



New Jersey Geological Survey
Open-File Report 11-1



**EXPANSION OF MONITORING WELL NETWORK
IN CONFINED AQUIFERS OF THE
NEW JERSEY COASTAL PLAIN, 1996-1997**



New Jersey Department of Environmental Protection
Water Resources Management

STATE OF NEW JERSEY

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NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

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Cover illustration: Great Bay monitoring well (well permit no. 36-20855), along Great Bay Boulevard, Little Egg Harbor Township, Ocean County, NJ, 4.9 miles south of Tuckerton Borough. This was the second of seven wells drilled during 1996-1997, for the statewide monitoring-well network.

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**Expansion of Monitoring Well Network
in Confined Aquifers of the
New Jersey Coastal Plain, 1996-1997**

by

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CONTENTS

Abstract	1
Introduction.....	1
Acknowledgments.....	1
Well construction	2
Water quality results.....	5
References.....	7

Well Data

Well 1	
Site details	8
Sample description	8
Geologic and hydrogeologic units	9
Elevation and thickness of hydrogeologic units.....	9
Well 2	
Site details	13
Sample descriptions	13
Driller's log	15
Geologic and hydrogeologic units	15
Elevation and thickness of hydrogeologic units.....	15
Wells 3 and 4	
Well 3 site details	20
Well 4 site details	20
Sample descriptions (composite log for wells 3 and 4)	20
Driller's log (composite log for wells 3 and 4)	22
Geologic and hydrogeologic units	23
Elevation and thickness of hydrogeologic units.....	23
Analysis of cuttings and split-spoon cores.....	24
Wells 5 and 6	
Well 5 site details	32
Well 6 site details	32
Sample descriptions (composite log for wells 5 and 6)	32
Geologic and hydrogeologic units	35
Elevation and thickness of hydrogeologic units.....	35
Strontium isotope age estimates.....	35
Well 7	
Site details	42
Sample descriptions	42
Driller's log	45
Geologic and hydrogeologic units	46
Elevation and thickness of hydrogeologic units.....	46
Analysis of cuttings and split-spoon cores	47

FIGURES

1. Map showing location of deep monitoring wells drilled in the New Jersey Coastal Plain, 1996-97	3
2. Well 1 monitoring well permit	10
3. Well 1 monitoring well record	11
4. Well 1 geophysical logs	12
5. Well 2 monitoring well permit	16
6. Well 2 monitoring well record	17
7. Well 2 geophysical logs	18
8. Well 3 monitoring well permit	26
9. Well 3 monitoring well record	27
10. Well 4 monitoring well permit	28
11. Well 4 monitoring well record	29
12. Wells 3 and 4 geophysical logs	30
13. Well 5 monitoring well permit	36
14. Well 5 monitoring well record	37
15. Well 6 monitoring well permit	38
16. Well 6 monitoring well record	39
17. Wells 5 and 6 geophysical logs	40
18. Well 7 monitoring well permit	49
19a. Well 7 monitoring well record.....	50
19b. Well 7 monitoring well record	51
20. Well 7 geophysical logs	52

TABLES

1. Geologic and hydrogeologic units of the New Jersey Coastal Plain	4
2. Records of new monitoring wells in confined aquifer of the New Jersey Coastal Plain (1996-1997)	5
3. Preliminary data on quality of water from monitoring wells.....	6

Expansion of Monitoring Well Network in Confined Aquifers of the New Jersey Coastal Plain, 1996-1997

ABSTRACT

State regulations implemented in 1986 establishing Water-Supply Critical Areas 1 and 2 in the New Jersey Coastal Plain have restricted water-supply options for many southern New Jersey communities. These restrictions and the growth patterns in the Coastal Plain have forced the need to seek additional and alternative water supplies.

The 1991 Update to the State Water Supply Master Plan describes the need for additional observation wells to better understand ground-water resources and the extent of saltwater intrusion in important confined aquifers of the New Jersey Coastal Plain. The New Jersey Geological Survey (NJGS), in cooperation with the U.S. Geological Survey (USGS), identified sites from which the most information could be gained from the placement of new monitoring wells. A contract was prepared by the NJGS, and 7 wells were drilled at 5 locations (1996-1997), from which valuable information about Coastal Plain hydrostratigraphy and water quality was obtained. The sites selected and aquifers drilled into were: Sandy Hook, Monmouth County (Englishtown aquifer system); Great Bay Boulevard Wildlife Management Area, Ocean County (Piney Point aquifer); two wells at the New Lisbon Developmental Center, Burlington County (Magothy Formation (upper aquifer Potomac-Raritan-Magothy aquifer system (upper PRM)) and (Englishtown aquifer system)); two wells at Parvin State Park, Salem County (upper PRM) and (Wenonah-Mount Laurel aquifer); Coyle Field, Burlington County (upper PRM).

Information from these wells is providing important new links for the statewide monitoring-well network, by supplying valuable hydrostratigraphic, water-supply planning and water-quality information.

INTRODUCTION

State regulations implemented in 1986 establishing Water-Supply Critical Areas 1 and 2 in the New Jersey Coastal Plain have restricted water-supply options for many southern New Jersey communities. These regulations and growth patterns in the Coastal Plain have forced communities and private purveyors to seek additional and alternate water supplies, inside and outside of the Critical Areas, and to seek increases from other aquifers (table 1). Impacts on regional potentiometric levels and the potential for increased saltwater intrusion in less developed parts of the confined Coastal Plain aquifers needed addressing.

Ground water withdrawal restrictions in Critical Area 1 extended to the Potomac-Raritan-Magothy aquifer system (PRM), Englishtown aquifer system and the Wenonah-Mount Laurel aquifer. Restrictions in Critical Area 2 extended to the PRM only.

The 1991 Update to the State Water Supply Master Plan describes the need for additional monitoring wells to better understand ground-water resources and the extent of saltwater intrusion in important confined aquifers of the New Jersey Coastal Plain (Further investigations of confined Coastal Plain aquifers (Items 9 and 17)). This information is required to assess the potential for additional ground-water supplies, and evaluate the impact of new ground-water diversions from: (a) major aquifers outside Water Supply Critical Areas 1 and 2, and (b) aquifers

that are currently underutilized or poorly defined. To address these ground-water concerns, funding was provided under an appropriation from the 1981 Water Resources Bond Issue (P.L. 1991, chapter 348, A-5009).

The New Jersey Geological Survey (NJGS), in cooperation with the U.S. Geological Survey (USGS), identified sites from which optimal information might be gained from the new monitoring wells (fig. 1). Contract specifications for new monitoring wells were written by the NJGS and submitted for public bid through the N.J. Department of Treasury. A contract to drill seven monitoring wells was subsequently awarded in November 1996 to A.C. Schultes, Inc. The New Jersey Department of Environment Protection (NJDEP) contract no. A-77874 called for the wells to be drilled at five sites in the New Jersey Coastal Plain.

Acknowledgments

Thanks are due to Stephen Pekar formerly of Rutgers University, for helping to identify formation contacts for the Great Bay Boulevard observation well. The work of James V. Browning at Rutgers University in helping to pick formation contacts for the observation wells at the New Lisbon Development Center, and the Coyle Field observation well, is also appreciated. Browning's work in analyzing the cuttings and split-spoon cores from the Coyle Field well is also acknowledged.

