (fig. 3). A detailed location map is provided in figure 16.

The Strat-4 test hole was drilled by the USACE drilling crew. Drilling began on March 27, 1995, and reached a total depth of 225 ft on March 29, 1995. A reverse rotary drilling method was used. Of the total 225 ft drilled, 11.4 ft were cored, with a targeted 2-ft interval (out of 10 ft) and a 93-percent core recovery. The cored intervals and amounts are listed in table 10. Lithologic determinations were made from the cuttings and core samples and are described in table 11. A more detailed core description is given in Daniel and others (1996).

The test hole was logged on March 30, 1995. Logs collected at Strat-4 included the lithologic log, a hydrologic log, natural gamma radiation, single-point resistance, spontaneous potential, and caliper. VSP included a hydrophone log and a holelock geophysical log. The abbreviated lithology and the borehole geophysical logs are shown in figure 17. A monitoring well was installed in the borehole, and a diagram of the well construction, including placement of the well screen, is shown in the monitoring-well construction report (fig. 18).

Strat-4 was assigned NC county number CR-619 and USGS station number 345539076524201. Periodic water-level measurements were made in the monitoring well between September 2000 and May 2002. Water-level data ranged from 21.56 to 23.12 ft below land surface (table 12; fig. 19).

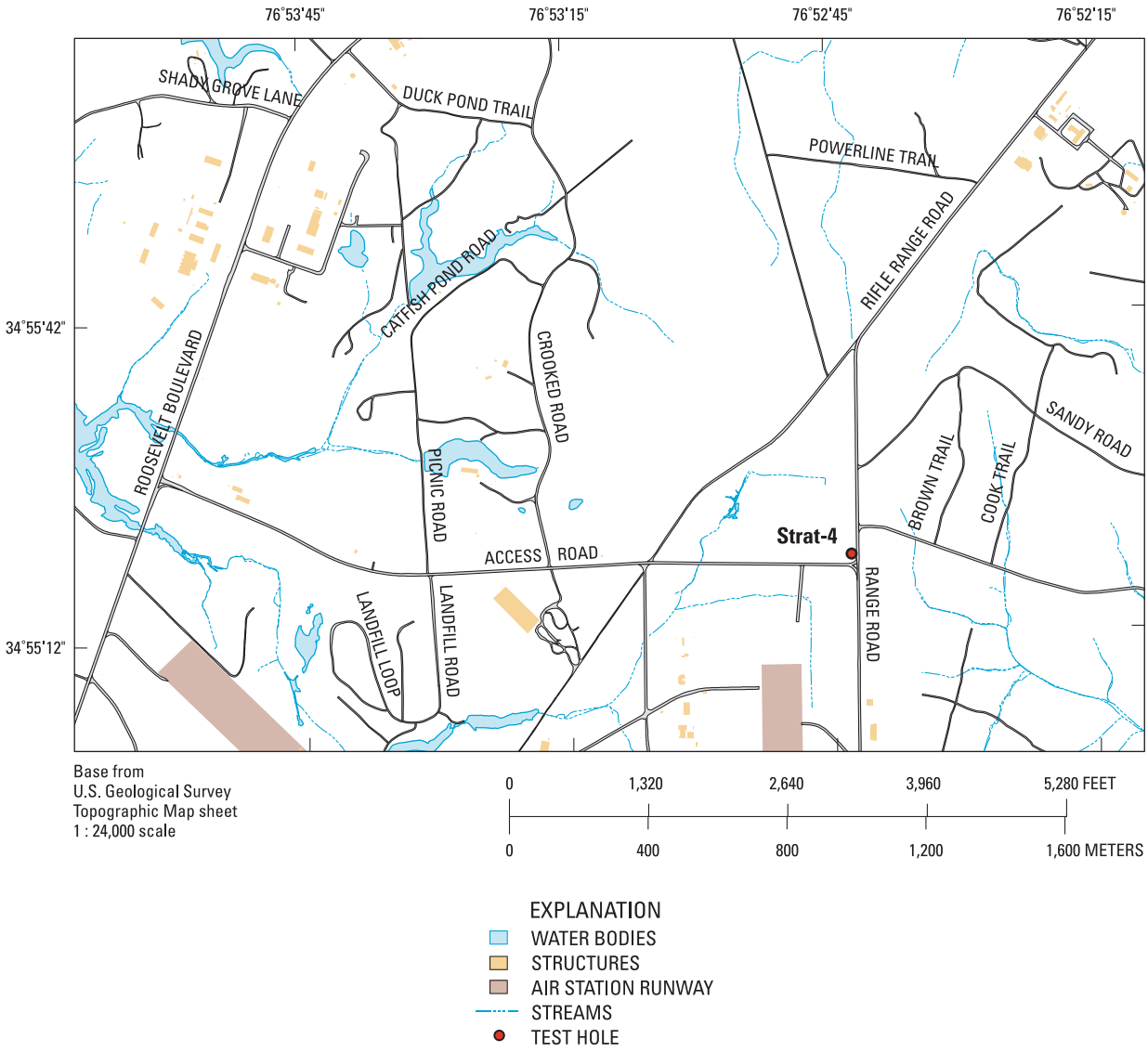


Figure 16. Location of Strat-4 well at U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 10. Core interval and recovery from Strat-4 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Cored interval, in feet	Recovery, in feet
35 – 37	2.0
55 – 57	1.9
150 – 152	2.0
180 – 182	1.4
120 – 122	2.0
Total = 10	9.3

Table 11. Lithologic log for Strat-4 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Depth below land surface (in feet)	Description (compiled by B.M. Wrege)
0.0 – 5.0	Sandy, clayey organic top SOIL, grading to sandy clay, trace gravel.
5.0 – 10.0	Clayey SAND, with silt, brownish gray.
10.0 – 15.0	Sand to gravel, clayey, grayish brown.
15.0 – 20.0	Sand, gravel, clay, silty.
20.0 – 25.0	Shells with clay, grayish brown.
25.0 – 30.0	Gray CLAY, some shells.
30.0 – 35.0	Gray CLAY with a few shells.
35.0 – 37.0	CLAY with shells.
37.0 – 40.0	CLAY, with shell hash, olive green, trace ochre.
40.0 – 48.0	Olive-green CLAY, dry, green clay with white and gray shell hash.
48.0 – 54.0	SAND with whitish clay stringers and some green clay with shells.
54.0 – 55.0	Olive green SAND.
55.0 – 57.0	SAND.
57.0 – 72.5	Silty, sandy CLAY.
72.5 – 79.0	Fine-grained SAND, heavy minerals, phosphate nodules.
79.0 – 82.0	Dry, dark olive-green CLAY.
82.0 – 91.0	Clayey SAND with shell hash.
91.0 – 97.0	Gray LIMESTONE with thin sand layers.
97.0 – 100.0	Gray LIMESTONE with shells, trace clay.
100.0 – 102.0	Gray SAND, trace heavy minerals.
102.0 – 119.0	Gray CLAY, tight, stiff.
119.0 – 120.5	Sandy CLAY, trace shells.
120.5 – 122.5	CLAY.
122.5 – 128.5	Very fine greenish-gray SAND, hard.
128.5 – 129.0	Dark-gray and whitish-gray SHELL layer.
129.0 – 131.0	Cherty SHELL hash, poor recovery, hard.
131.0 – 133.0	Silty SAND.
133.0 – 134.0	CLAY.
134.0 – 140.0	No sample, drills hard.
140.0 – 150.0	Green-gray CLAY.
150.0 – 151.0	Sandy CLAY, olive green.
151.0 – 152.0	Very fine SAND.
152.0 – 154.0	SHELL hash.
154.0 – 160.0	SHELL hash, sandy.
160.0 – 170.0	Dark-gray SHELL hash, sandy, some clay.
170.0 – 180.0	Dark-gray SHELL hash, sandy, some clay.
180.0 – 181.4	White LIMESTONE.
181.4 – 225.0	LIMESTONE.

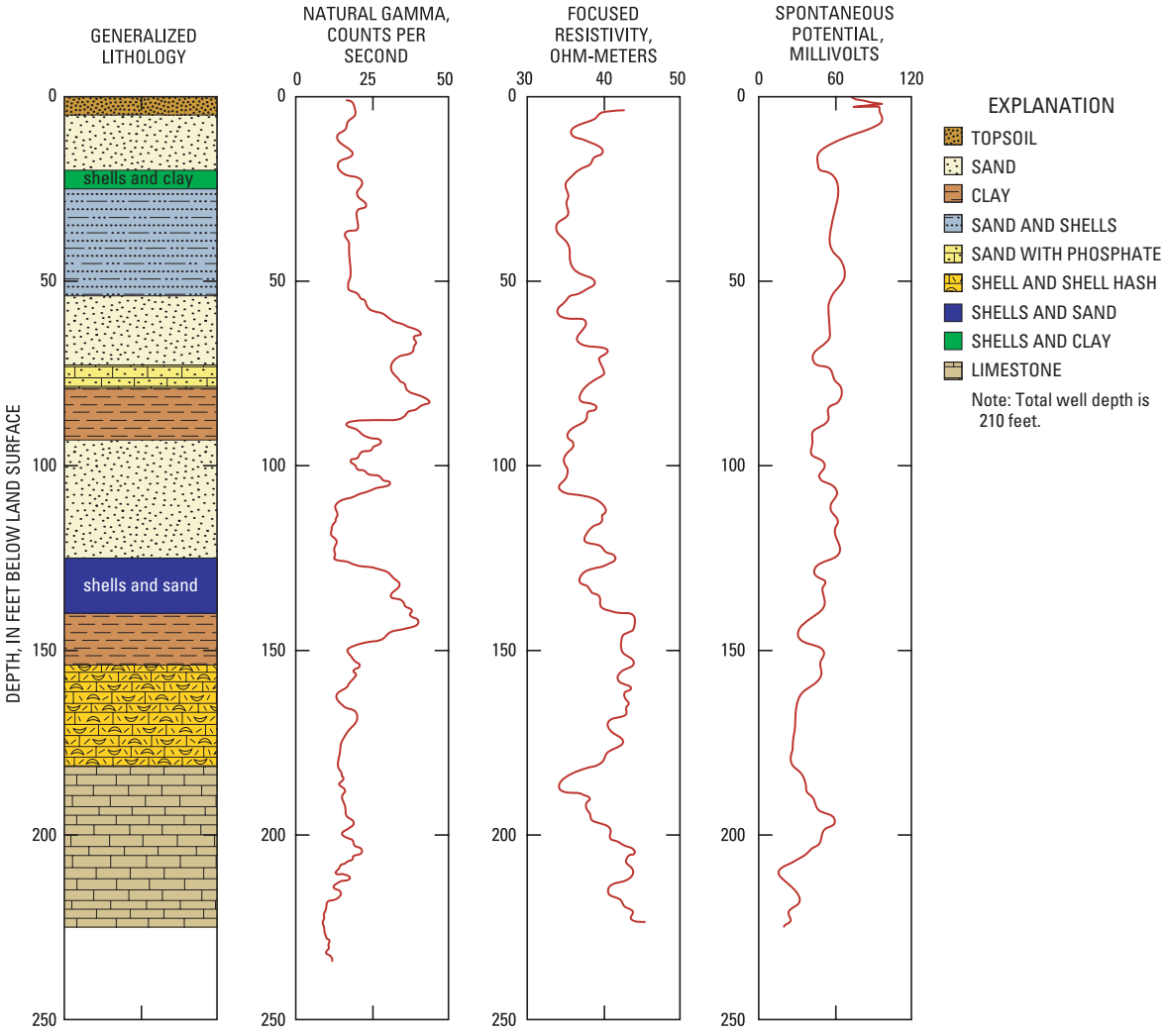


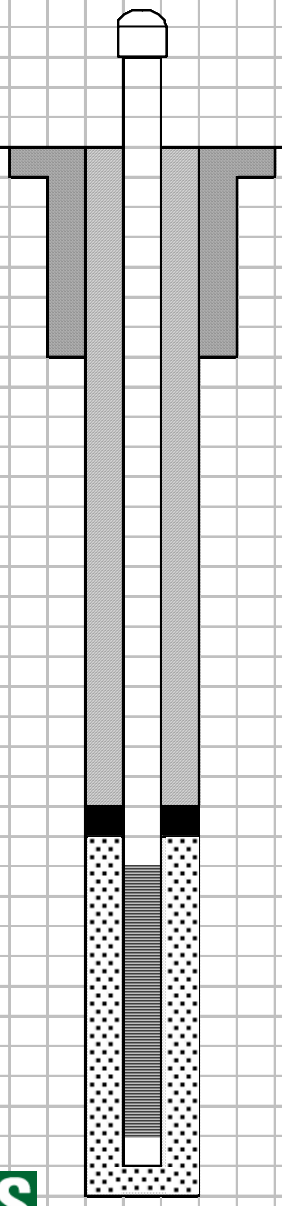
Figure 17. Selected borehole geophysical logs collected in Strat-4 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

MONITORING WELL CONSTRUCTION REPORT

U.S. Geological Survey
Water Resources Division
3916 Sunset Ridge Road
Raleigh, North Carolina 27607
(919) 571-4000

SITE:	CR-619 STRAT HOLE 4 AT CHERRY POINT MCAS				
WELL NUMBER:	345539076524201	LATITUDE:	34° 55' 39"	DATUM:	
DATE STARTED:	3-27-1995	LONGITUDE:	76° 52' 42"	NAD83	
DATE COMPLETED:	3-29-1995	AQUIFER:	CASTLE HAYNE		
USGS REPRESENTATIVE:	Beth Wrege	PROJECT NUMBER:	13800		

LAND SURFACE
ALTITUDE: 25.43 feet
DATUM: NGVD29



ALTITUDE OF MEASURING POINT	28.04 feet
HEIGHT OF MEASURING POINT ABOVE LAND SURFACE	2.61 feet
BOREHOLE DIAMETER	4.5 inches
CASING DIAMETER / TYPE	4 inches / PVC
SURFACE CASING DEPTH	20 feet
TYPE OF GROUT	Cement
DEPTH OF GROUT	50 feet
TOP OF FILTER PACK DEPTH	50 feet
TYPE OF FILTER PACK	DSSI* Sand
SCREEN SLOT NUMBER	0.10
SCREEN DIAMETER	4-inch ID / PVC
SCREEN INTERVAL TOP	180 feet
SCREEN INTERVAL BOTTOM	205 feet
WELL DEPTH	210 feet
HOLE DEPTH	225 feet

USGS science for a changing world

Figure 18. Strat-4 monitoring-well construction report, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 12. Periodic water levels in Strat-4 monitoring well, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Date	Water level, in feet below land surface
09-21-2000	21.56
02-09-2001	22.61
05-03-2001	21.58
08-09-2001	23.12
03-29-2002	21.57
05-15-2002	23.02

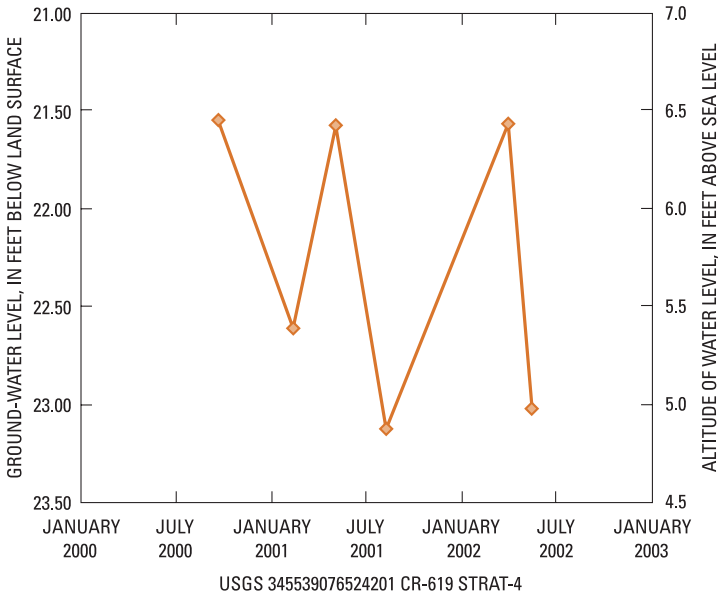


Figure 19. Hydrograph of ground-water levels in Strat-4 monitoring well, U.S. Marine Corps Air Station, Cherry Point, North Carolina, September 2000–May 2002.