WELL CONSTRUCTION

Drilling began in December 1996, with construction of Well 1 (fig. 1) at the Gateway National Recreation Area, at Sandy Hook, Sea Bright Borough, Monmouth County. The well, drilled to a depth of 307 feet, was screened in the Englishtown aquifer system. This well is on the northeastern edge of Critical Area 1 and provides water-level and water-quality information on an aquifer of importance to many Monmouth County communities to the south and west. Preliminary sampling and analysis indicated chloride concentrations of 16,000 mg/liter, much higher than anticipated. Among the closest users of this aquifer is the Rumson Country Club, situated 4 miles to the southwest in Rumson Borough, and Bell Labs, 9 miles to the west, in Holmdel Twp., Monmouth County.

Well 2 (fig. 1) was drilled on NJDEP, Division of Fish, Game and Wildlife property, at the old fish factory boat landing along Great Bay Boulevard, in the Great Bay Boulevard Wildlife Management Area, Little Egg Harbor Township, Ocean County. The well was drilled to a depth of 1,012 feet, and screened in the Piney Point aquifer. This well, located south of Critical Area 1, is screened in an aquifer not currently under supply restrictions, but supplying increased demand to the north, in east central Ocean County. Increasing development in this coastal Ocean County area makes this a potential alternative water-supply option. Since the 1988 drilling of a USGS observation well 16 miles to the south in Margate City, Atlantic County, water from the Piney Point aquifer has had elevated chloride concentrations above 250 mg/liter, at least at this location. Buena Borough, located 27 miles away, in the westernmost part of Atlantic County is the only community in the county tapping this aquifer for water. The closest public-supply wells tapping the Piney Point aquifer are to the north. These include wells 19 miles away, in Barnegat Light Borough, and 28 miles away, in the Bayville section of Berkeley Township. Information from Well 2 will be critical to future planning and decision making concerning the Piney Point aquifer's potential for sustainable development as a water-supply resource in east-central and southern Ocean and Atlantic Counties, where the aquifer is present.

Wells 3 and 4 (fig. 1) are at the New Lisbon Developmental Center, NJ Department of Human Services property, in Woodland Township, Burlington County. Well 3 was drilled to a depth of 935 feet, and screened in the Englishtown aquifer system. Well 4 was drilled to a depth of 1,049 feet and screened in the Magothy Formation (upper aquifer Potomac-Raritan-Magothy aquifer system (upper PRM)). These wells, in the northeastern part of

Critical Area 2, are downdip from pumping centers tapping these aquifers. Among these pumping centers are those 6 miles to the north, in the Browns Mills section of Pemberton Township, which draw water from both the upper PRM and Englishtown aquifer system. Wells pumping water from the upper PRM are also located 12 miles to the northwest, in Mount Holly Township, and 13 miles to the west, in Medford Township and Medford Lakes Borough, Burlington County. Medford Township also draws some water from the Englishtown aquifer system. Monitoring Wells 3 and 4 provide an early warning of any water-quality degradation resulting from pumpage in this rapidly growing part of Critical Area 2. Observation wells at New Lisbon also permit a better understanding of the extent of recovery, or slowdown in the decline of water level, resulting from the NJDEP-imposed reductions in permitted pumpage from the PRM within Critical Area 2.

Drilling next took place at Parvin State Park, Pittsgrove Township, Salem County, where Wells 5 and 6 (fig. 1) were constructed. Well 5 was drilled to a depth of 756 feet and screened in the marginally productive Wenonah-Mount Laurel aquifer. Well 6 was drilled to a depth of 1,137 feet and screened in the Magothy Formation (upper PRM). This site, just beyond the southern boundary of Critical Area 2, is downdip (southeast) from the pumping centers for these aquifers, to the north and northwest in Gloucester and Salem Counties. Preliminary water sampling and analysis indicates elevated chloride levels of 3,200 mg/liter in water from the Magothy Formation (upper PRM). Monitoring over time may provide important information concerning the stability and movement of saltwater fronts in these aquifers toward existing pumping centers. Nearby pumping centers for the upper PRM include those 10 miles to the north in Clayton Borough and Glassboro Borough, Gloucester County, and 18 miles to the northwest, in Oldmans Township, Salem County. The closest pumping centers for the Wenonah-Mount Laurel aquifer are 8 miles to the northwest, in Alloway Township and 6 miles to the north, in Elmer Borough, both in Salem County.

Lastly, Well 7 (fig. 1) completed July 15, 1997, was constructed on NJ Division of Parks and Forestry, State Forest Fire Service property, at Coyle Field, Woodland Township, Burlington County. It was drilled to a depth of 1,779 feet, and screened in the Magothy Formation (upper PRM). This site, along Route 72, about 1 mile west on the Burlington-Ocean County boundary, is on the easternmost edge of Critical Area 2, and 19 miles southwest

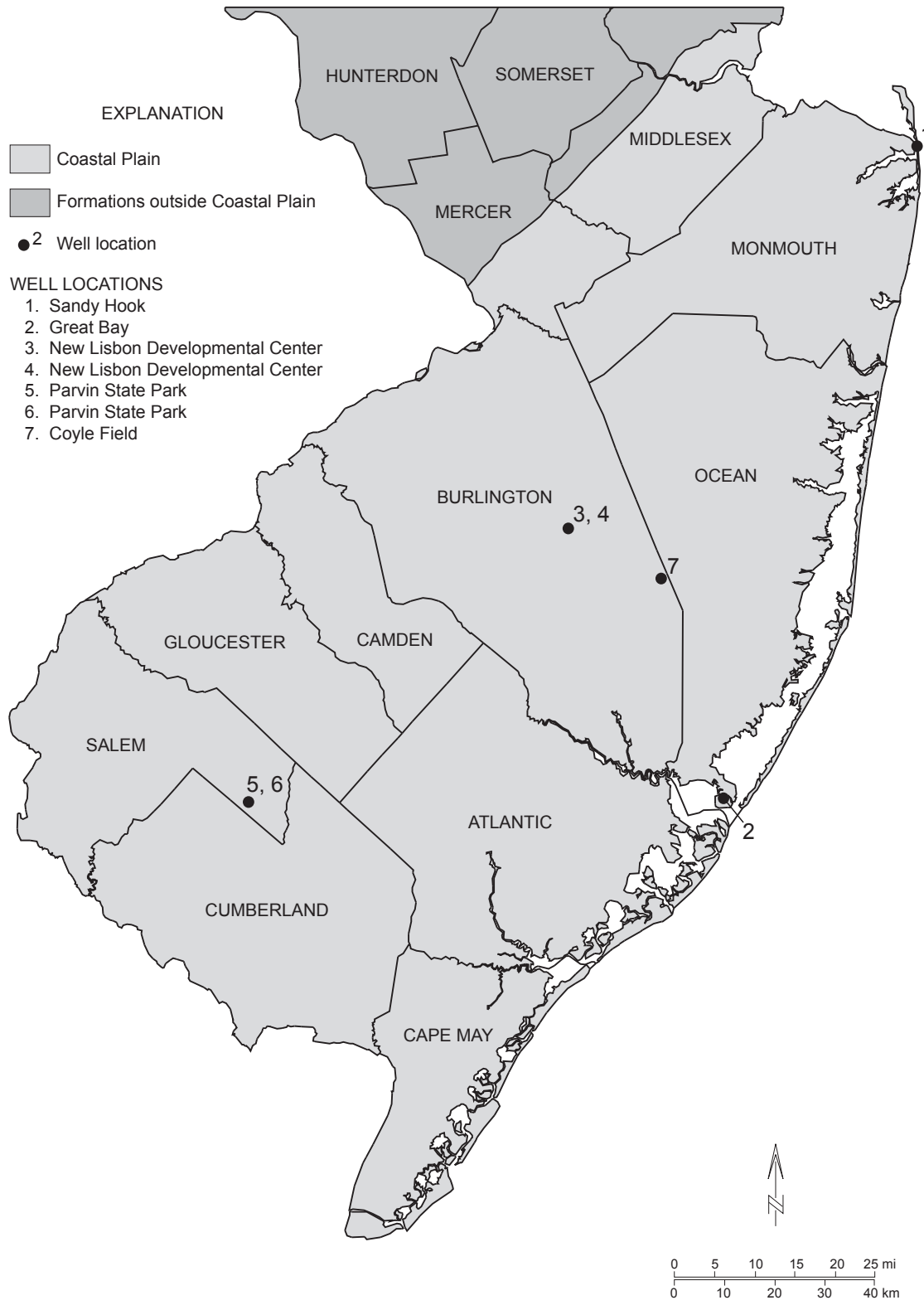


Figure 1. Map showing location of deep monitoring wells drilled in the New Jersey Coastal Plain, 1996-1997.

Table 1. Geologic and hydrogeologic units of the New Jersey Coastal Plain. (Modified from Zapezca,1989)

SYSTEM	SERIES	GEOLOGIC UNIT	LITHOLOGY	HYDROGEOLOGIC UNIT	HYDROGEOLOGIC CHARACTERISTICS			
QUATERNARY	Holocene	Alluvial and wetland deposits	Sand; silt; black mud and peat	Undifferentiated	Surficial material commonly hydraulically connected to underlying aquifers. Locally some units may act as confining units. Thicker sands are capable of yielding large quantities of water. May be included in Kirkwood-Cohansey aquifer system.			
		Beach Sand and gravel	Sand, medium to coarse, light-colored, quartzose, pebbly					
	Pleistocene	Cape May Formation	Sand, fine to coarse, light-colored, quartzose, local clay and silt beds, quartz pebble gravel					
TERTIARY	NEOGENE	Pliocene?¹	Pensauken Fm.	Sand, fine to coarse, arkosic, reddish yellow; quartz-pebble gravel	Kirkwood-Cohansey aquifer system	Ground water generally under water-table conditions. In southern Cape May County, the Cohansey is underconfined conditions.		
		Upper Miocene	Bridgeton Fm.	Sand, fine to coarse, arkosic, clayey, reddish yellow; quartz-pebble gravel				
	Beacon Hill gravel		Pebble gravel, quartz and chert; reddish yellow clayey sand					
	Middle Miocene	KIRKWOOD FORMATION	Cohansey Formation	Sand, medium to coarse, light-colored, quartz, pebbly; local clay beds	Wildwood- Belleplain confining unit	Thick diatomaceous clay unit occurs along coast, thinning inland to the west and north. A thin water-bearing sand occurs within the middle of this unit.		
			Belleplain Member²	Clay or silty clay, dark-gray, massive, diatomaceous; overlain by sand, fine to coarse, quartzose; micaceous				
			Wildwood Member²	Clay-silt, dark-gray, inter-bedded, very diatomaceous; overlain by sand, fine to coarse, quartzose; micaceous				
	Lower Miocene	KIRKWOOD FORMATION	Shiloh Marl Member²	Interbedded sand and clay, dark-gray, diatomaceous; overlain by sand, medium to coarse, medium-gray to pale-brown, massive; micaceous	Atlantic City 800-foot sand	upper sand	A major aquifer along the coast, found from Long Beach Island south, and in a southwest direction from the coast.	
			lower member	Clay, dark-gray, massive to finely laminated, diatomaceous; overlain by sand, coarse to very coarse, quartzose; micaceous		confining unit		
	PALEOGENE	Upper Oligocene	Atlantic City Formation²	Sand, medium to coarse, glauconitic, quartzose; clay-silt	Composite confining unit	lower sand	Poorly permeable sediments.	
		Lower Oligocene	Sewell Point Formation²	Sand, fine, quartzose, glauconitic; clayey; micaceous; woody		Piney Point aquifer	upper sand	Yields poor to moderate amounts of water locally.
		Upper Eocene	Absecon Inlet Formation²	Clay, blue- to pale-green, massive; clay-silt; sand			confining unit	
		Middle Eocene	Shark River Formation	Clayey sand, glauconitic; silty clay; silty sand, quartzose		lower sand	Poorly permeable sediments	
Lower Eocene		Manasquan Formation	Clay, green, gray and brown, silty and sandy; glauconitic; fine quartz sand	Vincetown aquifer			Yields small to moderate quantities of water in and near its outcrop area.	
Upper Paleocene		Vincetown Formation	Sand, fine to coarse, gray and green, calcareous, quartzose, glauconitic; clayey, brown; very fossiliferous; glauconite and quartz calcarenite					
Lower Paleocene		Hornerstown Formation	Sand, fine to coarse, dark green, clayey, glauconitic				Poorly permeable sediments	
CRETACEOUS		Upper Cretaceous	Tinton Formation	Sand, fine to coarse, brown and gray, quartzose, glauconitic, clayey, micaceous		Red Bank sand		Yields small quantities of water in and near outcrop area.
	Red Bank Formation							
	Navesink Formation		Kc4² Sand, medium to coarse, green and black, clayey, silty, glauconitic	Poorly permeable sediments.				
	Mount Laurel Sand			Wenonah-Mount Laurel aquifer		A major aquifer.		
	Wenonah Formation		Kc3² Sand, very fine to fine, gray and brown, silty, slightly glauconitic					
	Marshalltown Formation			Marshalltown-Wenonah confining unit		A leaky confining unit.		
	-----		Kc2² Clay-silt, dark-gray, sandy, lignitic; overlain by sand, fine, quartz-glauconite, light-color					
	Englishtown Formation			Englishtown aquifer system	upper sand	A major aquifer, containing two sand units in Monmouth and Ocean Counties.		
	Woodbury Clay		Kc1² Clay, gray and black; micaceous silt		confining unit			
	Merchantville Formation		Clay, gray and black, glauconitic, micaceous; locally very fine quartzose and glauconite sand		lower sand			
	Cheesequake Formation²			Merchantville-Woodbury confining bed		A major confining unit.		
			Clayey silt, dark-gray, micaceous, thick-bedded; sand, very fine, quartz, some glauconitic sand					
	Magothy Formation			Potomac-Raritan-Magothy aquifer system	upper aquifer	A major aquifer system. In the northern coastal plain, the upper aquifer is equivalent to the Old Bridge aquifer, and the middle aquifer is the equivalent of the Farrington aquifer. In the Delaware River Valley, three aquifers are recognized. In the deeper subsurface, units below the upper aquifer are undifferentiated.		
	Sand, fine to coarse, light-gray, quartzose; local beds of dark-gray, lignitic clay	confining unit						
Raritan Formation		middle aquifer						
			confining unit					
			lower aquifer					
Lower Cretaceous	Potomac Group							
Pre-Cretaceous	Bedrock			Bedrock confining unit	No wells known to obtain water from these rocks except along Fall Line.			
					Locally: Jurassic diabase, Triassic sandstone and shale, schist and gneiss			

¹Surficial Geology of New Jersey CD 06-1

²Formations and subsurface cycles (Owens and others, 1998)

of Critical Area 1. As demand increases in rapidly growing southern Ocean County, and in the southeastern half of Atlantic County, the Magothy Formation (upper PRM) becomes an increasingly important potential source of water. Water-quality information from this well will be vital to addressing future planning questions. Well 7 was subsequently deepened, and additional split-spoon cores collected. This additional work provided a better understanding of the deeper parts of the PRM, which may also provide future developmental opportunities. The closest

upper PRM pumping centers to Well 7 are 18 miles to the northwest in Southampton Township and Pemberton Township, Burlington County, and 17 to 22 miles to the northeast, in Manchester Township, Lakehurst Borough, Dover Township and Seaside Heights Borough, Ocean County.