Strat-5

The Strat-5 well is located in a grove of pine trees on the north side of the intersection of State Highway 70 and Slocum Road (fig. 3). Although the monitoring well is outside the gated area of the MCAS, it is on MCAS property. A detailed location map is provided in figure 20.

The Strat-5 test hole was drilled by the USGS core-recovery team. Drilling began on March 9, 2000, and reached a total depth of 235 ft on March 15, 2000. Continuous core was collected with a mud-rotary wire-line core rig (fig. 21). The entire section was cored, and all recovered samples were boxed. This method of sample recovery increased the accuracy of the depth and thickness determinations.

Lithologic determinations were made from drill cuttings, driller's penetration reports, and core samples, and are described in table 13. After the borehole was drilled, borehole geophysical surveys were collected. The abbreviated lithology and digitized borehole geophysical logs are shown in figure 22.

A monitoring well was constructed to target a specific hydrogeologic unit based on the aquifer determinations made on location. As a result, the well was installed in the borehole and was completed in the Castle Hayne aquifer of Oligocene and Eocene age. A diagram of the well construction, including the placement of the well screen, is shown in the monitoring-well construction report (fig. 23). The Strat-5 well was assigned NC county number CR-616 and USGS station number 345504076562801. Periodic standard tape-down water-level measurements were made in the monitoring well between September 2000 and May 2002. Water-level data during this period ranged from 15.36 to 18.16 ft below land surface (table 14; fig. 24). Land-surface datum at Strat-5 is 26 ft (referenced to National Geodetic Vertical Datum of 1929), and the water-level measuring point was the top of the 2-inch pipe, which is parallel to the top of the instrument shelter floor 2.79 ft above land surface.

A hydrologic DCP was installed at Strat-5 to demonstrate the collection of continuous near real-time water-level data. The

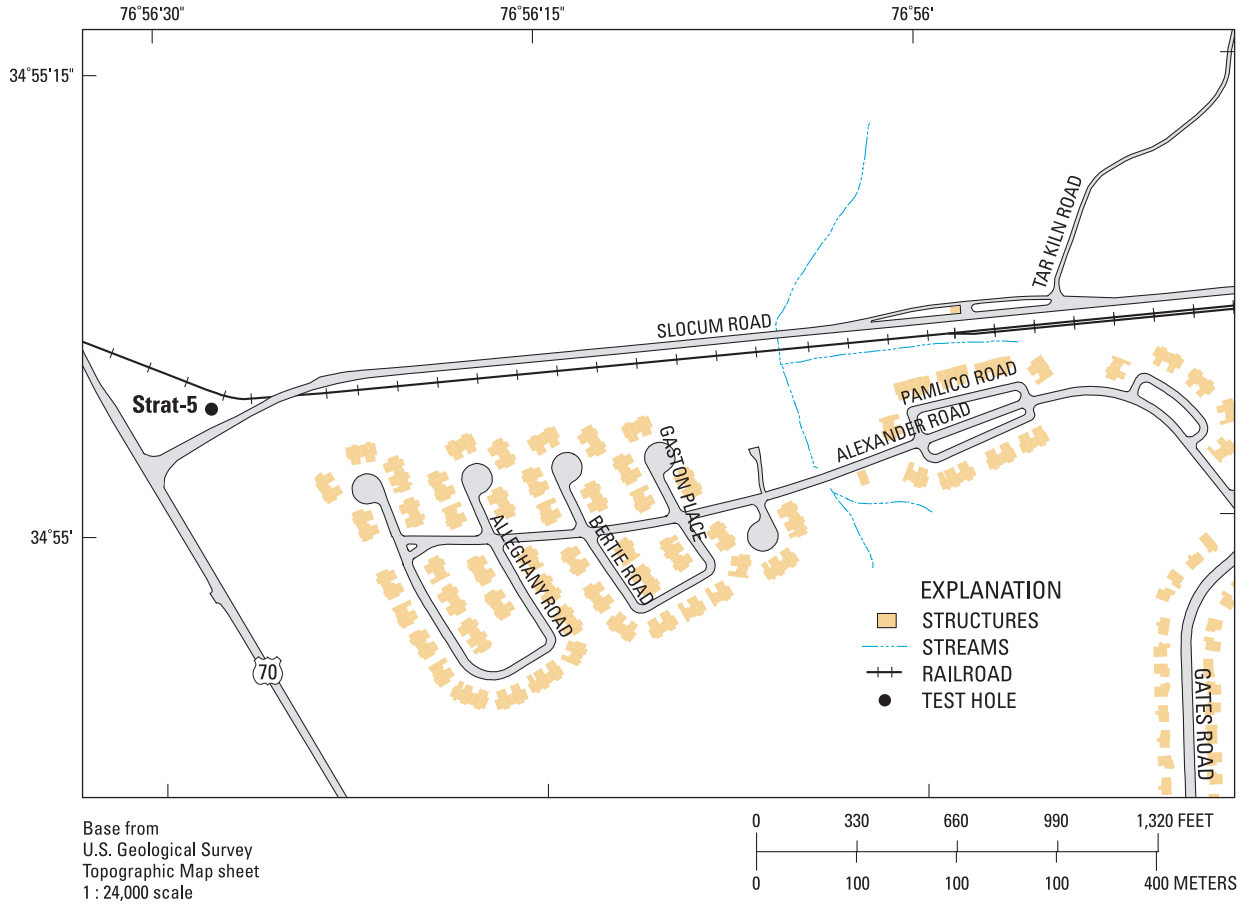


Figure 20. Location of Strat-5 well at U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Figure 21. Mud-rotary wire-line core rig used to drill the Strat-5 borehole.

Table 13. Lithologic log for Strat-5 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

[ft, feet; mm, millimeter]

Depth below land surface (in feet)	Description (compiled by C.C. Daniel, III)
0.0 – 1.2	Fill.
1.2 – 6.7	Silty CLAY, gray to orange.
6.7 – 7.5	Sandy silt.
7.5 – 20.7	Yellow-orange SAND.
20.7 – 26.8	Silty, clayey silt, CLAY all with storm sand layers – coarsens upward.
26.8 – 47.7	Shell hash, shell fragments with some whole shells, bivalves and gastropods. Matrix fines upward from clean, medium and fine sand to greenish silty, very fine sand. At 46.9 ft, phosphate nodules 3–4 mm in shell hash.
47.7 – 59.5	Greenish-gray silty SAND, fine to very fine, well-sorted large phosphate and quartz pebbles, coral and arenite fragments.
59.5 – 72.0	Medium to fine SAND with a few phosphate and quartz pebble layers, clean sand medium, uncemented.
72.0 – 75.6	Moldic calcarenite with quartz pebbles, a few shells and phosphate nodules.
75.6 – 84.0	Greenish-gray silt, very fine SAND, well sorted. Trace shell fragments.
84.0 – 107.1	Calcareous, fine SAND. Clay balls at 95.3 ft. Sand. Some phosphate grains.
107.1 – 128.2	Greenish silt, very fine SAND matrix. Silty clay. Abundant, large thick-shelled oysters.
128.2 – 137.8	Greenish silt, very fine SAND, scattered large oysters, some clay.
137.8 – 140.0	Oysters and phosphate limestone fragments and shell hash at bottom.
140.0 – 143.0	Silty zone.
143.0 – 147.0	LIMESTONE fragments, often moldic, shell fragments.
147.0 – 155.6	LIMESTONE and shell fragments, predominantly angular in silt.
155.6 – 165.5	Moldic (voidic) LIMESTONE, clams, other bivalves dissolutioned.
165.5 – 175.0	Calcareous fragments, angular, fine SAND matrix, phosphate calcarenite fragments, lumps.
175.0 – 185.0	Moldic LIMESTONE, some weathered shell material (lime) remaining in molds.
185.0 – 186.5	Competent moldic.
186.5 – 188.8	Weakly competent, fragmented.
188.8 – 194.5	Moldic LIMESTONE, moderately competent.
194.5 – 216.5	Weakly competent LIMESTONE composed of plates, flat fragments (pelagic?) with some calcite cement, especially pores and voids, some quartz and sand.
216.5 – 219.3	Transitional, becomes very sandy, fewer plates.
219.3 – 235.0	Weakly cemented fine SAND, well sorted, phosphate grains small, same size as the sand grains.

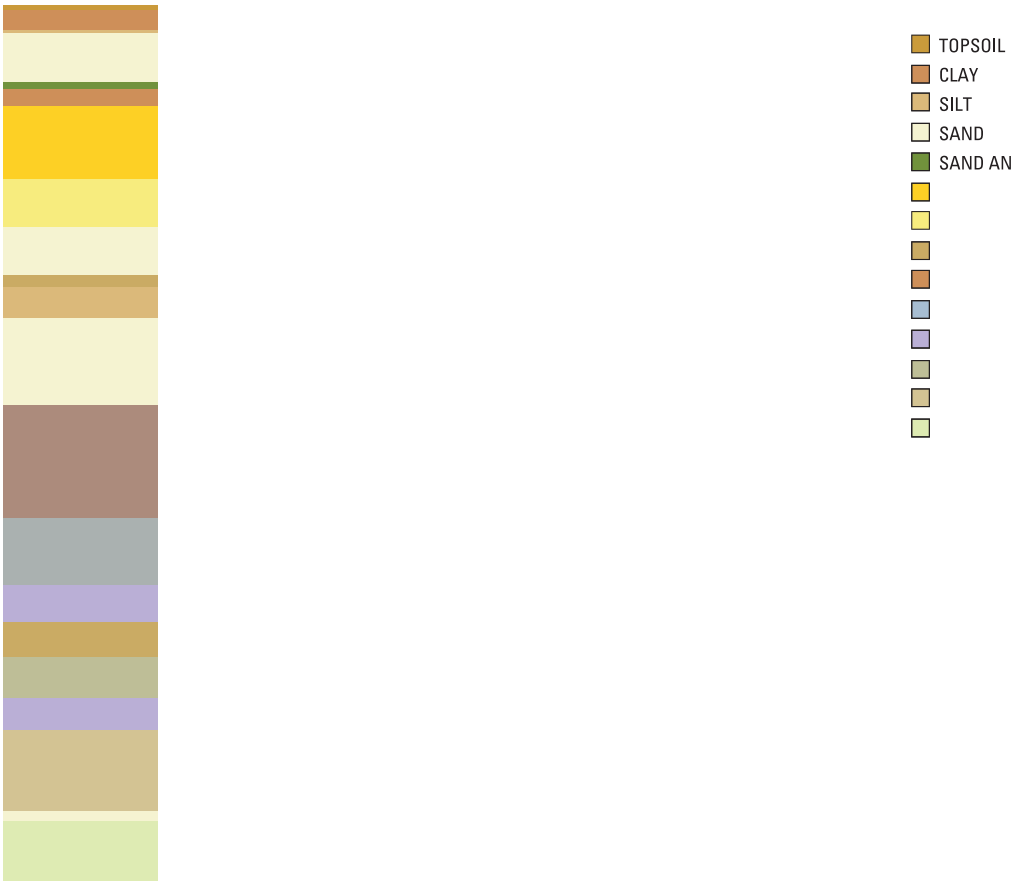


Figure 22. Selected borehole geophysical logs collected in Strat-5 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

instrumentation included satellite telemetry and a solar energy battery supply panel. Continuous recording began in December 2000 (table 15, 16), and water levels were collected at 60-minute intervals. Continuous water-level data are stored in the USGS National Water Information System (NWIS) database and can be accessed from the USGS Web site http://waterdata.usgs.gov/nc/nwis/ .

For the 2002 water year (October 1, 2001, through September 30, 2002), the highest water level was 16.48 ft below land surface, and the lowest water level was 18.63 ft below land surface (table 16; fig. 25). Water levels for the entire period of record are shown in figure 26. Rapid tree growth in the vicinity of Strat-5 interfered with solar energy power for the DCP and resulted in the loss of data.

Table 15. Continuous ground-water levels recorded for water year 2001 in the Strat-5 monitoring well, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

[Water year is the period from October 1 through September 30 and is defined by the year in which the period ends; thus, the 2001 water year is the period October 1, 2000, through September 30, 2001. Continuous data recording at this site began in December 2000. Data are in feet below land surface. —, missing data]

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1				16.24	16.48	16.02	—	16.91	16.98	17.01	17.32	—
2				16.35	16.48	15.94	15.95	16.84	16.96	17.23	17.33	—
3				16.39	16.54	15.93	15.97	16.89	16.94	17.29	17.32	—
4				16.24	16.48	15.83	16.15	16.92	16.94	17.18	17.29	—
5				16.16	16.39	15.78	16.24	16.93	16.95	17.14	17.41	—
6				16.22	16.42	15.79	16.22	16.94	16.95	17.13	17.54	—
7				16.25	16.33	15.97	16.06	16.96	17.09	17.11	17.55	—
8				16.27	16.30	16.14	16.04	17.03	17.11	17.09	—	—
9			16.08	16.47	16.21	16.10	16.11	17.07	17.19	17.17	—	—
10			16.03	16.57	16.22	15.96	16.16	17.06	17.26	17.21	—	—
11			16.02	16.57	16.45	15.93	16.12	17.20	17.26	17.24	—	—
12			16.05	16.39	16.38	15.87	16.12	17.26	17.36	17.23	—	—
13			16.12	16.39	16.25	15.76	16.12	17.29	17.45	17.35	—	—
14			16.16	16.39	16.18	15.97	16.16	17.30	17.47	17.33	—	—
15			16.29	16.33	16.13	16.06	16.15	17.29	17.47	17.37	—	—
16			16.24	16.44	16.18	16.05	16.13	17.24	17.21	17.50	—	—
17			15.97	16.49	16.32	16.02	16.16	17.24	17.10	17.46	—	—
18			15.98	16.47	16.44	16.14	16.24	17.08	17.03	17.43	—	—
19			15.99	16.33	16.44	16.34	16.51	16.97	16.96	17.43	—	—
20			16.18	16.18	16.38	16.29	16.65	16.97	16.91	17.47	—	—
21			16.17	16.31	16.16	16.02	16.72	16.99	16.89	17.55	—	—
22			16.12	16.33	16.05	16.03	16.75	16.99	16.84	17.57	—	—
23			16.18	16.22	16.08	16.08	16.76	16.98	16.83	17.51	—	—
24			15.94	16.20	16.13	16.05	16.76	16.97	16.81	17.45	—	—
25			15.97	16.24	16.05	16.04	16.72	17.03	16.84	17.45	—	17.47
26			15.99	16.30	16.19	16.20	16.59	16.99	16.93	17.45	—	17.41
27			15.94	16.29	16.28	16.32	16.60	16.98	16.97	17.47	—	17.32
28			15.90	16.34	16.21	16.35	16.72	16.96	16.91	17.60	—	17.30
29			16.06	16.30	—	16.09	16.99	16.95	16.89	17.55	—	17.46
30			16.15	16.17	—	15.95	17.01	16.96	16.89	17.31	—	17.47
31			16.30	16.30	—	15.94	—	16.99	—	17.30	—	—

Table 16. Continuous ground-water levels recorded for water year 2002 in the Strat-5 monitoring well, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

[Water year is the period from October 1 through September 30 and is defined by the year in which the period ends; thus, the 2002 water year is the period October 1, 2001, through September 30, 2002. Data are in feet below land surface. —, missing data]

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	17.46	17.98	18.36	18.63	18.15	17.73	16.54	—	17.68	—	—	—
2	17.34	18.14	18.28	18.62	18.24	17.59	16.53	—	17.68	18.11	—	—
3	17.31	18.17	18.26	18.31	—	—	16.48	—	17.77	18.15	—	—
4	17.32	18.19	18.44	18.41	—	—	16.68	—	17.92	18.25	—	—
5	17.44	18.03	18.50	18.41	—	—	16.72	—	17.96	18.23	—	—
6	17.52	18.02	18.48	18.36	—	17.39	16.78	—	17.96	18.22	—	—
7	17.47	18.04	18.45	18.46	—	—	16.76	—	17.96	18.22	—	—
8	17.47	18.17	18.36	18.52	—	—	16.68	—	17.96	18.22	—	—
9	17.48	18.30	18.36	18.37	—	—	16.66	—	17.96	18.25	—	—
10	17.55	18.31	18.37	18.32	—	—	16.67	17.42	18.09	18.34	18.40	—
11	17.55	18.30	18.41	18.37	—	17.34	16.83	17.53	18.14	18.38	18.43	—
12	17.44	18.22	18.53	18.48	—	17.18	16.87	17.52	18.15	—	18.45	—
13	17.60	18.18	18.50	18.52	—	—	16.87	17.27	—	—	18.45	—
14	17.64	18.15	18.47	18.55	—	—	16.64	17.22	—	—	—	—
15	17.56	18.28	18.43	18.33	—	—	16.59	17.33	—	—	—	—
16	17.47	18.32	18.44	18.36	—	—	16.59	17.41	—	—	—	—
17	17.53	18.40	18.34	18.31	—	—	16.61	17.50	—	—	—	—
18	17.57	18.35	18.42	18.52	—	—	16.80	17.52	—	—	18.52	—
19	17.69	18.29	18.50	18.49	17.74	—	16.86	17.53	—	—	18.53	—
20	17.79	18.26	18.58	18.58	17.63	—	16.77	17.49	—	—	—	—
21	17.86	18.44	18.52	18.42	17.55	16.59	16.71	17.49	—	—	—	—
22	17.77	18.50	18.51	18.39	17.61	16.82	16.73	17.62	—	—	—	—
23	17.60	18.52	18.42	18.25	—	16.88	16.96	17.70	—	—	—	—
24	17.60	18.31	18.50	18.12	—	16.87	17.12	17.70	—	—	18.63	—
25	17.64	18.23	18.58	18.14	17.73	16.75	17.07	17.69	—	—	18.62	—
26	17.86	18.18	18.53	18.27	—	16.69	17.04	17.67	—	—	—	—
27	18.00	18.24	18.58	18.32	—	16.63	16.90	17.67	—	—	—	—
28	18.12	18.39	18.41	18.26	17.73	16.65	16.77	17.67	—	—	—	—
29	18.03	18.43	18.39	18.13	—	16.78	—	17.72	—	—	—	—
30	17.95	18.43	18.45	18.04	—	16.80	—	17.71	—	—	—	—
31	17.95	—	18.59	18.15	—	16.75	—	17.68	—	—	—	—

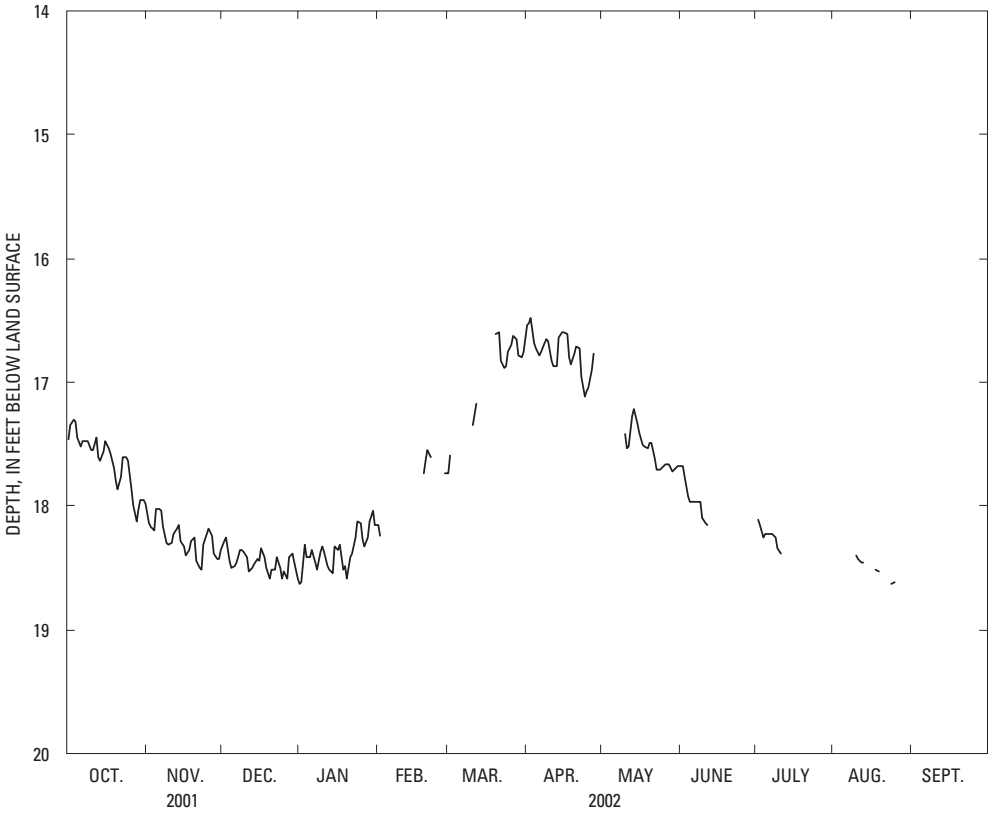


Figure 25. Hydrograph of continuous daily mean ground-water levels at Strat-5 for water year 2002.

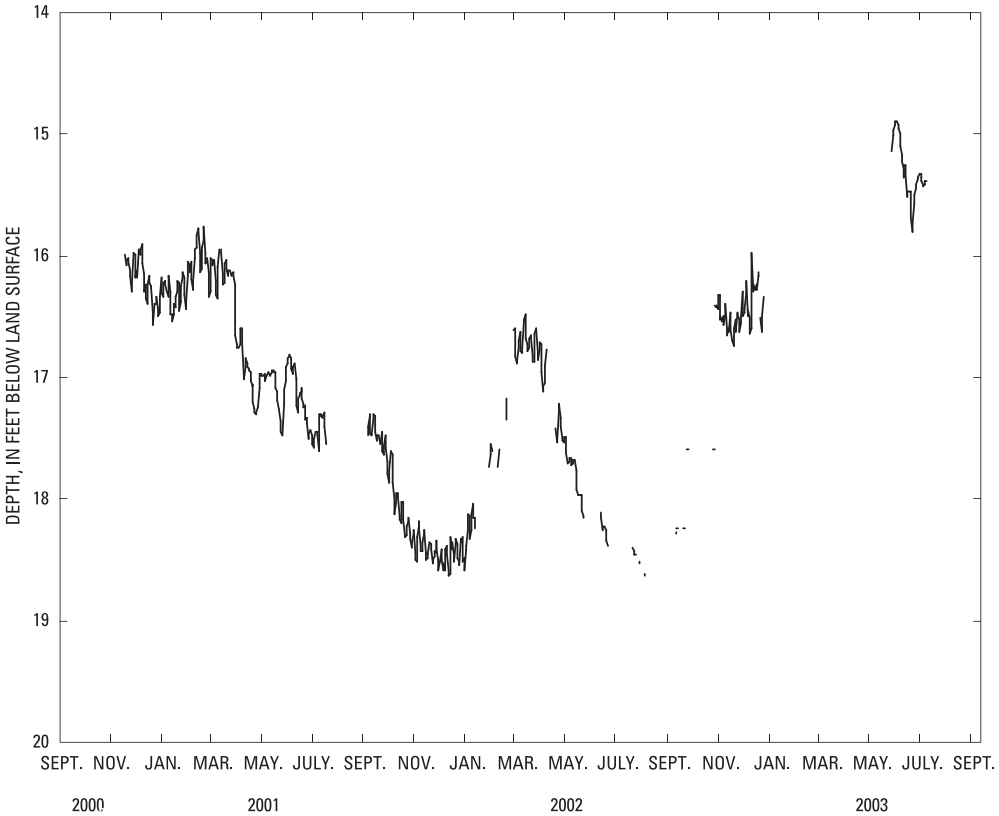


Figure 26. Hydrograph of continuous daily mean ground-water levels at Strat-5 for the period of record.

Strat-6

The Strat-6 well is near the marina on Hancock Creek (fig. 3) about 20 ft west of a stand of pine trees. A detailed location map is provided in figure 27.

The Strat-6 test hole was drilled by the USGS core-recovery team. Drilling began on August 11, 2000, and reached a total depth of 305 ft on August 19, 2000. Continuous core was collected by using a wire-line rotary core rig. Lithologic determinations were made from cuttings and core samples, and are described in table 17.

Geophysical surveys were collected after the test hole reached its total depth of 305 ft. The abbreviated lithology and borehole geophysical logs are shown in figure 28. The Strat-6 test hole was the deepest test hole drilled during this study. Two sets of geophysical data are presented—one with a 250-ft scale (fig. 28A) and the other with a 300-ft scale (fig. 28B). The 250-ft scale allows an overlay comparison of the geophysical data with the other stratigraphic well logs in this series; the 300-ft scale provides complete data.

Core samples and geophysical logs were used to make aquifer determinations and to design the well. The Strat-6 test hole penetrated an unconformity. A diagram of the well construction, including the placement of the well screen, is shown in the monitoring-well construction report (fig. 29). A monitoring well was installed in the corehole and completed on August 20, 2000, with a flush-mounted well cap.

The Strat-6 well was assigned NC county number CR-620 and USGS station number 345613076513701. Periodic water-level measurements were made in the monitoring well between September 2000 and August 2002. Water-level data ranged from 10.78 to 13.61 ft below land surface (table 18; fig. 30). The initial water level was 12.09 ft below land surface, and the well was pumped for 20 minutes at a rate of 6.67 gallons per minute until the water ran clear. The water level declined to 110 ft; when the pumping stopped, the water level recovered to 11.99 ft below land surface.

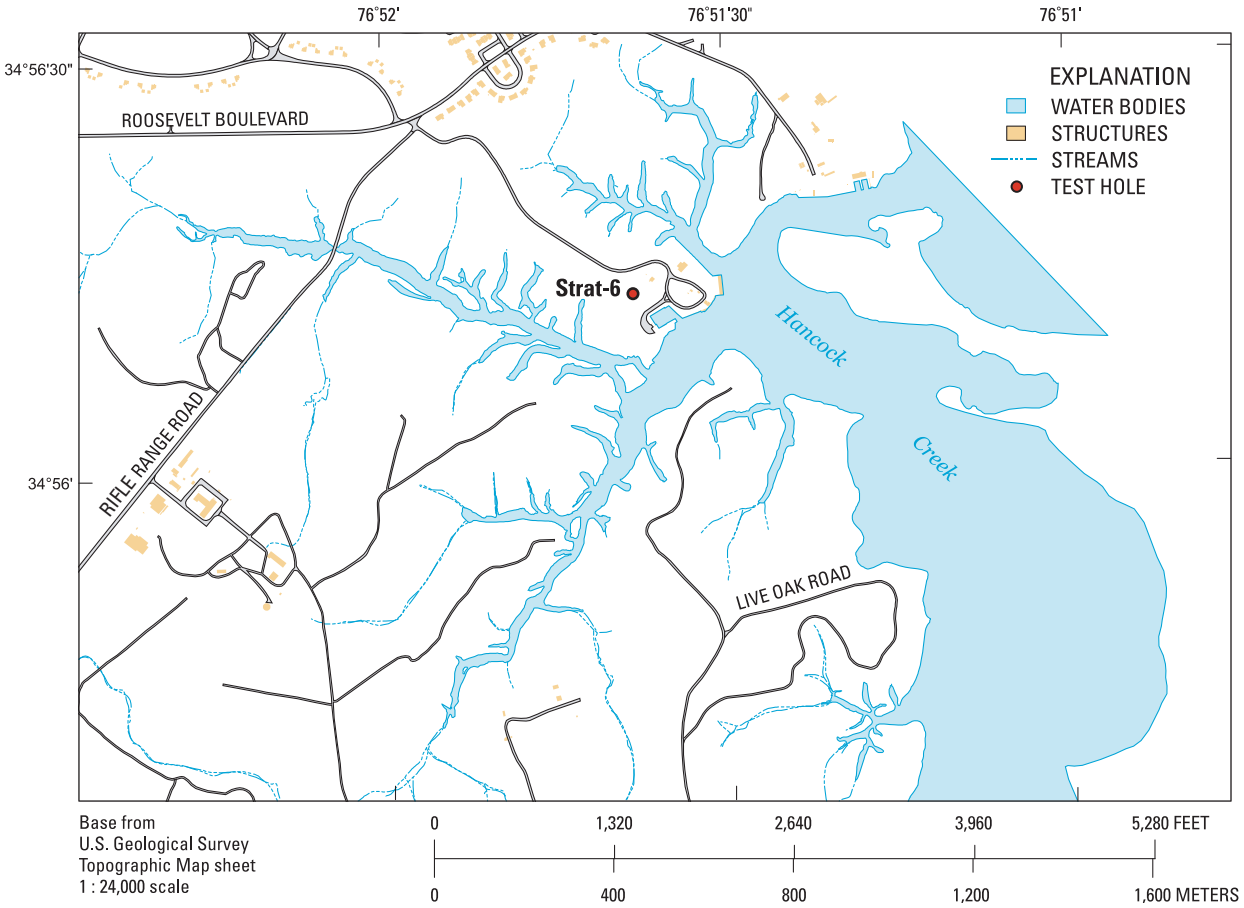


Figure 27. Location of Strat-6 well at U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 17. Lithologic log for Strat-6 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

[%, percentage; <, less than; mm, millimeter]

Depth below land surface (in feet)	Description (compiled by B.M. Wrege)
0.0 – 1.0	Topsoil A'B' horizons.
1.0 – 25.0	Interbedded layers of SAND and CLAY, layers range from 0.2 to 0.8 inch thick. Clay in coarse sand, 10YR6/6. Clay, gray, lenticular deposition in gray stringers. Silt, ochre, with coarse sand. Clay, lenticular, orange and gray. Clay, orange-brown. Silty clay. Sand.
25.0 – 25.4	CLAY, silty, sandy, gray-blue.
25.4 – 31.9	SAND, shelly, light gray. Phosphatic – grain size on phosphate is coarse. Shells angular. 30.0 – 31.9, increase in % fine sand, decrease in shells. 31.9 – 33.0, increase in shell % and size. Formation is still sand, shelly. 35.0 – 37.4, increase in phosphates. 37.4 – 37.9, both percentage and grain size = 0.3 inch, shell fragments to 0.8 inch.
31.9 – 40.0	Layers, SAND, CLAY, sand with shells. Phosphate to 0.4 inch.
40.0 – 45.0	SAND, medium, gray, fairly well graded, fine – silt, absence of phosphate, fining downward.
45.0 – 50.0	SILT with very fine sand, trace phosphate, increasing % of clay.
50.0 – 58.2	CLAY, dark olive-green.
48.2 – 60.0	Nodular phosphate, black, high luster, 0.1- to 0.4-inch subrounded, flat, smooth pebbles, trace glossy pink minerals, dup sed in a clayey, sandy, silt matrix. NOTE: Medium sand, coarse sand, fine gravel – absent.
60.0 – 68.0	SAND, fine with significant % phosphate pebbles, dark olive-green. Sandy silt matrix with phosphate nodules from 0.1 inch to a bone fragment 1.3 inches long. Sharks' teeth.
68.0 – 80.0	SAND with weathered quartz and phosphate pebbles, light yellow-gray sand, quartz glauconite subrounded, well graded, uniform, medium to medium fine. 78.0–80.0, increase in size of pebbles.
80.0 – 86.0	CLAY, light gray, uniform, very few inclusions; core had a coating of manganese ribbons on exterior at time of recovery.
86.0 – 92.0	SAND, medium to fine with zones of phosphate and layers of clay.
92.0 – 105.3	SANDSTONE with consolidated to poorly consolidated sandstone and sand with phosphate nodules. Uniform graded, medium to fine sand, flossy matrix.
105.3 – 105.7	CLAY, 5Y4/1.
105.7 – 106.1	SHELLS in sand matrix, 5Y4/1.
106.1 – 107.0	Thin 0.4- to 0.5-inch layers of SAND and CLAY.
107.0 – 110.2	CLAY, silty with fine to very fine sand.
110.2 – 119.6	SAND, silt with fine sand, clay lenses. 110.4–111.7, dry, hard, uniform sand, silty, clayey, light, very fine. 112.0, SAND, shelly. 115.0, SAND. 116.0, CLAY. 117.5, SAND.
119.6 – 122.0	SAND, fine, shelly, infilled burrows, traces of phosphate.
122.0 – 128.0	LIMESTONE, sandy, shelly, variably cemented transitioning from competent to very fine sand with shells. 125.0–133.0, sandy, becoming coarser downward to fine gravel.
128.0 – 129.3	LIMESTONE, consolidated, competent, medium gray, small <0.3 voids, compressed, very small crystals, no free shells, transmissive. 128.5, calcarenite, carbonate cementation.
129.3 – 130.0	SAND and SHELLS, shells 0.1–0.4, subangular, gray, subrounded quartz pebbles.