Upon completion of well construction, the location and site elevation for each well was surveyed (table 2).

TABLE 2: RECORDS OF NEW MONITORING WELLS IN CONFINED AQUIFERS IN THE NEW JERSEY COASTAL PLAIN (1996-1997)

Well no.	Site name and permit number	Elevation ¹ top of casing (feet)	Elevation ¹ land surface (feet)	Screen Interval (feet below land surface)	Aquifer screened	Latitude ²	Longitude ²	Potentiometric level depth (feet below land surface) & date of water sampling
1	Sandy Hook 29-36217	12.8	8.4	258-278	Englishtown aquifer system	40° 23' 51.976"	73° 58' 37.562"	9.05 5/28/97
2	Great Bay 36-20855	10.2	5.6	860-880	Piney Point aquifer	39° 31' 15.632"	74° 19' 10.231"	18.79 5/28/97
3	New Lisbon 1 32-21804	110.7	107.3	615-635	Englishtown aquifer system	39° 53' 08.447"	74° 35' 22.315"	92.48 5/20/97
4	New Lisbon 2 32-22005	109.2	107.0	900-920	PRM ³ (upper aquifer)	39° 53' 08.397"	74° 35' 22.031"	144.38 5/20/97
5	Parvin 1 35-17374	78.0	76.6	675-695	Wenonah-Mt. Laurel aquifer	39° 30' 55.731"	75° 08' 36.440"	55.86 7/1/97
6	Parvin 2 35-17766	80.4	77.2	1,005-1,025	PRM ³ (upper aquifer)	39° 30' 56.302"	75° 08' 35.838"	129.34 6/11/97
7	Coyle Field 32-21805	190.5	186.8	1,420-1,440	PRM ³ (upper aquifer)	39° 49' 04.175"	74° 25' 35.387"	209.91 7/17/97

¹ Elevations are based on National Geodetic Vertical Datum of 1929.

² Latitude and Longitude are based on North American Datum of 1927.

All well sites have been GPS located, and elevations leveled in.

³ PRM = Potomac-Raritan-Magothy aquifer system

WATER-QUALITY RESULTS

During the well-development phase, water samples from each of the seven monitoring wells (table 3) were field analyzed for specific conductance by the NJGS, using a Cole Parmer (Model 1484-10) Conductivity Meter. Before analysis the instrument was calibrated with standard solutions. This test determined the effectiveness and completeness of well development. Table 3 shows the results.

Ground-water samples from the monitoring wells at Sandy Hook, Great Bay, and both wells at the New Lisbon Developmental Center were collected according to the established field sampling protocols by NJDEP, Bureau of Water Monitoring. An exception was water from the Sandy Hook well, which was analyzed chiefly

for chloride and sodium. The New Jersey Department of Health Laboratory analyzed the samples for inorganics and metals. A summary of the analytical results is included in table 3.

The USGS collected ground-water samples from the Sandy Hook well and the upper PRM well at Parvin State Park. These samples were field analyzed for pH and specific conductance and were analyzed in the USGS laboratory for chloride, sodium, and specific conductance. USGS also field tested the two New Lisbon Developmental Center wells for pH and specific conductance. A summary of the analytical results is included in table 3.

Table 3: Preliminary data on quality of water from monitoring wells

Well location	Sandy Hook	Great Bay	New Lisbon 1	New Lisbon 2	Parvin 1	Parvin 2	Coyle Field	Standard
Laboratory Analytical Results								
Sample Date	10/27/97	5/6/97	4/29/97	5/1/97	9/2/98	9/2/98	NS	N/A
Alpha (pCi/L)	-48	ND	0.19	3.5	NS	NS	NS	15 ²
Nitrite Nitrogen (mg/L)	----	0.003	0.003	0.003	NS	NS	NS	1 ²
Nitrite and Nitrate Nitrogen (mg/L)	----	0.16	0.04	0.02	NS	----	NS	10 ²
Amonia Nitrogen (mg/L)	----	0.72	0.27	0.22	NS	NS	NS	----
Ortho Phosphorous (mg/L)	----	0.06	0.08	0.03	NS	----	NS	----
Total Residue (mg/L) (Filtered)	----	642	172	155	NS	----	NS	500 ¹
Total Organic Carbon (mg/L) (Filtered)	----	69	22	14	NS	----	NS	----
Chloride (mg/L)	16000 (15000) ^{USGS}	68	2	2.0	NS	(3200) ^{USGS}	NS	250 ¹
Sulfate (mg/L)	----	19.0	4.9	8.1	NS	----	NS	250 ¹
Fluoride (mg/L)	----	0.90	0.23	0.16	NS	----	NS	2 ¹
Silica (mg/L)	----	12.0	8.7	10.0	NS	----	NS	----
Alumium (ug/L)	----	8.1	20.1	25.2	NS	----	NS	200 ¹
Arsenic (ug/L)	----	1.0	1.0	1.0	NS	----	NS	50 ²
Barium (ug/L)	----	2.2	14.7	52.3	NS	----	NS	2000 ²
Calcium (mg/L)	----	5.8	7.4	14.0	NS	----	NS	----
Cadmium (ug/L)	----	1.0	1.0	1.0	NS	----	NS	5 ²
Chromium (ug/L)	----	1.0	1.0	1.0	NS	----	NS	100 ²
Copper (ug/L)	----	1.0	1.3	1.0	NS	----	NS	1300 ²
Iron (ug/L)	----	320	686	513.0	NS	----	NS	300 ¹
Lead (ug/L)	----	1.0	1.0	1.5	NS	----	NS	15 ²
Potassium (mg/L)	----	7.7	8.0	7.7	NS	----	NS	----
Sodium (mg/L)	8370 (8020) ^{USGS}	160	46.5	20.9	NS	(1880) ^{USGS}	NS	50 ¹
Strontium (ug/L)	----	96.7	143	401.5	NS	----	NS	----
Zinc (ug/L)	----	2.0	20.2	5.0	NS	----	NS	5000 ¹
Phenols (ug/L)	50	50	6	50	NS	----	NS	1 ²
Specific Conductance (umhos/cm)	36800	----	----	----	----	9630	----	----
Field Screening Results								
Screening Date	12/18/96	1/27/97	3/14/97	3/18/97	6/4/97	6/13/97	6/30/97	----
Specific Conductance (umhos/cm)	13,250 (42,200) ^{USGS} (7/29/97)	875	240; 243 ^{USGS}	200; 208 ^{USGS}	3,250	9,400; 10,200 ^{USGS} (9/2/98)	300	----
pH	7.0	----	8.73 ^{USGS}	8.16 ^{USGS}	----	7.5	----	6.5-8.5 ¹
Remarks/ Preliminary Characterization	clear, salty like Atlantic Ocean	clear, some initial sand, fresh	clear fresh but mineralized	clear probably potable	Probably salty and not potable	Probably salty and not potable	almost clear, probably potable	----

1 New Jersey Secondary Drinking Water-Secondary Maximum Contaminant Levels

2 Maximum Contaminant Levels

N/A, not applicable

NS, well was not sampled to date.

Alpha, (TTL) laboratory noted minimum detection limit of 3 picocuries per liter has been exceeded. Result is questionable and unreliable.

USGS, United States Geological Survey sampled the Sandy Hook Well on July 29, 1997 and the Parvin 1 Well (Mount Laurel Aquifer) on September 2, 1998.