Table 17. Lithologic log for Strat-6 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.—Continued

[%, percentage; <, less than; mm, millimeter]

Depth below land surface (in feet)	Description (compiled by B.M. Wrege)
130.0 – 149.7	SAND (NOTE: Upper Pungo River Formation). Transmissive, medium-coarse, clean, with shell fragments grading to zone (0.6 ft) of coarse gravel, subangular with full range of mineral varieties. 138.0–142.0, sand zone of pink barnacles 0.25–1.3 inch, somewhat consolidated sand – sandstone matrix. 140.0–150 0, no shells, shell fragments, coarse or gravel-sized particles, rounded to subrounded, frosted.
149.7 – 170.5	Oysters, lagoonal deposition, large mollusks in green clay matrix, shell size limited to diameter of core barrel. Significant number of large shell slices (greater than 4 inches), holes about 0.5 to 0.7 mm in shells.
170.5 – 180.5	Weathered LIMESTONE, shelly, limey, very low to non-transmissive, casts, no shells above 175 ft, thin shells in tight clay in lower portion.
180.5 – 185.0	CLAY with sand, rounded, weathered cobbles, size limited by core barrel.
185.0 – 192.2	CLAY, shelly.
192.2 – 194.5	(Transition zone) Weathered LIMESTONE, yellow-gray calcite crystals.
194.5 – 199.2	Weathered LIMESTONE, gray sand – cobble size, poorly consolidated, pelecypod casts, no distinct shells.
199.2 – 208.3	LIMESTONE, weathered, sandy, calcareous layers of medium-grained sand. Yellow-gray.
208.3 – 223.7	LIMESTONE, moldic vuggy, light gray with yellow. Calcite crystals, clean, very high transmissivity, vuggs to 1.2 inches, clast pieces 0.4 to 0.5 inch. 222.0–223.7, becomes coarser from sand to pea gravel.
223.7 – 225.0	No recovery; driller suggests fine sand.
225.0 – 241.1	SAND, uniform, unconsolidated fine to medium, trace silty, moderate to low transmissivity.
241.1 – 242.1	LIMESTONE, weakly cemented.
242.1 – 242.9	SAND, uniform, shelly, dirty.
242.9 – 250.0	Transition zone. 245.0, layer of sand. 246.0, layer of sandstone, competent. 247.0, layer of shell hash. 248.0, layer of sandstone, fractured. 249.0, layer of sand.
250.0 – 251.7	LIMESTONE, vuggy, moldic, calcite crystals in vuggs, medium gray with yellow, weathered sandstone pieces, interspersed.
251.7 – 266.0	SAND, fine, uniform, light gray with glauconite or heavy metal, very fine, low percentage (<5%) inclusions.
266.0 – 266.8	Hard sandstone with fossils <0.3-inch thick, layered with very fine sand, uniform, clean.
266.8 – 292.2	SAND, uniform, well graded, medium fine to very fine, light gray, no shells, heavy metal, very fine <5%.
292.2 – 292.8	Transition zone. Iron oxide, sand and shell hash, limey, black infilling, dark gray.
292.8 – 305.0	LIMESTONE, moderately compressed, moderately cemented, vuggy, light gray.

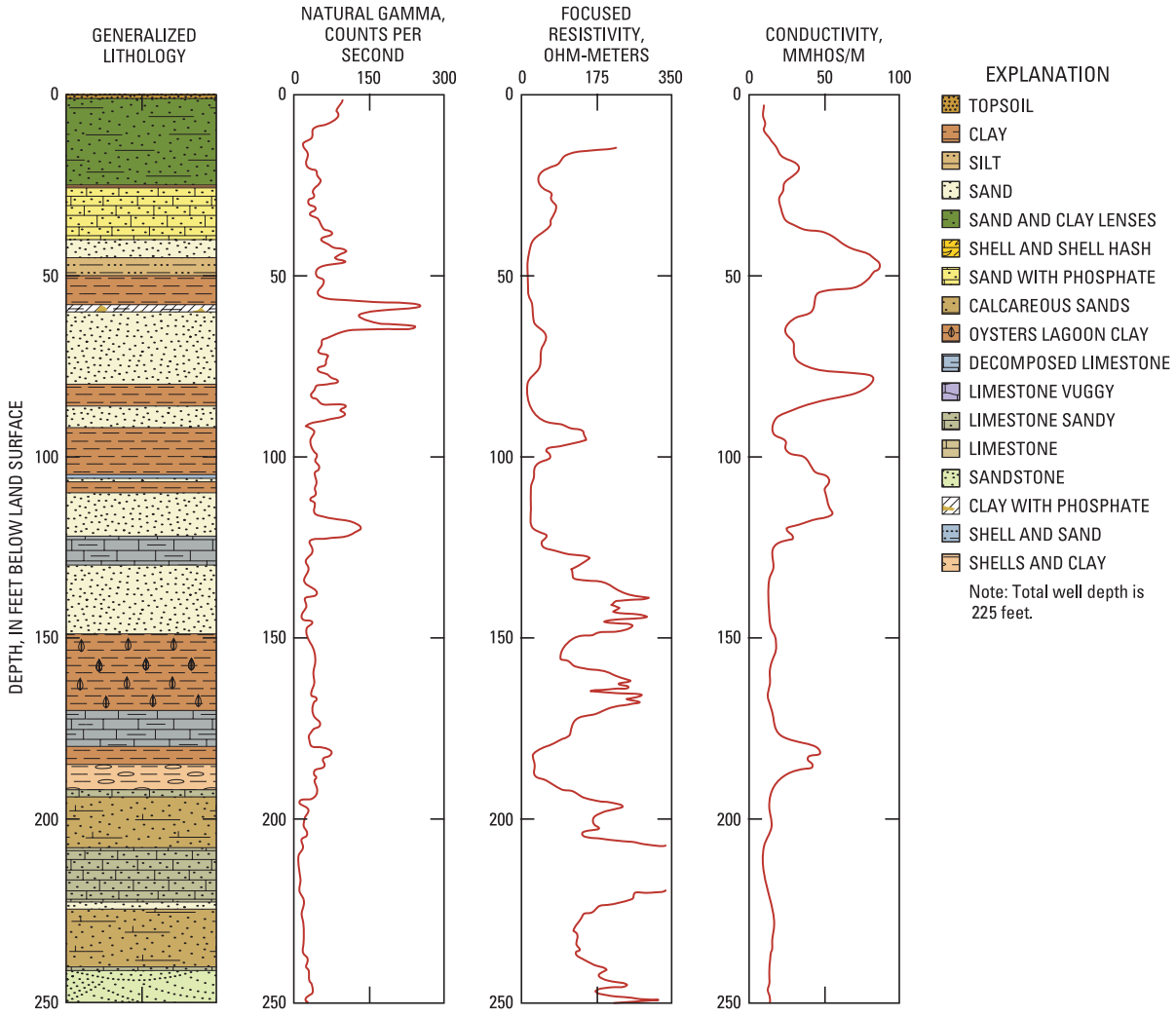


Figure 28A. Selected borehole geophysical logs collected in Strat-6 test hole displayed to a depth of 250 feet, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

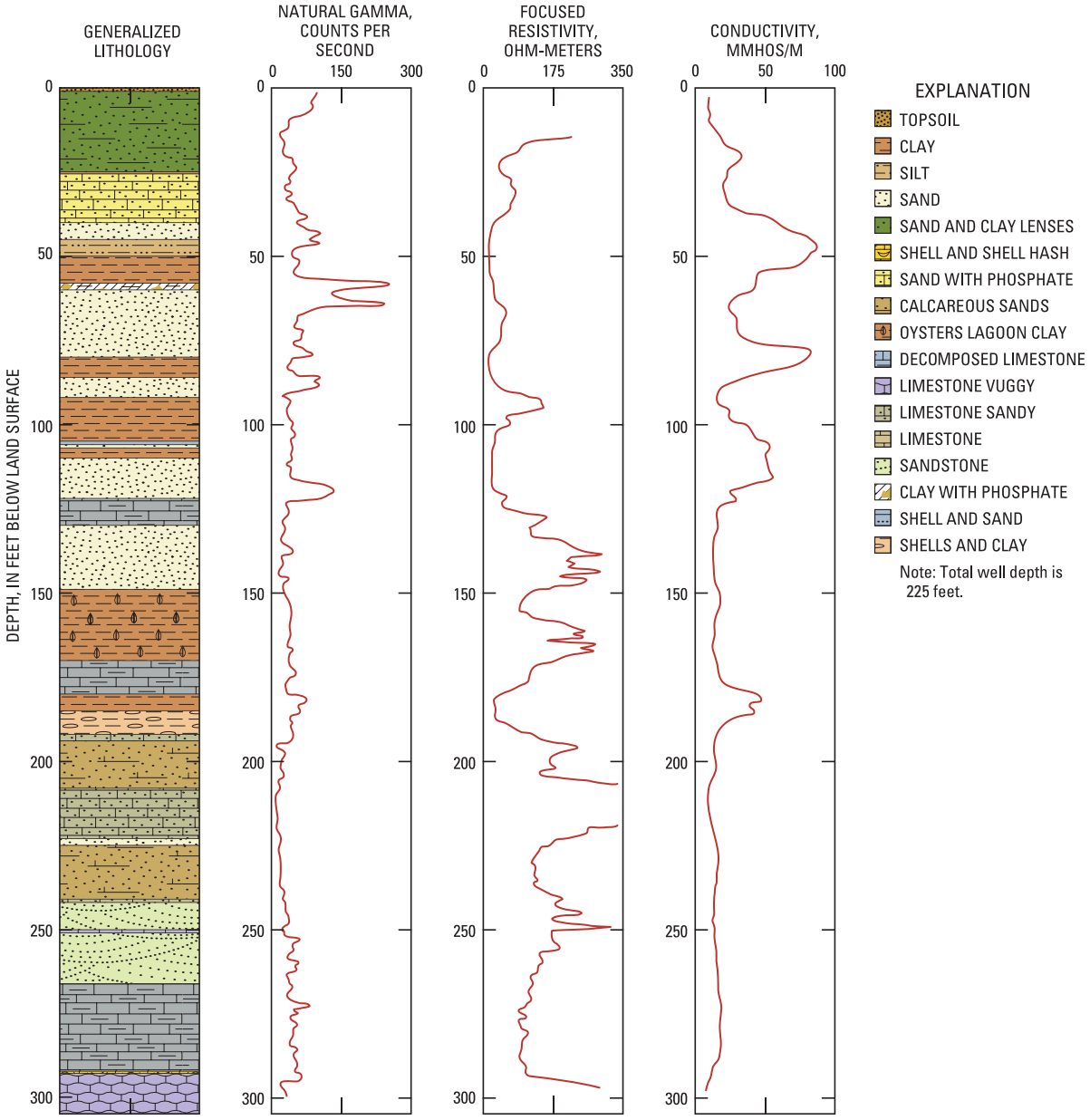
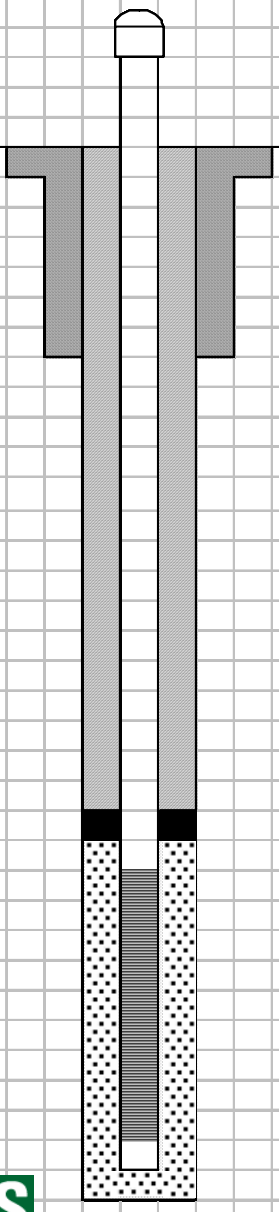


Figure 28B. Selected borehole geophysical logs collected in Strat-6 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

MONITORING WELL CONSTRUCTION REPORT

U.S. Geological Survey
Water Resources Division
3916 Sunset Ridge Road
Raleigh, North Carolina 27607
(919) 571-4000

SITE:	CR-620 STRAT HOLE 6 AT CHERRY POINT MCAS			
WELL NUMBER:	345613076513701	LATITUDE:	34° 56' 13"	DATUM:
DATE STARTED:	8-11-2000	LONGITUDE:	76° 51' 37"	NAD83
DATE COMPLETED:	8-19-2000	AQUIFER:	CASTLE HAYNE	
USGS REPRESENTATIVE:	Beth Wrege	PROJECT NUMBER:	13800	



LAND SURFACE
ALTITUDE 10 feet
DATUM: NGVD29

ALTITUDE OF MEASURING POINT	9.90 feet
HEIGHT OF MEASURING POINT ABOVE LAND SURFACE	-0.10 foot
BOREHOLE DIAMETER	4.5 inches
CASING DIAMETER / TYPE	2 inches / PVC
SURFACE CASING DEPTH	Surface casing removed
TYPE OF GROUT	Type I Portland Cement*
DEPTH OF GROUT	200 feet
TOP OF FILTER PACK DEPTH	200 feet
TYPE OF FILTER PACK	DSSI* Sand
SCREEN SLOT NUMBER	0.10
SCREEN DIAMETER	2-inch ID / PVC
SCREEN INTERVAL TOP	210 feet
SCREEN INTERVAL BOTTOM	220 feet
WELL DEPTH	225 feet
HOLE DEPTH	305 feet

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Figure 29. Strat-6 monitoring-well construction report, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 18. Periodic water levels in Strat-6 monitoring well, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Date	Water level, in feet below land surface
09-21-2000	11.05
02-09-2001	11.43
05-03-2001	10.78
08-09-2001	12.72
03-29-2002	11.53
05-15-2002	12.16
08-16-2002	13.61

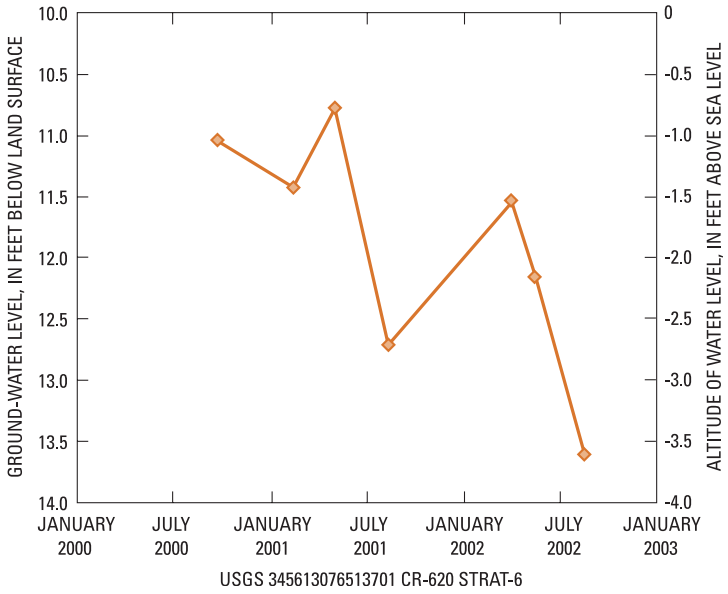


Figure 30. Hydrograph of ground-water levels in Strat-6 monitoring well, U.S. Marine Corps Air Station, Cherry Point, North Carolina, September 2000–August 2002.

Strat-7

The Strat-7 well is near the intersection of Slocum Road and Buncombe Road, west of Slocum Creek (fig. 3). The well is east of an unpaved trail and has a concrete pad and bollards protecting it. A detailed location map is provided in figure 31.