PROJECT CONCLUSION

The seven wells, maintained jointly by the NJDEP and the U.S. Geological Survey-Water Resources Division (USGS-WRD), West Trenton, NJ, are supplying valuable hydrostratigraphic, water supply planning and water-quality information. They are important new links in the statewide monitoring well network.

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**Well 1
Sandy Hook Site Details**

U.S. Department of Interior, National Park Service, Gateway National Recreation Area. Between park entrance tollgate and Route 36 Bridge, Sea Bright Borough, Monmouth County, NJ.
 Location: 40° 23' 51.976" N 73° 58' 37.562" W
 Elevation (land surface): 8.4 feet
 Elevation (top of casing): 12.8 feet
 Well permit no.: 29-36217
 Atlas Sheet Coordinate no.: 29.04.831
 Depth drilled (below land surface): 307 feet
 Aquifer screened: Englishtown aquifer system
 Formation screened: Englishtown Formation
 Screen interval: 258-278 feet below land surface, with 0.020 inch, 304-stainless steel
 Casing: 4-inch black steel, extending to 3 feet above land surface, with no tail piece below screen
 Gravel pack: Morie grade no. 1 well gravel
 Drillers: Dennis Gaughan and Thomas Callahan, A.C. Schultes, Inc.
 Drilling method: Mud rotary
 Sampling method: 24-inch split spoon
 Sample log: Lloyd G. Mullikin, NJGS
 Borehole geophysically logged: 12/13/96, by John Curran, NJGS; witnessed by Lloyd Mullikin, NJGS
 Well development: 12/18/96, witnessed by Richard Shim Chim and Steven Johnson, NJGS
 Date well completed: 12/18/96

**Well 1
Sandy Hook Sample Descriptions¹**

Depth (feet)	Recovery (feet)	Lithology
16-18	0.30	Gravel and sand, equal amounts, quartz, some iron-stained; gravel, 0.5 to 1.0 cm, white (2.5Y 8/2) to iron-stained light-olive-brown (2.5Y 5/4); sand, coarse to medium; less than 5 percent glauconite; trace lignite
31	--	Top of clay, black (5Y 2.5/2)
45-47	0.90	Clay, olive-gray (5Y 3/2), hard, uniform; sand, medium to coarse, glauconitic
55-57	0.80	Same as 45-47- foot interval
75-77	0.60	Clay, olive-gray (5Y 4/2), softer than last interval, uniform; increasing sand, 10 percent, medium to coarse, quartz and glauconite in equal amounts, salt-and-pepper appearance; mica, medium to fine
85	--	Change in drilling noted, which may indicate increasing sand content.
95-97	0.50	Clayey sand, dark-greenish-gray (5GY 4/1); sand, coarse to medium, quartz and glauconite; trace mica, fine; mostly clay in bottom 0.1 foot
115-117	1.20	Clay, black (5Y 2.5/1), hard, uniform; sand, medium to fine, quartz, much less glauconitic; some mica
127	Ditch sample	Lignite
135-137	Ditch sample	Shell fragments, lignite, clay and sand
155-157	0.90	Clay, black (5Y 2.5/1), firm, uniform; some interbedded sand, medium to fine, dark-gray (5Y 4/1), quartz, in bottom 0.2 foot; some shell fragments, greater than 2 mm thick, 0.2 to 0.4 foot from top
175-177	0.50	Sand, coarse to medium, dark-gray (5Y 3/1), quartz; some lignite; sandy clay, very dark-gray (5Y 3/1), top 0.1 foot
195-197	--	No sample, due to equipment problem
215-217	--	No sample, due to equipment problem
225-227	0.50	Sand, medium to fine, gray (2.5Y N5/6), uniform, clean; heavy minerals, fine, black, less than 5 percent
245-247	0.75	Same as last interval
265-267	0.80	Sand, similar to last interval, increasing coarse; clay, very dark-gray (5Y 3/1), sandy, malleable, in bottom 0.1 foot
285-287	1.30	Sand, fine, very dark-gray (5Y 3/1), with interbedded lignite, top 0.6 foot; sand, very fine to silty, micaceous, bottom 0.7 foot
305	--	Change in drilling noted, which may indicate increasing clay content
305-307	2.00	Silty clay, very dark-gray (5Y 3/1), uniform, malleable; no mica or lignite noted

¹ Color designations based on Munsell soil color charts (Munsell Color Co., 1975)

Well 1
Geologic and Hydrogeologic Units
Elevation (land surface): 8.4 feet

Depth below sea level ¹ (ft)	Formation	Age
	Beach deposits	Holocene
-23	Red Bank Formation, Shrewsbury Member	Upper Cretaceous
----	Navesink Formation	Upper Cretaceous
-55	Mount Laurel Formation	Upper Cretaceous
-95?	Wenonah Formation	Upper Cretaceous
----	Marshalltown Formation	Upper Cretaceous
-121	Englishtown Formation	Upper Cretaceous
-295	Woodbury Formation	Upper Cretaceous

¹Datum is National Geodetic Vertical Datum of 1929
Contacts of geologic units by Peter Sugarman, NJGS

Well 1
Elevation and Thickness of Hydrogeologic Units

Depth below sea level (feet)		Thickness (feet)	Hydrogeologic Unit
Top	Bottom		
-69	-96	27	Wenonah-Mount Laurel aquifer
-124	-218	94	Englishtown aquifer system

DWR-133M (7/92) SERIAL # 38537

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION AND ENERGY
TRENTON, NJ

Permit No. 2936217

Mail to
Water Allocation
CN 029
Trenton, N.J. 08625

MONITORING WELL PERMIT 43

VALID ONLY AFTER APPROVAL BY THE D.E.P.E.

COORD #: 29.04.831

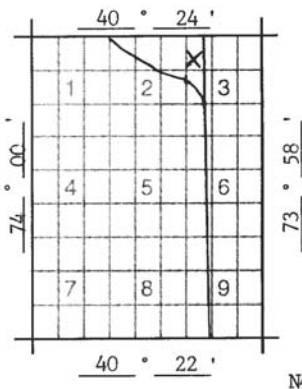
Owner <u>Charles Baerlin, Superintendent</u> <u>US Dept. of Interior-National Park Service</u>	Driller <u>A.C. Schultes, Inc.</u>
Address <u>Sandy Hook Unit, P.O. Box 530</u> <u>Fort Hancock, NJ 07732</u>	Address <u>664 S. Evergreen Ave.</u> <u>Woodbury, NJ 08096</u>
Name of Facility <u>Gateway National Rec. Area</u>	
Address <u>Sandy Hook Unit</u> <u>P.O. Box 530, Fort Hancock, NJ 07732</u>	

Diameter of Well(s) <u>4</u> inches	Proposed Depth of Well(s) <u>400</u> Feet
# of Wells Applied for (max. 10) <u>1</u>	Will pumping equipment be installed? YES <input type="checkbox"/> NO <input checked="" type="checkbox"/>
Type of Well (see reverse) <u>Monitoring/OBS</u>	If Yes, give pump capacity <u> </u> GPM

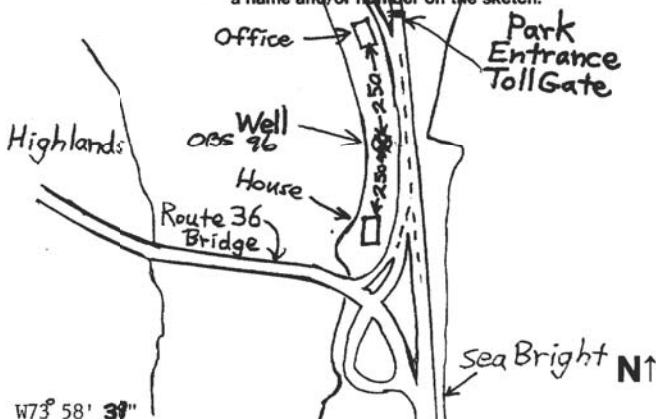
LOCATION OF WELL(S)

Lot #	Block #	Municipality	County
None	None	Sea Bright Boro	Morrmouth

Federal Property
State Atlas Map No. 29



Draw sketch of well(s) nearest roads, buildings, etc. with marked distances in feet. Each well MUST be labeled with a name and/or number on the sketch.

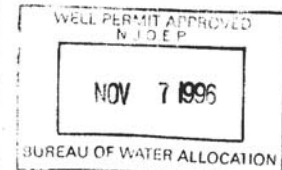


FOR MONITORING WELLS, RECOVERY WELLS, OR PIEZOMETERS, THE FOLLOWING MUST BE COMPLETED BY THE APPLICANT. PLEASE INDICATE WHY THE WELLS ARE BEING INSTALLED:

- Spill Fund Case
- ECRA Case
- CERCLA (Superfund) Site
- RCRA Site
- Underground Storage Tank
- NJPDES Municipal Discharge Permit
- NJPDES Industrial Discharge Permit
- Water and Hazardous Waste Enforcement Case
- Water Supply Aquifer Test Observation Well
- Other (explain) _____

Case I.D. Number _____

This Space for Approval Stamp



FOR D.E.P.E. USE

- Issuance of this permit is subject to the conditions attached. (see next page)
- For monitoring purposes only
- The well(s) may not be completed with more than 25 feet of total screen or uncased borehole.

SEE REVERSE SIDE FOR IMPORTANT PROVISIONS AND REGULATIONS PERTAINING TO THIS PERMIT.

In compliance with N.J.S.A. 58:4A-14, application is made for a permit to drill a well as described above.

Date 9-18-96
Job # 25069

Signature of Driller [Signature] License # M-1152
Signature of Owner [Signature]

COPIES: Water Allocation — White and Pink Health Dept. — Yellow Owner — Blue Driller — White

WELPMT 111 0425

Figure 2. Well 1 monitoring well permit.

MONITORING WELL RECORD

Well Permit No. 29 36217
Atlas Sheet Coordinates 29 04 831

OWNER IDENTIFICATION - Owner US DEPT. OF INTERIOR NATI
SANDY HOOK UNIT, PO BOX 530
Address FORT HANCOCK State NJ
City _____ State _____ Zip Code _____

WELL LOCATION - If not the same as owner please give address. Owner's Well No. OBS-96
County MONMOUTH Municipality SEA BRIGHT BORO Lot No. NA Block No. NA
Address SANDY HOOK UNIT Date well started 12 / 05 / 96
TYPE OF WELL (as per Well Permit Categories) MONITORING Date well completed 01 / 10 / 97
Regulatory Program Requiring Well AT OBS WELL Case I.D. # _____
CONSULTING FIRM/FIELD SUPERVISOR (if applicable) _____ Tele. # _____

WELL CONSTRUCTION

Total depth drilled 300 ft.
Well finished to 278 ft.
Borehole diameter:
Top 8 in.
Bottom 8 in.

Well was finished: above grade
 flush mounted
If finished above grade, casing height (stick up) above land surface 3 ft.

Was steel protective casing installed?
 Yes No

Static water level after drilling 13 ft.
Water level was measured using M-Scope
Well was developed for 16 hours at 70 gpm
Method of development Air Lift
Was permanent pumping equipment installed? Yes No
Pump capacity N/A gpm
Pump type: _____
Drilling Method Rotary
Drilling Fluid Bentonite Type of Rig D-9 Mud
Name of Driller Tom Callahan/Dennis Gaughan
Jim Schultes
Health and Safety Plan submitted? Yes No
Level of Protection used on site (circle one) None D C B A
N.J. Registration No. M-1152
A.C. SCHULTES INC.
Name of Drilling Company _____

	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Type and Material
Inner Casing	-3'	258'	4"	Steel
Outer Casing (Not Protective Casing)	—	—	—	—
Screen (Note slot size) .20	258	278	4"	Stainless Steel
Tail Piece	—	—	—	—
Gravel Pack	238'	278'	8"	#1 Morie
Annular Seal/Grout	0	238	8"	Cement
Method of Grouting	Tremie Pipe			

GEOLOGIC LOG (Copies of other geologic logs and/or geophysical logs should be attached.)

0-31'	Gray sand
31-77'	White sand & clay
77-85'	Gray clay
85-115'	Green sand & some clay
115-135'	Black clay
135-177'	Gray-black clay & gray sand
177-287'	Gray sand, white sand & some gray clay
287-310'	Gray clay & fine sand

I certify that I have drilled the above-referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Driller's Signature [Signature] Date 02 / 04 / 97
COPIES: White - DEP Canary - Driller Pink - Owner Goldenrod - Health Dept.

Figure 3. Well 1 monitoring well record.