The Strat-7 test hole was drilled by the USGS core-recovery team. Drilling began on August 2, 2000, and reached a total depth of 265 ft on August 8, 2000. Continuous core was collected by using a wire-line rotary core rig. Field determinations of the lithology and hydrology were made on location from cuttings and core samples, and are described in table 19.

After the test hole was drilled, geophysical surveys were collected. The abbreviated lithology and borehole geophysical logs are shown in figure 32. Lithology, cores, and geophysical logs were used to determine the aquifers and design the monitoring well. A diagram of the well construction, including the placement of the well screen, is shown in the monitoring-well construction report (fig. 33).

The Strat-7 well was assigned NC county number CR-621 and USGS station number 345510076544901. Periodic water-level measurements were made in the monitoring well between September 2000 and May 2002. Water-level data ranged from 16.71 to 18.74 ft below land surface (table 20; fig. 34).

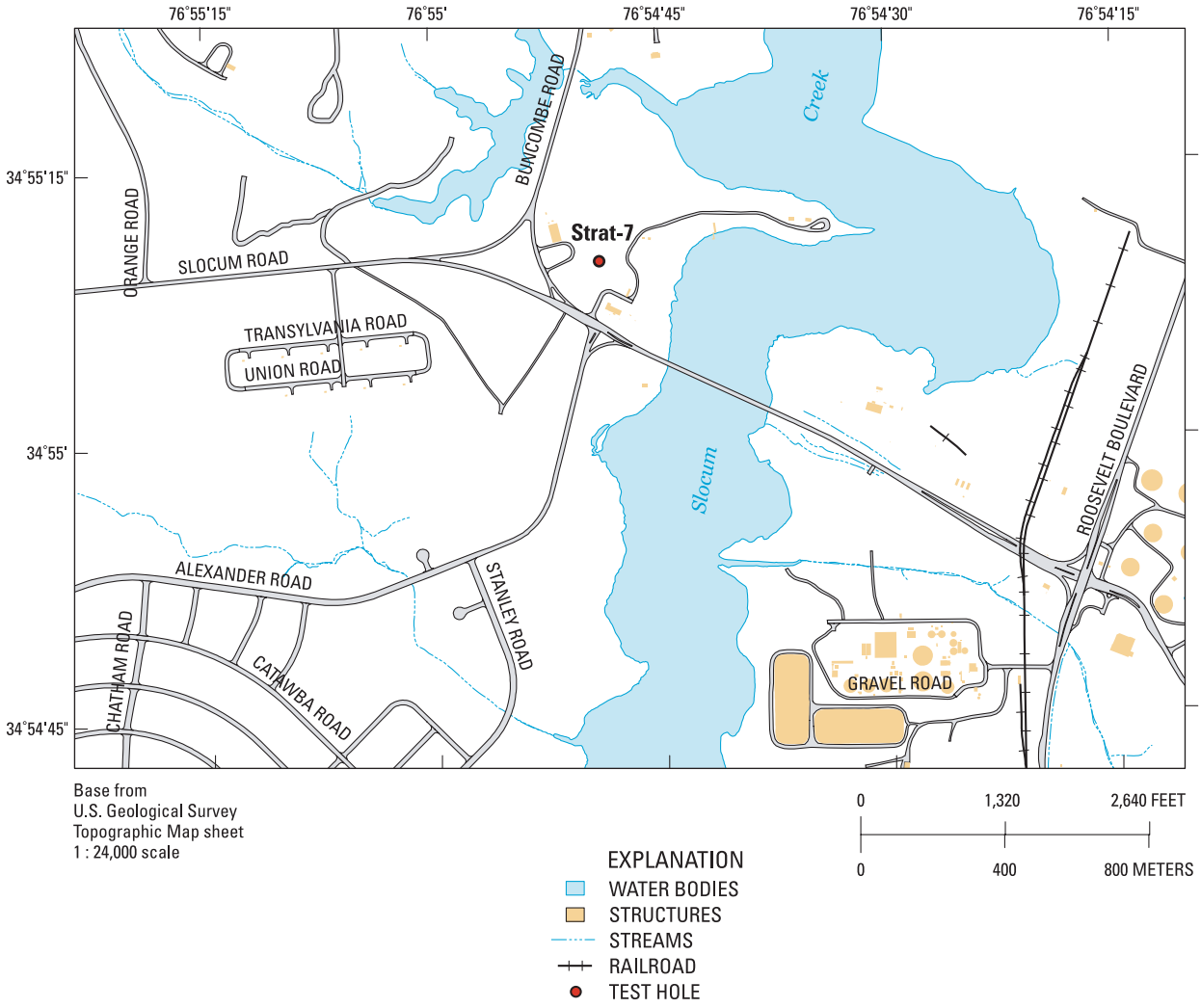


Figure 31. Location of Strat-7 well, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 19. Lithologic log for Strat-7 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

[ft, feet; mm, millimeter; cm, centimeter; %, percent; <, less than]

Depth below land surface (in feet)	Description (compiled by C.C. Daniel, III)
0.0 – 0.9	"A" horizon; soil zone gray, very fine sand, silty minor clay, roots.
0.9 – 4.0	Grayish-tan silty SAND, very fine sand.
4.0 –5.5	Orange, very fine SAND, silty, some clay.
5.5 – 7.5	Orange CLAY.
7.5 – 11.0	Yellowish-orange very fine SAND, silty, some thin clay disseminated through interval—thin sand layers (0.1 ft) with little clay color 5Y8/4.
11.0 – 17.3	SAND, well sorted, subrounded, frosted yellowish-gray sand, very fine.
17.3 – 17.7	CLAY.
17.7 – 19.6	Yellowish-gray SAND, very fine.
19.6 – 21.5	Grayish-orange CLAY.
21.5 – 27.5	Sandy CLAY with thin storm sands, heavy mineral lenses, grayish-yellow 5Y8/4 to pale yellowish-orange 10YR8/6.
27.5 – 28.8	Silty sand, clay 10YR6/6.
28.8 – 30.0	Silty clay, light olive-gray 5Y6/1.
30.0 – 32.0	Sandy CLAY—coarse, poorly sorted sand, fraction small pebbles 2–12 mm, well rounded.
32.0 – 44.6	SAND—coarse sand, moderately sorted, well rounded, frosted.
44.6 – 60.5	Fine to very fine SAND with some silt and clay. Sand angular to subrounded. Light olive-gray 5Y5/2. Sparse, widely scattered phosphate and quartz pebbles, 1- to 6-mm long dimension. Phosphate and quartz pebbles below 60 ft increase in size and abundance.
60.5 –64.0	62.0–64.0 ft, quartz pebbles to 1 cm, phosphate pebbles to 2 cm.
64.0 – 65.2	Carbonate lag gravel, shell hash, with quartz and phosphate up to 3 mm.
65.2 – 68.3	Fossiliferous carbonate, light gray N7.
68.3 – 71.5	Sandy, silty, shell hash with scattered phosphate.
71.5 – 73.4	CLAY.
73.4 – 86.2	SAND with a few clay lenses, a few widely scattered quartz pebbles, well rounded, 3–5 mm. Fine to very fine sand, angular to subrounded scattered phosphate, fine to very fine, 1–2%.
86.2 – 90.0	Clayey, silty SAND.
90.0 – 93.5	Sandy CLAY with clay rip-up clasts, light gray N7 to very light gray N8 with no sand, slick when wet.
93.5 – 100.3	Silty, sandy CLAY to silty clayey SAND with shell fragments, chalky thin-walled bivalves. A few phosphate pebbles 2–3 mm, medium light gray N6 to medium greenish-gray, very fine sand fraction.
100.3 – 102.5	Silty, yellowish greenish-gray CLAY.
102.5 – 124.5	Fossiliferous sandy CLAY with abundant shell hash, lag gravel zones. 102–105, chert and chert fragments. 115–115.6, moldic, limestone, clay, yellowish-gray 5Y7/2. 123.9–124.5, sand content increases, contains shell fragments; interval has increased quartz and phosphate well-rounded pebbles 4–8 mm in diameter.
124.5 – 134.7	SAND, well sorted, fine; 1% phosphate of similar size, scattered phosphate pebbles 2–4 mm, scattered shell fragments subangular to rounded, partially frosted. 10YR7/1 light gray.
134.7 – 154.8	Fossiliferous CLAY, sandy, contains large shell fragments <2 inches in diameter of core contains chert nodules, some with chalky coating. Light greenish-gray 5G7/1. Sandy fraction decreases upward, size decreases. 153–154.8, shell hash with quartz pebbles, phosphate nodules, quartz and phosphate 3–9 mm, sandy-clay matrix, large shell fragments.
154.8 – 198.0	LIMESTONE, carbonate – interlayered sequence of porous calcarenite moldic limestone and friable to very friable moldic limestone, also includes lag gravel of carbonate fragments. Rare pieces of mother-of-pearl and chalky shells remain at places in the section. Sand in section is fine to medium, well rounded, and frosted. Minor phosphate mixed with the sand. Grayish-tan-buff color, may have some silt-clay in matrix.
198.0 – 210.8	LIMESTONE, "dirty" moldic limestone at top, gray 5Y7/1. Moldic limestone – "clean," light tan yellowish-gray 5Y8/1. Large voids up to 1.5–2 cm. "Dirty" moldic limestone at base of interval 5Y7/1.

Table 19. Lithologic log for Strat-7 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.—Continued

[ft, feet; mm, millimeter; cm, centimeter; %, percent; <, less than]

Depth below land surface (in feet)	Description (compiled by C.C. Daniel, III)
210.8 – 212.0	LIMESTONE, "lag gravel" limestone fragments.
212.0 – 214.0	LIMESTONE, calcarenite – no megafossils.
214.0 – 214.5	LIMESTONE, "lag gravel" limestone fragments mixed with calcarenite (shell hash, plates?).
214.5 – 257.5	LIMESTONE, calcarenite – no megafossils. Small limestone fragments, plates? Small shells and shell fragments leached out 10YR8/1 very pale yellowish-gray. Friable to indurated/cemented sand. Sand is fine to medium, moderately well sorted, subangular to rounded, 1–2% phosphate sand-size grains. Scattered plates (carbonate/aragonite?).
257.5 – 264.0	LIMESTONE, calcarenite with shell, shells are chalky, appear to be bivalve shell fragments, aragonite (?); plates, 263–264.
264.0 – 265.0	LIMESTONE, moldic.

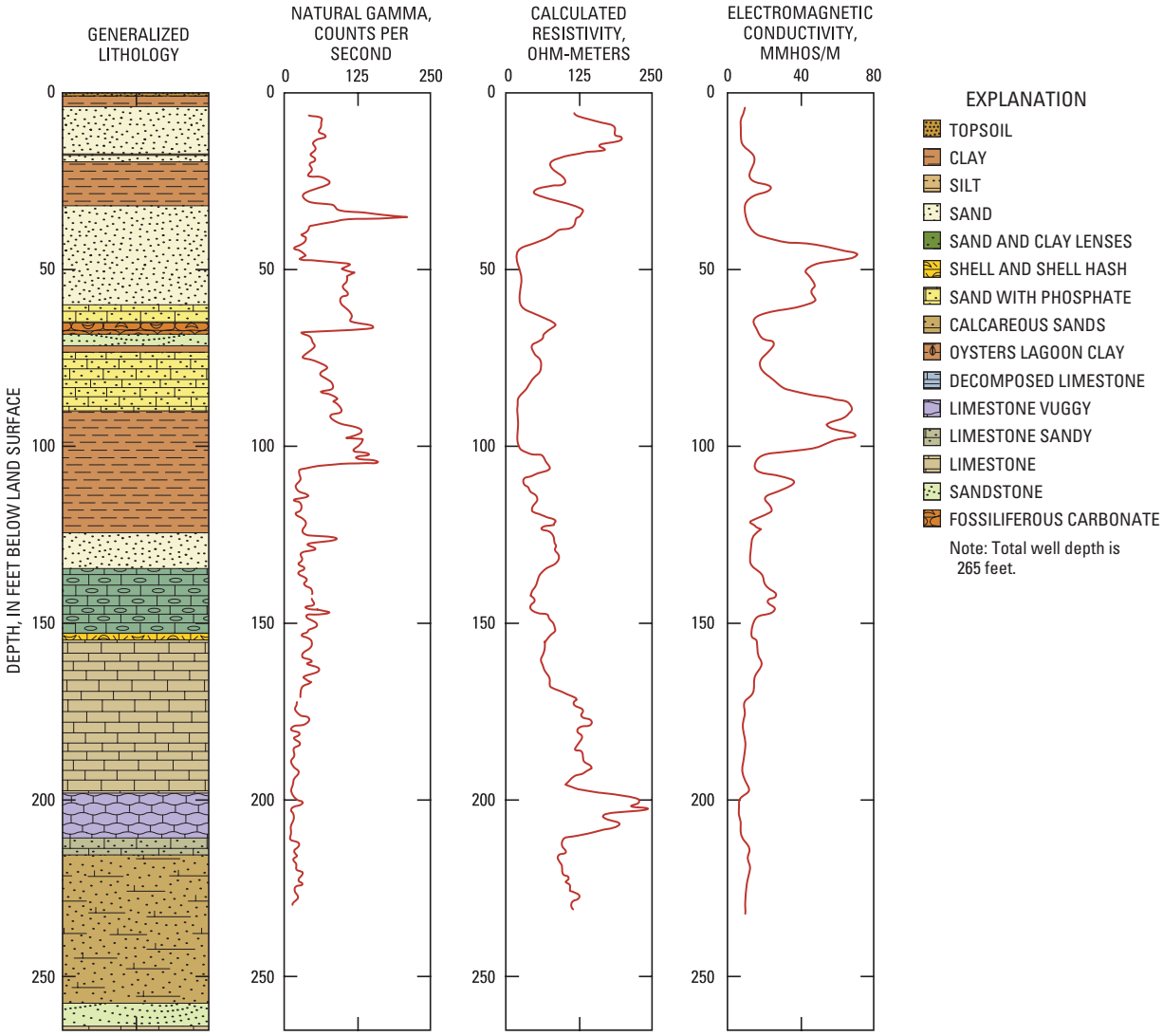
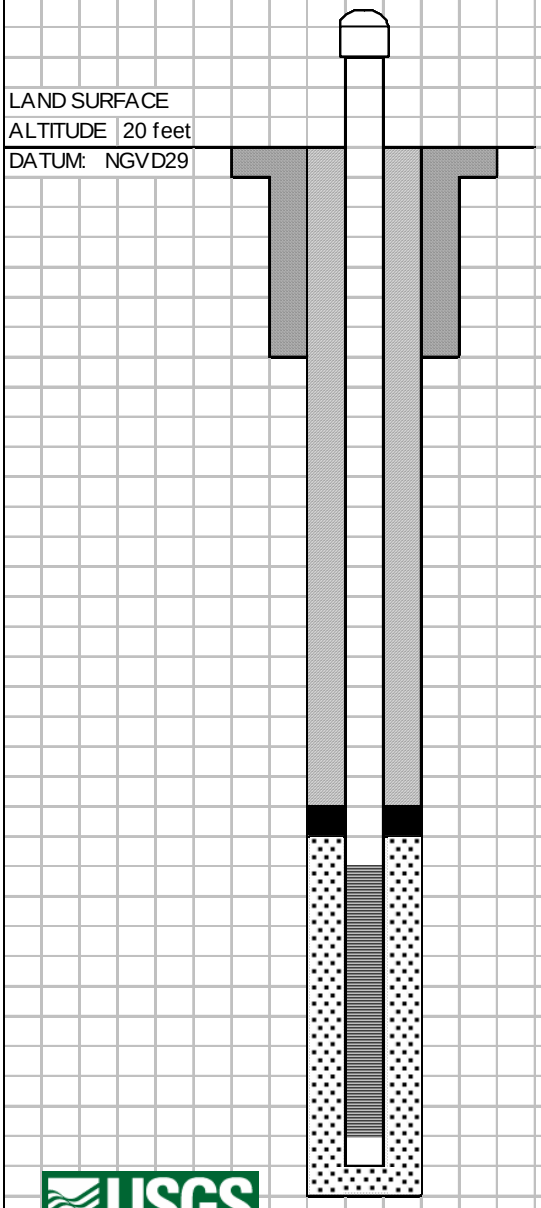


Figure 32. Selected borehole geophysical logs collected in Strat-7 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