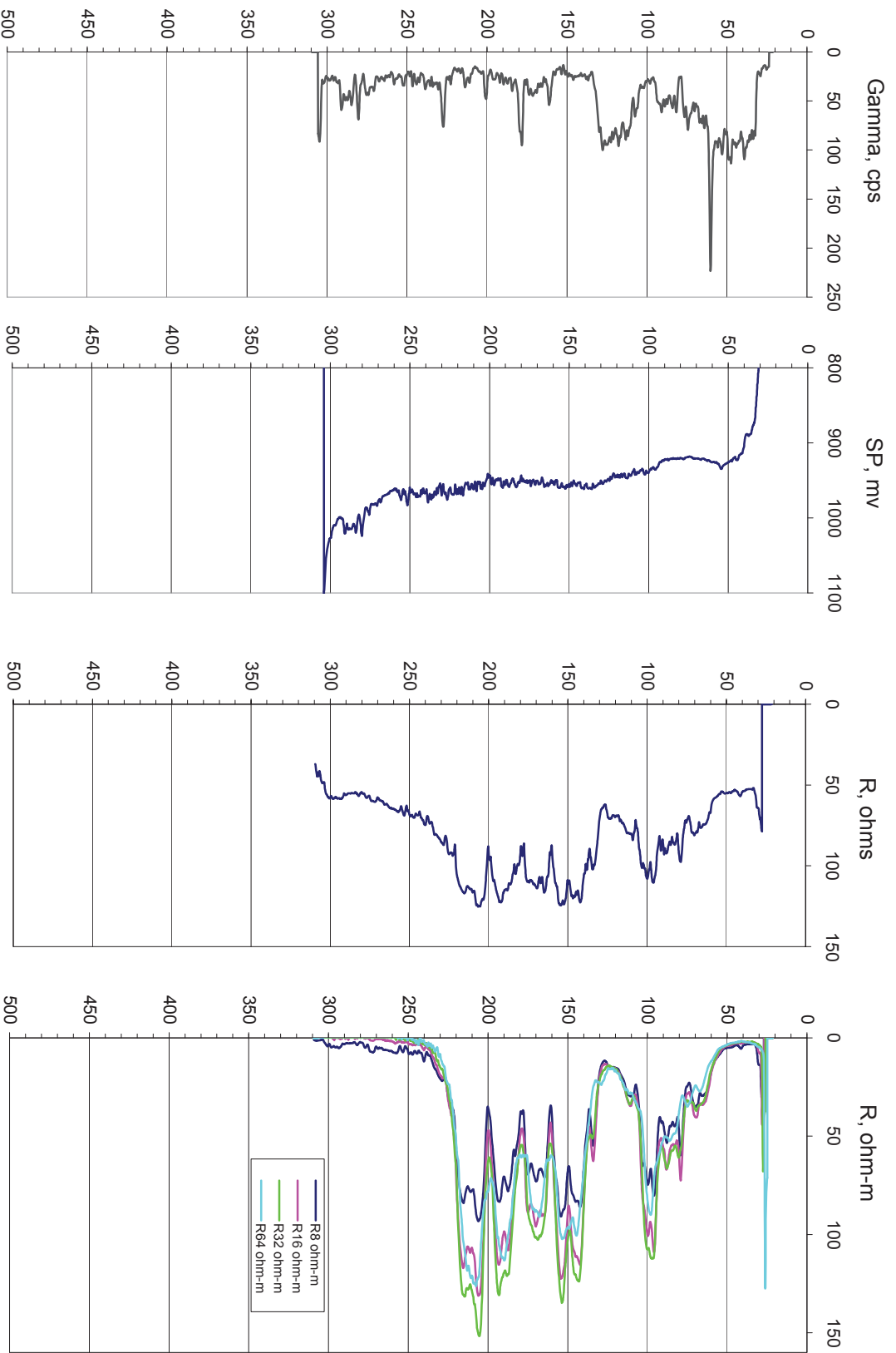


Figure 4. Well 1 geophysical logs

Well 2
Great Bay Site Details

On NJDEP, Division of Fish, Game and Wildlife, Great Bay Boulevard Wildlife Management Area property. At west side of Great Bay Boulevard, at Fish Factory boat landing, on north side of wooden bridge crossing Little Sheepshead Creek, Little Egg Harbor Township, Ocean County, NJ.

Location: 39° 31' 15.632" N 74° 19' 10.231" W

Elevation (land surface): 5.6 feet

Elevation (top of casing): 10.2 feet

Well permit no.: 36-20855

Atlas Sheet Coordinate no.: 36.05.251

Depth drilled (below land surface): 1,012 feet

Aquifer screened: Piney Point aquifer

Formation screened: Atlantic City Formation

Screen interval: 860-880 feet below land surface, with 0.020-inch, 304-stainless steel

Casing: 4-inch black steel, extending to 3 feet above land surface, with no tail piece below screen

Gravel pack: Morie grade no. 1 well gravel

Drillers: Dennis Gaughan and Thomas Callahan, A.C. Schultes, Inc.

Drilling method: Mud rotary

Borehole geophysically logged: 01/23/97, by John Curran, NJGS, witnessed by Lloyd Mullikin, NJGS

Well development: 12/18/96, witnessed by Richard Shim Chim and Steven Johnson, NJGS

Date well completed: 01/27/97

Well 2
Great Bay Sample Descriptions

Depth (feet)	Recovery (feet)	Lithology
85-105	Ditch sample	Sand and gravel; sand, very coarse to coarse, gray (5Y 5.5/1), quartz; gravel, 0.4 to 2.0 cm, over 30 percent of sample, mostly quartz, some chert, some iron-stained grains; some clay, light-gray (5Y 6/1)
105-125	Ditch sample	Sand, very coarse to coarse, olive-gray (5Y 5/2), quartz; sandy clay, light-gray (5Y 7/1) and olive-gray (5Y 5/2), soft; gravel, 0.2 to 1.3 cm, quartz, less than 5 percent of sample; shell fragments
125-127	0.40	Sand, medium to coarse, trace very coarse, olive-gray (5Y 5/2), quartz; heavy mineral, opaque, fine to medium, less than 1 percent
190	--	Borehole took much water, then washed up much coarse sand, noted by driller
245-247	0.65	Silty sandy clay, silty to fine, very dark-gray (5Y 3/1), uniform; sand, medium, olive-gray (5Y 5/2), quartz; heavy minerals, fine, less than 1 percent
265-267	0.45	Sand, fine to medium, dark-olive-gray (5Y 3/2), uniform; some mica, fine to medium; trace heavy mineral, fine
275	--	Change to clay, dark-olive-gray (5Y 3/2), drilling quieter, formation softer, noted by driller
285-287	1.65	Silty clay, dark-olive-gray (5Y 3/2), firm, uniform; trace mica, fine-very fine
325-327	2.00	Clay, dark-gray (5Y 4/1), hard, uniform
365-367	1.70	Clay, dark-gray (5Y 4/1), silty, hard, uniform
405-407	0.20	Sand, medium to coarse, olive-gray (5Y 4/2), quartz, top 0.10 foot ; clay, dark-gray (5Y 4/1), bottom 0.10 foot
405-425	--	Borehole took on an increased amount of water, noted by driller
425-427	0.20	Sand and sandy clay, interbedded; sand, medium to coarse, olive-gray (5Y 4.5/2); sandy clay, dark-gray (5Y 4/1); some mica, very fine
430	--	Change back to clay, much harder drilling, noted by driller
445-447	1.60	Clay, very dark-grayish-brown (2.5Y 3/2), hard, uniform; some silt
485-487	1.20	Clay, dark-grayish-brown (2.5Y 4/2), hard, uniform; some silt
525-527	1.30	Clay, very dark-grayish-brown (2.5Y 3/2), hard, dry, uniform; some sand, fine, quartz; shell fragments; a very thin shelled pelecypod fragment, 3 cm across, 0.30 foot from top
555	--	Change to sand, noted by driller
565-567	0.30	Sand, coarse to very coarse, grayish-brown (2.5Y 5/2), quartz; sandy clay, black (5Y 2.5/2)
2 nd attempt	0.30	Clay, very dark-grayish-brown (2.5Y 3/2); some sand, very coarse to coarse, quartz
565-585	Ditch sample	Sand, very coarse to coarse, grayish-brown (2.5Y 5/2), quartz; shell fragments, fine; lignite, fine