MONITORING WELL CONSTRUCTION REPORT

U.S. Geological Survey
Water Resources Division
3916 Sunset Ridge Road
Raleigh, North Carolina 27607
(919) 571-4000

SITE:	CR-621 STRAT HOLE 7 AT CHERRY POINT MCAS			
WELL NUMBER:	345510076544901	LATITUDE:	34° 55' 10"	DATUM:
DATE STARTED:	8-2-2000	LONGITUDE:	76° 54' 49"	NAD83
DATE COMPLETED:	8-8-2000	AQUIFER:	CASTLE HAYNE	
USGS REPRESENTATIVE:	Beth Wrege	PROJECT NUMBER:	13800	



LAND SURFACE
ALTITUDE 20 feet
DATUM: NGVD29

ALTITUDE OF MEASURING POINT	22.34 feet
HEIGHT OF MEASURING POINT ABOVE LAND SURFACE	2.34 feet
BOREHOLE DIAMETER	8 inches
CASING DIAMETER / TYPE	2 inches / PVC
SURFACE CASING DEPTH	Surface casing removed
TYPE OF GROUT	Type I Portland Cement*I
DEPTH OF GROUT	20 feet
TOP OF FILTER PACK DEPTH	190 feet
TYPE OF FILTER PACK	#2 sand
SCREEN SLOT NUMBER	0.12, 12 slot
SCREEN DIAMETER	2 inches
SCREEN INTERVAL TOP	200 feet
SCREEN INTERVAL BOTTOM	210 feet
WELL DEPTH	265 feet
HOLE DEPTH	265 feet

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Figure 33. Strat-7 monitoring-well construction report, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 20. Periodic water levels in Strat-7 monitoring well, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Date	Water level, in feet below land surface
09-21-2000	17.33
10-05-2000	17.15
02-09-2001	17.60
05-03-2001	17.92
08-09-2001	18.74
03-29-2002	16.71
05-15-2002	18.23

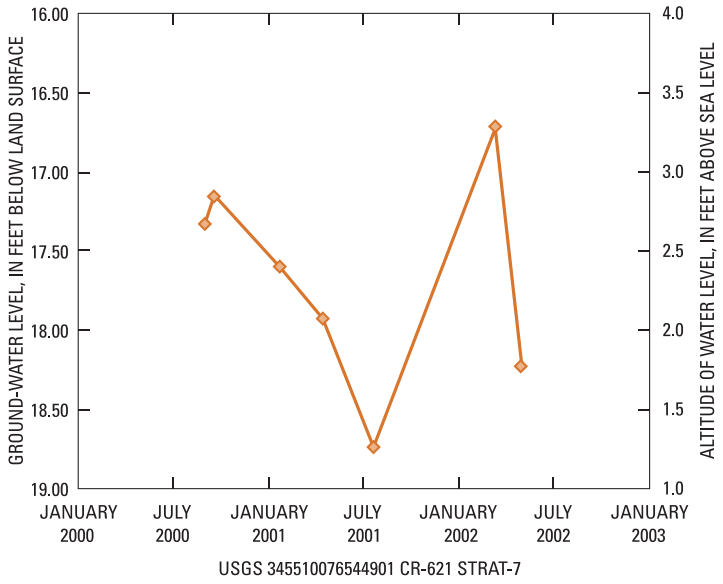


Figure 34. Hydrograph of ground-water levels in Strat-7 monitoring well, U.S. Marine Corps Air Station, Cherry Point, North Carolina, September 2000–May 2002.

Strat-8

The Strat-8 well is in a secured, fenced, northwest area of the MCAS (fig. 3). A detailed location map is provided in figure 35.

The Strat-8 test hole was drilled by the USGS core-recovery team. Drilling reached a total depth of 220 ft on February 12, 2001. Continuous core was collected by using a wire-line rotary core rig. Field determinations of the lithology were made on location from cuttings and core samples and are described in table 21.

After the test hole was completed, borehole geophysical surveys were collected. The abbreviated lithology and borehole geophysical logs are shown in figure 36. Lithology and geophysical logs were used to determine the aquifers and design the monitoring well. A diagram of the well construction, including the placement of the well screen, is shown in the monitoring-well construction report (fig. 37).

The Strat-8 well was assigned NC county number CR-622 and USGS station number 345707076553501. The water level was measured on May 15, 2002, at a depth of 22.91 ft below land surface.

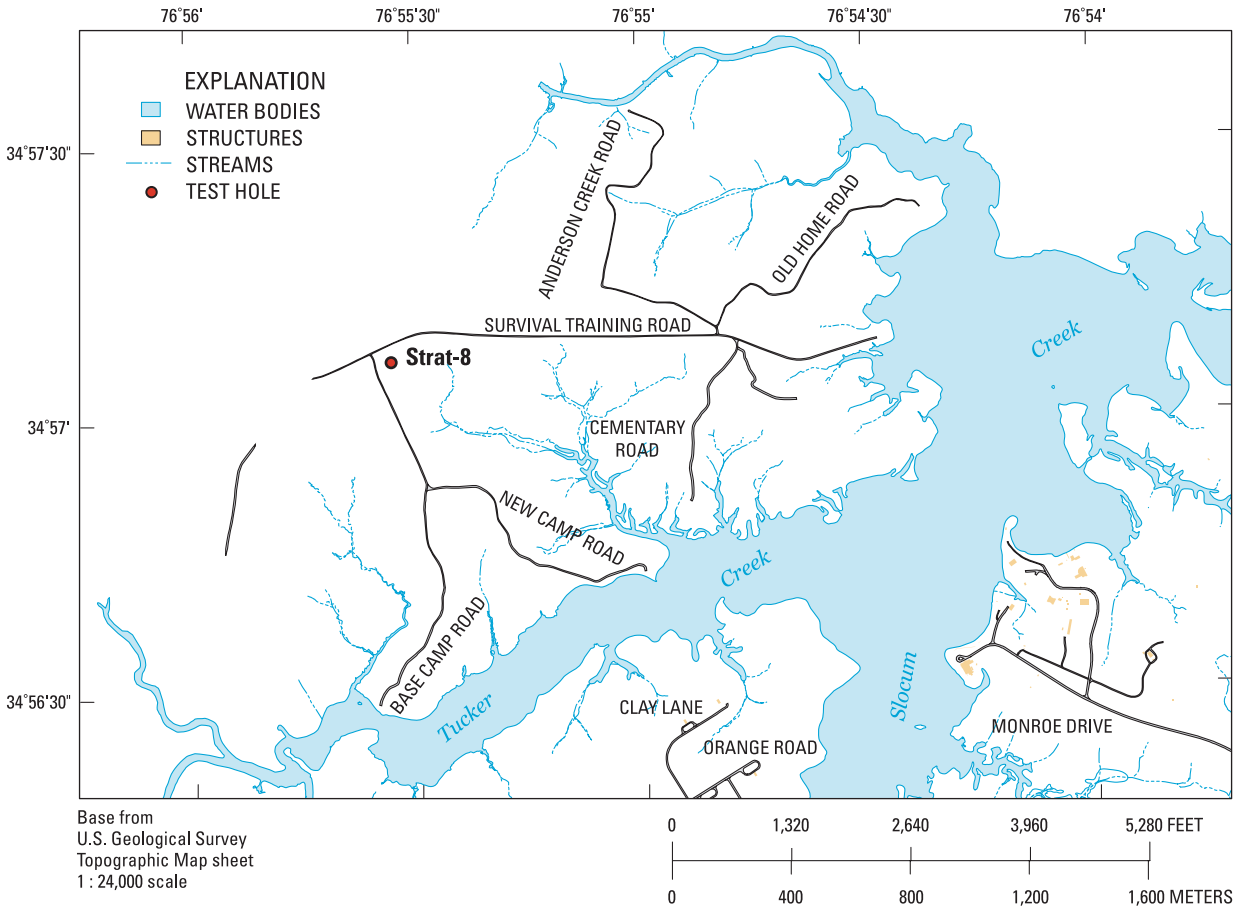


Figure 35. Location of Strat-8 well, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 21. Lithologic log for Strat-8 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

[%, percent; mm, millimeter; ft, feet; cm, centimeter]

Depth below land surface (in feet)	Description (compiled by C.C. Daniel, III)
0.0 – 1.0	Missing.
1.0 – 3.7	Silty CLAY, tan to orange.
3.7 – 6.0	Fine to medium SAND, grayish with bits of carbon/charcoal.
6.0 – 14.0	White to light gray, very fine sand with scattered clay-silt balls, blue-gray clay balls.
14.0 – 16.4	Gray to buff non-fossiliferous CLAY with thin sand layers, storm sand layers.
16.4 – 24.0	CLAY, fossiliferous with pelecypods, silty, gray clay, fewer shells at top of interval.
24.0 – 24.4	SAND, sandy carbonate.
24.4 – 24.8	Gray CLAY, some shells.
24.8 – 29.0	Sand? Washout?
29.0 – 30.0	Shell hash, some whole shells, gray silty clay.
30.0 – 48.6	CLAY, gray silty; scattered shells and shell fragments, some fine sand toward base of interval, a few phosphate grains.
48.6 – 52.2	SAND, shells, and shell hash, phosphate grains, small pebbles, some silty clay toward top.
52.2 – 58.0	SAND and abundant shell hash, shells and fragments, 10–20%, small quartz pebbles 2–4 mm phosphate.
58.0 – 61.0	Calcareous SAND, limey some phosphate.
61.0 – 62.0	Sandy chert, grayish-green chips.
62.0 –63.5	CLAY, silty, greenish.
63.5 – 66.0	Abundant quartz pebbles at base, clayey silt.
66.0 – 70.0	Calcareous SANDSTONE, fossiliferous with pelecypods, moldic in part shell fragments, 69–70 ft.
70.0 – 78.5	Silty, clayey SAND, fine to medium.
78.5 – 81.0	Cemented calcareous SAND.
81.0 – 89.8	Sandy, silty CLAY, grayish-green, very fine sand/silty at base.
89.8 – 96.5	Calcareous SANDSTONE. Moldic limestone layers, thin.
96.5 – 103.5	SAND with quartz pebble layers, calcareous. Abundant pebbles 3–6 mm diameter. Sand, partially cemented, hard zones, shell fragments, light gray.
103.5 – 105.3	Calcareous fossiliferous SANDSTONE with hard, cemented layers.
105.3 – 126.0	Greenish-gray silty CLAY with thin shell-hash layers and scattered phosphate grains and small pebbles 2–3 mm, shell fragments scattered through the interval.
126.0 – 129.5	Sandy, silty shell hash with shell fragments 2–3 cm.
129.5 – 130.5	Green CLAY with storm sand streaks/lenses.
130.5 – 143.9	134.5–135, sand lenses. 142.0–143, shell hash, sandy, silty, uncemented thin clay lenses near base of interval, phosphatic at base, large oyster shells.
143.9 – 160.0	Moldic LIMESTONE; shells have been removed by dissolution, interstitial material is silty, micritic and minor clay to 148 ft. Weakly cemented/friable to 160 ft.
160.0 – 165.5	Gray moldic LIMESTONE, indurated/hard micrite.
165.5 – 191.9	Light tan to buff moldic LIMESTONE, competent to friable, very sandy matrix, calcareous cement, small scattered phosphate grains, nearly all shell material removed by dissolution, calcite crystals (spar) occur as druse on mold-void surfaces. 186–191.9, sand increases.
191.9 – 210.0	Fine to very fine, well sorted SAND, subrounded to angular, abundant, fine phosphate grains 2–3% "salt and pepper."
210.0 – 210.4	Cemented sand/chert.
210.4 – 215.0	Fine to very fine, well sorted SAND, subrounded to angular, abundant, fine phosphate grains, 2–3% "salt and pepper."
215.0 – 215.3	Cemented sand/chert.
215.3 – 220.0	Fine to very fine, well sorted SAND, subrounded to angular, abundant, fine phosphate grains, 2–3% "salt and pepper."

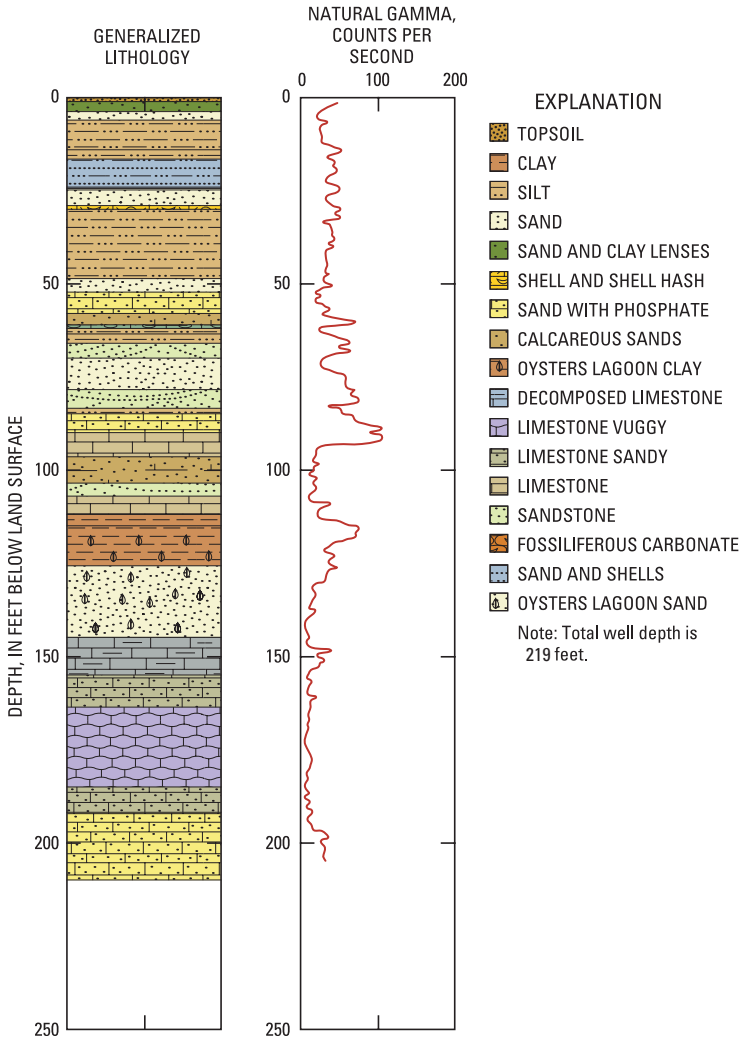
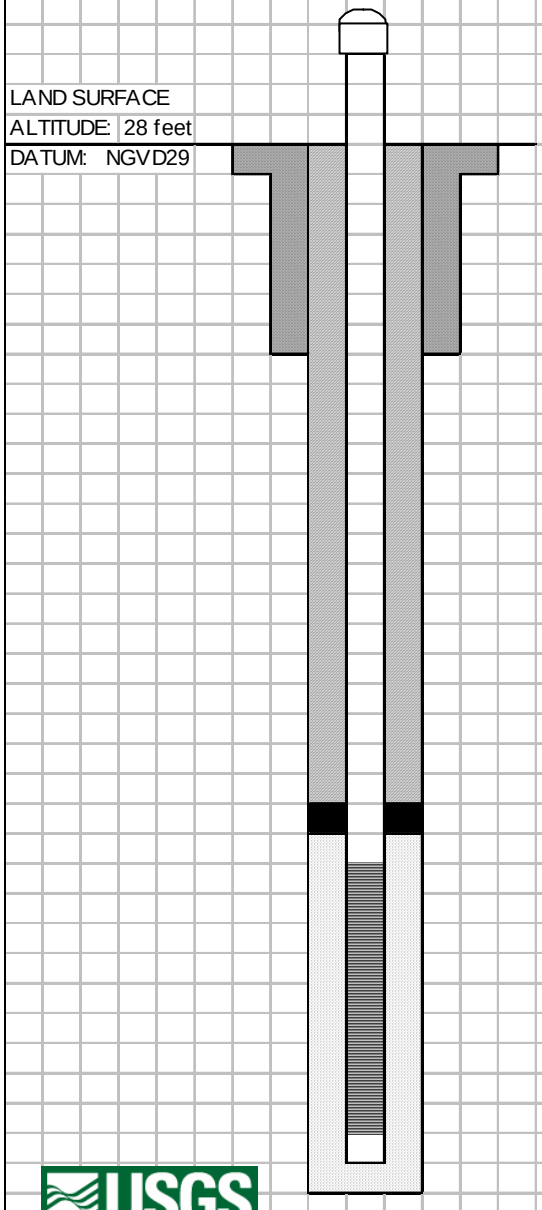


Figure 36. Selected borehole geophysical logs collected in Strat-8 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

MONITORING WELL CONSTRUCTION REPORT

U.S. Geological Survey
Water Resources Division
3916 Sunset Ridge Road
Raleigh, North Carolina 27607
(919) 571-4000

SITE:	CR-622 STRAT HOLE 8 AT CHERRY POINT MCAS			
WELL NUMBER:	345707076553501	LATITUDE:	34° 57' 07"	DATUM:
DATE STARTED:	2-5-2001	LONGITUDE:	76° 55' 35"	NAD83
DATE COMPLETED:	2-12-2001	AQUIFER:	CASTLE HAYNE	
USGS REPRESENTATIVE:	Beth Wrege	PROJECT NUMBER:	13800	



LAND SURFACE
ALTITUDE: 28 feet
DATUM: NGVD29

ALTITUDE OF MEASURING POINT	30.92 feet
HEIGHT OF MEASURING POINT ABOVE LAND SURFACE	2.92 feet
BOREHOLE DIAMETER	4.5 inches
CASING DIAMETER / TYPE	2 inches / PVC
SURFACE CASING DEPTH	20 feet
TYPE OF GROUT	Type I Portland Cement*
DEPTH OF GROUT	20 feet
TOP OF FILTER PACK DEPTH	192 feet
TYPE OF FILTER PACK	#2 sand
SCREEN SLOT NUMBER	0.10, 10 slot
SCREEN DIAMETER	2-inch ID / PVC
SCREEN INTERVAL TOP	199.5 feet
SCREEN INTERVAL BOTTOM	209.5 feet
WELL DEPTH	219 feet
HOLE DEPTH	220 feet

USGS science for a changing world

Figure 37. Strat-8 monitoring-well construction report, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Strat-9

The Strat-9 test hole is north of State Highway 70 and south of Slocum Creek (fig. 3). A detailed location map is provided in figure 38.

The Strat-9 test hole was drilled by the USGS core-recovery team. Drilling began on February 14, 2001, and reached a total depth of 220 ft on February 18, 2001. Continuous core was collected by using a mud-rotary wire-line core rig. Lithologic determinations were made from cuttings and core samples and are described in table 22.

After the test hole was completed, borehole geophysical surveys were collected. The abbreviated lithology and borehole geophysical logs are shown in figure 39. No monitoring well was installed at this location. The test hole was pressure grouted from the bottom (220 ft) to the land surface using type-I Portland cement and abandoned in compliance with State regulations (North Carolina Department of Environment, Health, and Natural Resources, 1976).

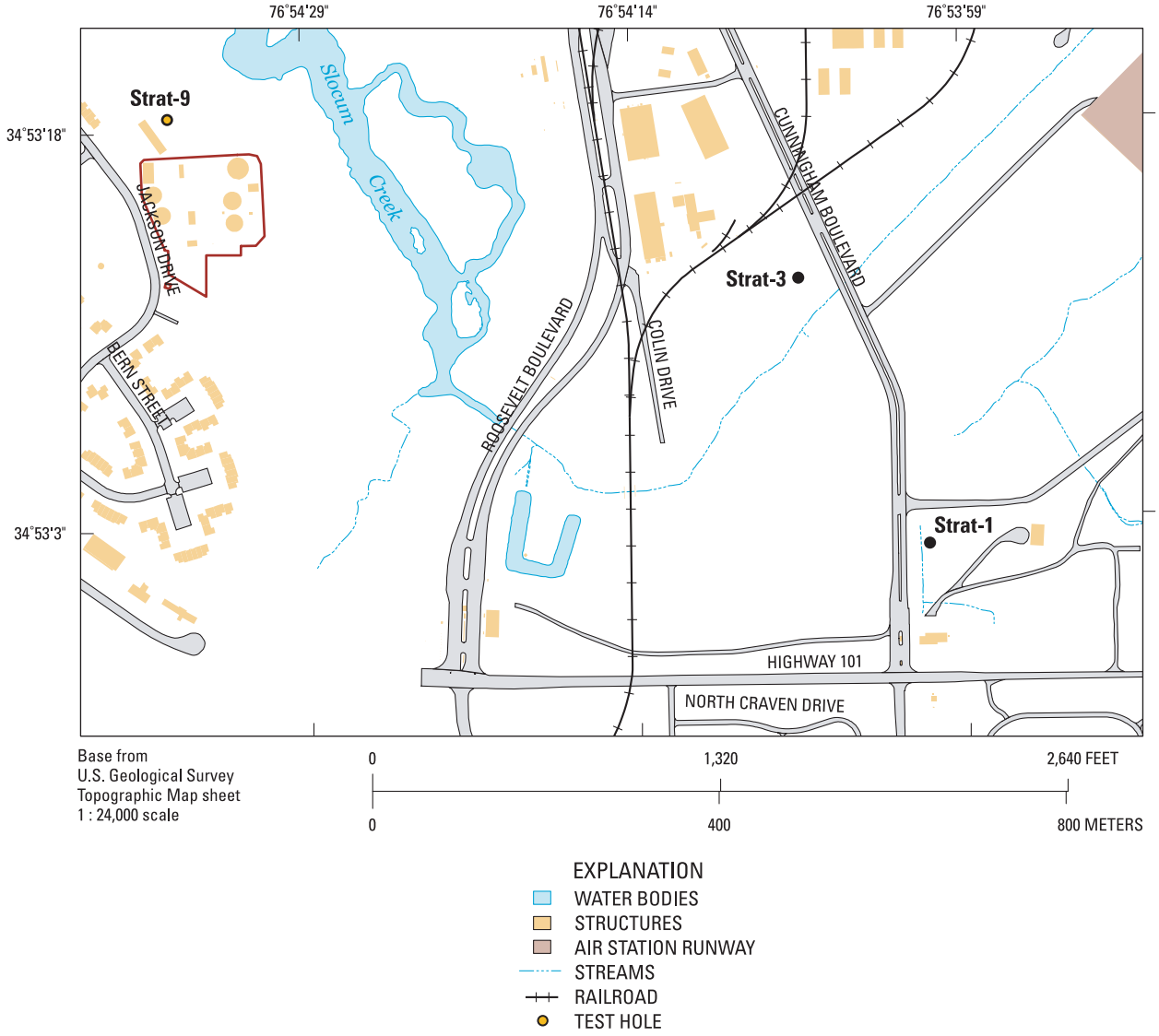


Figure 38. Location of Strat-9 test hole at U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Table 22. Lithologic log for Strat-9 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

[mm, millimeter; ft, feet; cm, centimeter; >, greater than]

Depth below land surface (in feet)	Description (compiled by C.C. Daniel, III, and B.M. Wrege)
0.0 – 1.0	Soil zone, roots 10YR2/2.
1.0 – 2.4	Coarse, poorly sorted SAND, silty-clayey matrix. Dark yellowish orange 10YR6/6.
2.4 – 3.5	Lost, sand?
3.5 – 5.0	Silty sand and SAND. Silty, fine sand
5.0 – 6.5	Lost, sand?
6.5 – 7.7	Fine to very fine sand, light gray.
7.7 – 15.5	CLAY, silty, sandy clay, mottled color ranges from gray to orange-tan, greenish-gray.
15.5 – 17.5	SAND, coarse, poorly sorted with gravel, some elongated pebbles to 8 mm.
17.5 – 31.2	Fine SAND with interbedded silty zones and thin, sandy clays, fining downward. 17.7–20.0, no sample. 22.0–23.5, no sample. 25.6–27.0, no sample. 30.2–31.0, no sample.
31.2 – 45.0	Fine, coarse, and very coarse SAND with scattered quartz pebbles, some elongated, well rounded, up to 9 mm in dimension.
45.0 – 46.3	Amount of gravel, very coarse SAND increases, sediment is brown to orange and appears oxidized, sharp contact at 46.3 ft with limonite zone about 1 cm thick at contact.
46.3 – 60.0	Silty, sandy shell hash with some intact shells, medium gray to very light gray N6 – N8. Matrix is, in part, calcareous.
60.0 – 65.0	Greenish-gray, silty with some clay, a few shell fragments.
65.0 – 66.0	SAND, medium to fine, moderately well sorted, medium light gray, N6.
66.0 – 67.0	Silty CLAY, clay lenses, light olive-gray, 5Y5/2.
67.0 –67.3	Cemented sand/sandstone.
67.3 – 69.8	Very fine, fine SAND, yellowish-gray, 5Y4/2.
69.8 – 70.0	Cemented sand/sandstone.
70.0 – 75.3	Silty, clayey fine SAND, moderately olive-gray, 5Y4/2.
75.3 – 86.4	A few widely scattered shell fragments. Color becomes lighter below 75 – 75.3 ft, gradational change. Very fine, silty, clayey SAND; silt and clay 30–40% (est.), yellowish-gray, 5Y7/2.
86.4 – 90.5	Color darkens, light olive-gray, 5Y5/2. 86.4, silty, sandy CLAY; clay and silt >50% (est.).
90.5 – 91.4	Transition zone. Fine silt to clay, greenish olive-green, 5GY43/2 moderate sorting.
91.4 – 138.0	Shell hash, gray, fragment size well sorted from 1/16-inch to >2-inch pieces of high angular calcite crystal matrix. 105.0, shell and coral size increasing to >1 inch. 110.0, increase in % fine matrix, decrease in shell fragments. 111.0, shells (gastropods and bivalves, highly phosphatized increase in oysters and clay, deep green-black lagoonal fines. 117.0, gravel, phosphated to coarse sand, greenish-gray (5GY6/1, wet). Poorly graded, some angular pebbles (5%), some subrounded frosted quartz pebbles (5%), some ½-inch phosphatic polished, flat, wood fragments. 125.0, increasing sand, darker gray, less shell hash (5GY6/1), increased sandy matrix. 132.0, gravel in sandy matrix, greenish-gray (5GY6/1).
138.0 – 145.0	Lagoonal deposit, very large oyster shells; shell limited by size of core barrel (up to 4 inches), blackish-green clay matrix 5GY3/2 (wet), very poorly sorted.
145.0 – 161.0	Oyster bed in green-gray sandy matrix with continuing phosphates. Very large oyster fragments.
161.0 – 170.0	LIMESTONE, unconsolidated, 0.1–0.4 shell fragments, sandy, light gray.
170.0 – 175.0	LIMESTONE, consolidated zone.
175.0 – 205.0	LIMESTONE, moldic moderately consolidated to well consolidated. Very high porosity, very high transmissivity. 180–186, yellow calcite crystals inside of bivalve mold; small, well-formed, angular crystals. 190–197, limestone, unconsolidated, moldic vuggy, shell molds ranging from 0.2 to 1.4 inches, pelecypod ridges are sharp and subangular.
205.0 – 220.0	SAND, uniform, well sorted, 80%, small percent subrounded limestone and shell fragments. Sand, uniform, medium fine, small percent very fine.

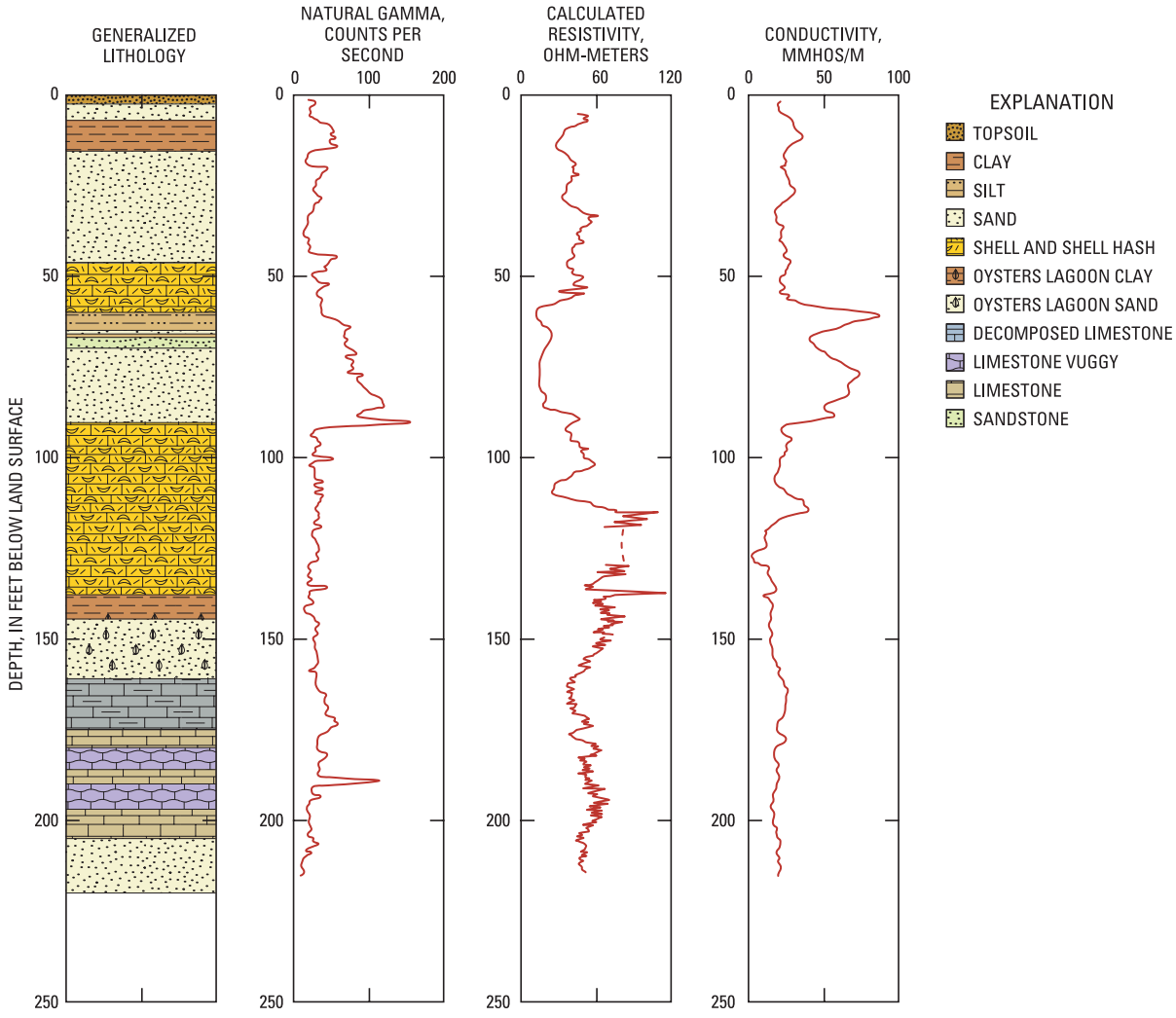


Figure 39. Selected borehole geophysical logs collected in Strat-9 test hole, U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Seismic Data

Marine and high-resolution land-seismic surveys were conducted for stratigraphic interpretations and paleochannel delineation from 1994 to 2001. The locations of the seismic data lines (fig. 3), the surveyed elevation inflection points, and the dates of data collection are provided herein.

The seismic profiles were used to delineate structures and correlate stratigraphy of the subsurface geology. Marine seismic data were collected in Slocum Creek, Hancock Creek, and in the Neuse River by the USGS in 1994 and 1998. The high-resolution land-seismic data were collected by the KGS. The data collected through 1998, analyses, and data-collection methods were published previously in Daniel and others (1996), Miller and Xia (1996), Cardinell (1999), and Wrege and Daniel (2001).

As part of this current study, two objectives were addressed with the acquisition of high-resolution land-seismic data: (1) to detect and delineate the subsurface trace of the Eocene and younger paleochannels inferred to underlie the MCAS (Mixon and Pilkey, 1976), and (2) to determine the feasibility of acoustically imaging and correlating the subsurface geology to existing geologic, hydrogeologic, and geophysical data. Initial short-line surveys were conducted and then extended with longer geophysical surveys sufficient to provide linear coverage across most of the Air Station. This approach was intended to provide an acoustic signature of the subsurface geology. The following discussion documents seismic data-collection activities from 1994 through 2001.

Marine Seismic Data

The locations of the 1994 marine seismic data lines are shown in figure 3. A detailed discussion of the 1998 marine seismic study is provided in Cardinell (1999). The marine seismic survey provided additional information for delineating the channels along the northern border of the MCAS.

Land Seismic Data

High-resolution seismic data were collected to support detailed interpretation of the underlying geology of the MCAS for water-supply management. The KGS collected the geophysical surveys during four separate field surveys (table 23).

Three methods were used as part of the land seismic surveys to acoustically image, correlate, and extend the borehole and point data beyond the test holes and across the MCAS. The first method combines walk-away noise tests, velocity check shots, and VSP to determine the signal-to-noise ratio of the upper 90 meters (m) of the geologic units. Seismic surveys were collected during September 1994 along 13 short (73 m) seismic lines, totaling approximately 240 ft. These common midpoint (CMP) lines are designated lines 1A–13A (Miller and Xia, 1996). The locations of the seismic lines and elevations by station are listed in table 24. The line locations were carefully selected to correlate with projected paleochannel locations from marine seismic and stratigraphic information. These profiles allowed data-collection parameters and equipment to be maximized for each site and enhanced placement so areal coverage of the longer continuous profiles could be optimized (Miller and Xia, 1996). The methods development phase of this investigation has been presented by Miller and Xia (1996).

The second seismic application method correlates the geologist's formation determinations with seismic acoustic properties using VSP. Based on the first 13 CMP surveys, three boreholes were drilled and geophysically logged for ground truth and to allow a series of time-domain walk-away VSPs to be acquired in each of the boreholes (Miller and Xia, 1996). The geologist's formation determinations were correlated with the VSPs.

Table 23. Field surveys conducted to collect land seismic data at the U.S. Marine Corps Air Station, Cherry Point, North Carolina, 1994–2000.

[m, meter; VSP, vertical seismic profiling; MCAS, Marine Corps Air Station]

Field survey	Date	Description
Survey A – short (calibration) seismic lines and VSP	September 1994	13 short (73-m) seismic surveys were conducted to determine the velocities of the formations and to calibrate the collection methods to the area of interest.
Survey B – long seismic lines	February 1995	Three long seismic-survey lines (1B—2,160 m; 2B—1,460 m; and 3B—1,450 m) were run after preliminary analyses of the short seismic lines and adjustments were made.
Survey C – long seismic lines and VSP	July 1999	Three seismic-survey lines (1C, 2C, and 3C) were run to extend the existing data.
Survey D – long seismic lines	March 2000	Three survey lines were run—line 1D provided coverage on the western side of the MCAS; line 2D provided coverage in the central portion of the MCAS; and line 3D completed the east-side coverage of the MCAS.

Table 24. Surveyed station location data and elevation inflection points for seismic surveys at U.S. Marine Corps Air Station, Cherry Point, North Carolina.

Station	Elevation	Northings	Eastings	Latitude	Longitude	Remarks
Line 1						Site 1
1001	22.83	N429013	E2627567	34°54'38.3"	76°54'23.87"	
1080	22.56					
1150	23.24	N428633	E2627575	34°54'34.54"	76°54'23.63"	
Line 2						Site 3
2001	21.02					
2040	20.47					
2110	21.02					
Line 3						Runway 1
3001	24.09	N422798.146	E2634176.422	34°53'35.45"	76°53'05.87"	
3120	22.87	N422694.277	E2633964.221	34°53'34.47"	76°53'08.44"	
Line 4						REA gate
3501	23.16	N419245	E2638165	34°52'59.47"	76°52'18.91"	
3620	24.20	N419500	E2638153	34°53'01.99"	76°52'19.99"	
Line 5						Dog pen
4001	31.91	N420481.05	E2631029.858	34°53'13.19"	79°53'44.22"	
4020	31.99					
4060	31.12					
4090	30.93					
4110	30.14					
4120	29.16	N420669.287	E2631173.958	34°53'15.03"	76°52'42.45"	
Line 6						Cunningham
2501	25.19	N418188	E2629533	34°52'50.83"	76°54'02.77"	
2530	24.78					
2570	24.64	N417950	E2629562	34°52'48.47"	76°54'02.84"	
Line 7						Soccer
5001	13.32					
5075	14.58					
5130	15.83					
Line 8						Slocum
5501	29.82	N431805	E2621433	34°55'07.19"	76°55'36.57"	
5560	29.39					
5620	28.60	N431775	E2621203	34°55'06.94"	76°55'39.34"	
Line 9						Building 99
6120	16.72	N420470	E2628155	34°53'13.69"	76°54'18.73"	
6110	23.21					
6090	24.18					
6040	23.48					
6001	23.56	N420705	E2628120	34°53'16.02"	76°54'19.09"	
Line 10						Runway 4
6501	36.56	N421237	E2631173	34°53'20.64"	76°53'42.31"	
6540	38.24					
6620	41.14	N421396	E2631837	34°53'22.07"	76°53'34.30"	

Table 24. Surveyed station location data and elevation inflection points for seismic surveys at U.S. Marine Corps Air Station, Cherry Point, North Carolina.—Continued

Station	Elevation	Northings	Eastings	Latitude	Longitude	Remarks
Line 11						Gate 6
7001	23.32	N419160.249	E2629633.04	34°52'49.54"	76°54'00.92"	
7120	22.87	N419402.586	E2629648.589	34°53'02.82"	76°54'01.08"	
Line 12						Gas
7501	23.81	N421425	E2637375	34°53'21.19"	76°52'27.83"	
7620	22.39	N421200	E2637800	34°54'18.88"	76°52'22.79"	
Line 13						Tall grass
7801	24.14	N422179.207	E2632901.862	34°53'29.59"	76°53'21.33"	
7860	25.09					
7920	24.50	N422052.71	E2632672.471	34°53'28.39"	76°53'24.1"	

The third seismic data method used at the MCAS after the initial calibration of acoustic properties and determination of local formations was to extend the data collection along 12-fold CMP seismic-reflection surveys (fig. 3). The longer CMP surveys were collected during separate field trips (table 23). A more extensive discussion of the three methods and the data collected prior to February 1995 can be found in Miller and Xia (1996).

In February 1995, seismic lines 1B, 2B, and 3B were run (fig. 3). These three 12-fold CMP seismic-reflection profiles had total linear lengths of about 2,160 m, 1,460 m, and 1,450 m, respectively (table 23), and provided boundary coverage to the south and north across the MCAS. The surveys cross the Air Station from the west near Slocum Creek to the east near Hancock Creek (fig. 3). Line 2B is a northeast-trending line beginning near the south-central boundary of the MCAS, generally paralleling the runway.

In July 1999, seismic lines 1C, 2C, and 3C were run (fig. 3). Line 1C is on the west side of the MCAS and extends along the eastern portion of Slocum Road. Line 2C, or the "Gas Mask" line, is a north-south line beginning near State Highway 101 at the southern boundary of the MCAS. Line 3C, or the "Runway" line, lies along the northeastern extent of the MCAS runway.

In March 2000, seismic lines 1D, 2D, and 3D were run (fig. 3). Line 1D is on the west side of the MCAS and extends along the western portion of Slocum Road (west of line 1C). Line 2D runs from southwest to northeast and nearly parallels C-Street. Line 3D also runs from southwest to northeast along Rifle Range Road in the northeast area of the MCAS. The data-collection methodology evolved with each new period of data collection as a result of improvements in knowledge, understanding, and technology. Acoustic velocity signatures were developed in each of these locations.

Several seismic lines have stratigraphic test holes near their terminus (fig. 3). VSPs, a borehole geophysical method, were run in the test holes. The VSPs provide a link to the high-resolution seismic profile, serve as calibration for the land seismic surveys, and can be correlated with the lithologic units in the test hole. After the VSP parameters are determined for a test hole, the lithologic unit velocities can be used to interpret data along the seismic line. The seismic section shown in figure 40 was taken from the central part of the Slocum line (line 1D, fig. 3). The multiple returns in this example of raw data are of a 12-fold CMP stacked section of the line on the eastern side of the Slocum Road profile. A travel time of 150 minutes per second is equal to a depth of 377 ft (R.D. Miller, Kansas Geological Survey, written commun., 2000). The geophone (receiver) location is critical in the interpretation of data. Seismic survey lines have vertical and limited horizontal dimensions. Elevation surveys were collected along the seismic lines to provide elevation inflection points at the linear stations (table 24). Changes in elevation inflection points provide guidance for depth determinations of the subsurface elevation of the geological formations.

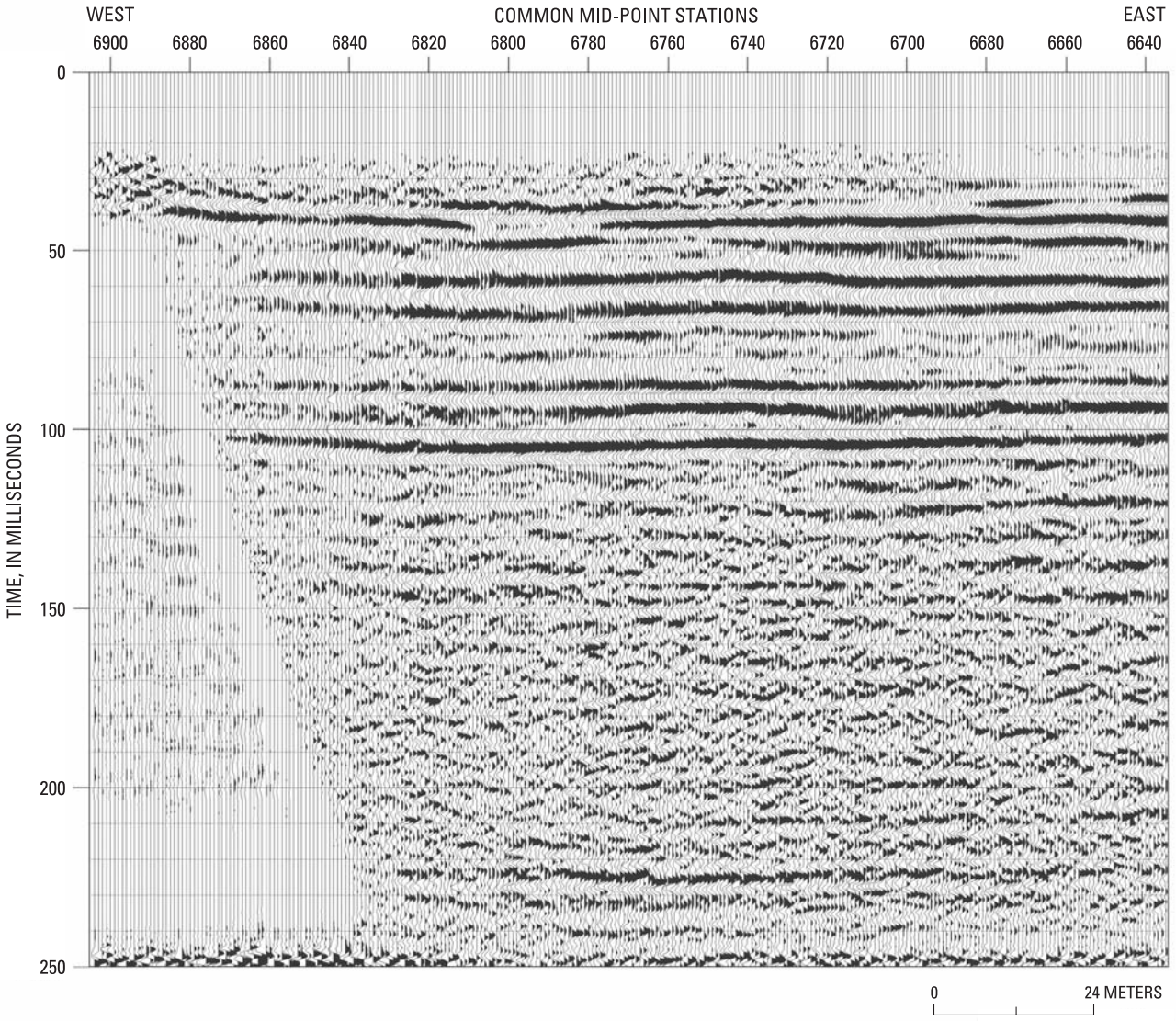


Figure 40. Section of seismic data collected along the Slocum line (line 1D, fig. 3), U.S. Marine Corps Air Station, Cherry Point, North Carolina (courtesy J. Xia, Kansas Geological Survey).

Summary

Nine stratigraphic test holes were drilled and cored at the U.S. Marine Corps Air Station, Cherry Point, North Carolina, between 1994 and 2001.The lithologic summary data and the borehole geophysical data collected from these test holes are included in this report, including the drilling and sample-collection methods. Water-level monitoring wells were installed in eight of the nine test holes, and the water-level data collected from seven of the eight wells are included in this report along with the well-construction records. Also included are the locations of the high-resolution seismic surveys conducted in conjunction with this stratigraphic investigation.

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Appendix Table 1-1. Reports of previous investigations conducted in cooperation with the U.S. Marine Corps Air Station, Cherry Point, North Carolina, 1988–2003.

[WRIR, Water-Resources Investigations Report; MCAS, Marine Corps Air Station; OFR, Open-File Report]

Year	Report title	Focus
1988	Lloyd, O.B., Jr., and Daniel, C.C., III, 1988, Hydrogeologic setting, water levels, and quality of water from supply wells at the U.S. Marine Corps Air Station, Cherry Point, North Carolina: U.S. Geological Survey WRIR 88-4034, 76 p.	Analysis of water-quality and water-level data from supply wells at the MCAS.
	Lloyd, O.B., Jr., and Daniel, C.C., III, 1988, Distribution, source, and significance of selected organic compounds in water from the Castle Hayne aquifer, Cherry Point, North Carolina, *in* Lyke, W.L., and Hoban, T.J., 1988, Proceedings of the AWRA Symposium on Coastal Water Resources, Wilmington, N.C., May 22–25, 1988: Bethesda, Md., American Water Resources Association, p. 519–530.	Water quality in the Coastal Plain aquifer.
1990	Murray, L.C., Jr., and Daniel, C.C., III, 1990, Hydrogeologic and water-quality data from well clusters near the wastewater-treatment plant, U.S. Marine Corps Air Station, Cherry Point, North Carolina: U.S. Geological Survey OFR 89-615, 56 p.	Localized water quality in areas near the wastewater-treatment plant at the MCAS.
	Murray, L.C., Jr., and Keoughan, K.M., 1990, Hydrogeologic, water-level, and water-quality data from monitoring wells at the U.S. Marine Corps Air Station, Cherry Point, North Carolina: U.S. Geological Survey WRIR 89-4200, 86 p.	Analysis of ground-water-quality and water-level data at the MCAS.
1994	Eimers, J.L., Daniel, C.C., III, and Coble, R.W., 1994, Hydrogeology and simulation of ground-water flow at U.S. Marine Corps Air Station, Cherry Point, North Carolina, 1987–90: U.S. Geological Survey WRIR 94-4186, 75 p.	Ground-water flow model based on available data.
1996	Daniel, C.C., III, Miller, R.D., and Wrege, B.M., 1996, Application of geophysical methods to the delineation of paleochannels and missing confining units above the Castle Hayne aquifer at U.S. Marine Corps Air Station, Cherry Point, North Carolina: U.S. Geological Survey WRIR 95-4252, 106 p.	Summary of stratigraphic data from four test holes and 16 seismic lines for paleochannel delineation.
	Miller, R.C., and Xia, Jianghai, 1999, High resolution seismic surveys at U.S. Marine Corps Air Station, Cherry Point, North Carolina: Lawrence, Kansas Geological Survey OFR 96-4, 16 p.	Descriptions of seismic surveys conducted in 1994–95.
1999	Cardinell, A.P., 1999, Application of continuous seismic-reflection techniques to delineate paleochannels beneath the Neuse River at U.S. Marine Corps Air Station, Cherry Point, North Carolina: U.S. Geological Survey WRIR 99-4099, 29 p.	Analysis of marine seismic data to delineate paleochannels beneath the Neuse River.
2001	Wrege, B.M., 2001, Paleochannel definition at Cherry Point marine Corps Air Station, North Carolina [poster]: Charleston, S.C., USGS/DoD Environmental Conservation Program, May 1–4, 2001.	Lateral distribution of paleochannels beneath the MCAS.
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