**Well 2
Great Bay Sample Descriptions**

Depth (feet)	Recovery (feet)	Lithology
585-605	Ditch sample	Same as 565-585-foot interval; lignite, increasing to 1 cm size and in quantity
605-607	0.30	Sand, coarse to medium, dark-grayish-brown (2.5Y 4/2), quartz, top 0.10 foot; sandy clay, dark-olive-gray (5Y 3/2), bottom 0.10 foot
2 nd attempt	0.90	Sand, coarse to medium, dark-olive-gray (5Y 3/2), quartz; silty sandy clay, dark-gray (5Y 4/1), top 0.20 foot and 0.40 to 0.50 foot from top; some heavy mineral, fine
625-645	Ditch sample	Sand, coarse to very coarse, dark-gray (5Y 4/1); shell fragments; some lignite
645-647	0.50	Sand, medium, dark-gray (5Y 4/1), quartz, silt-free
677	--	Change to clay, noted by driller
685-687	0.60	Clay, very dark-gray (10YR 3/1), hard; some silt; sand, 0.30 to 0.35 foot above bottom, fine to medium, dark-gray (5Y 4/1); trace mica, very fine
725-727	1.35	Clay, very dark-gray (10YR 3/1), hard, uniform; some silt to very fine sand, quartz; some glauconite, very fine, black; some sand laminations, very fine, quartz
745-747	0.60	Clay, dark-olive-gray (5Y 3.5/2), uniform; top 0.20-foot contains sand, coarse to very coarse, quartz, which may represent contamination from higher in the borehole
765-767	0.60	Silty sand, olive-gray (5Y 4/2), uniform; sand, medium to fine, quartz; shell fragments, up to 1 cm
785-787	1.70	Sandy silty clay, dark-olive-gray (5Y 3/2), hard; sand, fine to silt, quartz, glauconite; shell fragments, very thin
805-807	0.85	Clayey sandy silt, greenish-black (5GY 2/1) to black (5Y 2.5/2), trace grayish-green (10G 4/2), uniform; sand, medium to fine, glauconite; some sand, coarse, quartz
825-827	0.60	Silty sandy clay, dark-olive-gray (5Y 3/2) and grayish-olive-green (5GY 3/2), hard; shell fragments, some over 2 cm, thick oyster and clam fragments; sand, fine to medium, black, clear and greenish, but mostly black
845-847	0.50	Silty sand and sandy clay, interbedded, dark-greenish-gray (5GY 4/1); sand, coarse to fine, glauconite-black, quartz-clear; some shell fragments
865-867	0.50	Silty clayey sand, olive (5Y 4/4); sand, medium, black, glauconitic; sand, coarse to medium, clear, quartz
885-887	0.75	Silty sand, olive-gray (5Y 4/2), hard, uniform; sand, coarse to medium, quartz; glauconite, medium to fine, black
905-907	1.05	Sandy silty clay, dark-olive-gray (5Y 3/2) and grayish-olive-green (5GY 3/2); glauconite, very fine to medium; shell fragments, thin, abundant; some sand, medium, quartz
925-927	0.55	Silty sandy clay, dark-gray (5Y 3.5/1), hard; glauconite, fine to medium; shell fragments
945-947	1.60	Sandy clay, dark-olive-gray (5Y 3/2), hard, uniform; glauconite, very fine to medium; shell fragments, very thin, friable
965-967	0.70	Sandy clay, hard, dry, uniform; clay, dark-olive-gray (5Y 3/2); glauconite, fine to medium, black (2.5Y N2/0) and dark-yellowish-green (10GY 4/4)
985-987	0.55	Silty clay, dark-grayish-brown (2.5Y 4/2) and dark-olive-gray (5Y 3/2), mottled appearance, soft, malleable; glauconite, fine to medium, black (2.5Y N2/0); some sand, medium to coarse, quartz; shell fragments, very small, thin
1,005-1,007	0.85	Clay, dark-gray (5Y 4/1), soft, uniform, malleable; some silt; some glauconite, very fine, black; shell fragments, very fine to fine

**Well 2
Great Bay Driller's Log¹**

Depth (ft)	Lithology	Depth (ft)	Lithology
190	Borehole took on water; large amount of coarse sand washed up	775-785	Clay
		785-800	Silty sand
275	Drilling became quieter and formation softer; clay noted in ditch sample cuttings, dark-olive-gray (5Y 3/2)	800-800.5	Hardpan
		800.5-815	Sand
390	Change to sand	815-871	Clay; sand laminations
405-425	Borehole took on water, at greater rate than previous 20-foot interval	871-873	Shells; hard drilling
430	Change to clay, much harder drilling	873-893	Clay, gray; sand, green
555	Change to sand	893-905	Sand and clay, green
677	Change to clay	905-925	Clay, green
725-758	Clay; sand laminations	925-985	Clay, green and brown
758-775	Sand	985-1,012	Clay, gray; hard drilling 1,000-1,012 feet

¹Modified by Lloyd Mullikin, NJGS

**Well 2
Geologic and Hydrogeologic Units¹**

Elevation (land surface): 5.6 feet

Depth below sea level ² (ft)	Formation	Age
-90	Beach sand and gravel	Quaternary
	Cohansey Sand	Miocene
-250	Kirkwood Formation/Belleplain Member	Miocene
-315	Kirkwood Formation/Wildwood Member	Miocene
-540	Kirkwood Formation/Shiloh Marl	Miocene
-588	Kirkwood Formation/lower member	Miocene
-825	Atlantic City Formation	upper Oligocene
-904	Sewell Point Formation	lower Oligocene

¹Stephen Pekar, Rutgers University and Peter Sugarman, NJGS

²Datum is National Geodetic Vertical Datum of 1929

**Well 2
Elevation and Thickness of Hydrogeologic Units**

Depth below sea level (feet)		Thickness (feet)	Hydrogeologic Unit
Top	Bottom		
+5.6	-252	257.6	Kirkwood-Cohansey aquifer system
-400	-430	30	Rio Grande water bearing zone
-555	-570	15	Atlantic City 800-foot sand/upper sand
-600	-680	80	Atlantic City 800-foot sand/lower sand
-807	-905	98	Piney Point aquifer/upper sand

DWR-133M (7/92) SERIAL # 38536

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION AND ENERGY
TRENTON, NJ

Mail to
Water Allocation
CN 029
Trenton, N.J. 08625

Permit No. 3620855

MONITORING WELL PERMIT 16

COORD # : 36 . 05 . 251
Count is correct

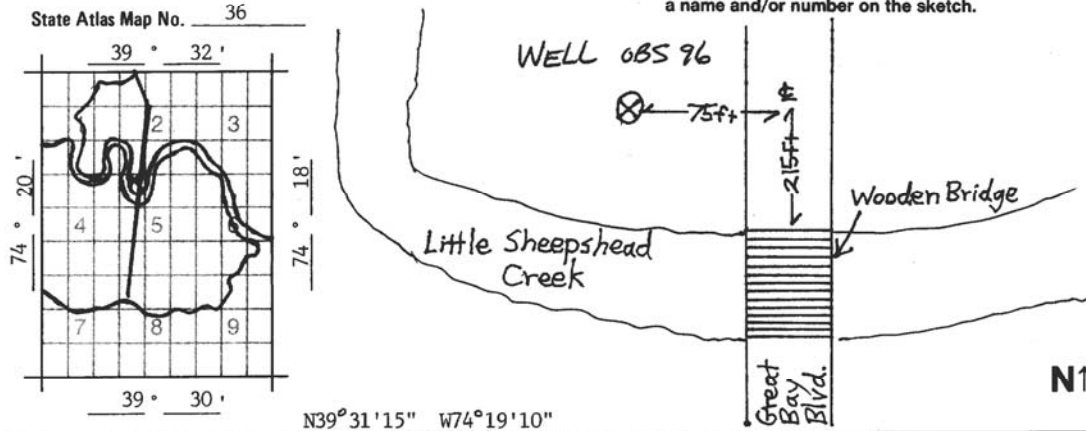
VALID ONLY AFTER APPROVAL BY THE D.E.P.E.

Owner <u>NJDEP, Div. of Fish, Game & Wildlife</u>	Driller <u>A.C. Schultes, Inc.</u>
Address <u>CN400</u>	Address <u>664 S. Evergreen Ave.</u>
<u>Trenton, NJ 08625-0400</u>	<u>Woodbury, NJ 08096</u>
Name of Facility <u>Boat Landing on Little Sheephead Creek</u>	Diameter of Well(s) <u>4</u> Inches
Address <u>Great Bay Blvd.</u>	Proposed Depth of Well(s) <u>1000</u> Feet
<u>Wildlife Management Area</u>	# of Wells Applied for (max. 10) <u>1</u>
	Will pumping equipment be installed? YES <input type="checkbox"/> NO <input checked="" type="checkbox"/>
	Type of Well (see reverse) <u>Monitoring/OBS</u>
	If Yes, give pump capacity <u></u> GPM

LOCATION OF WELL(S)

Lot #	Block #	Municipality	County
42	326	Little Egg Harbor	Ocean

Draw sketch of well(s) nearest roads, buildings, etc. with marked distances in feet. Each well MUST be labeled with a name and/or number on the sketch.



FOR MONITORING WELLS, RECOVERY WELLS, OR PIEZOMETERS, THE FOLLOWING MUST BE COMPLETED BY THE APPLICANT. PLEASE INDICATE WHY THE WELLS ARE BEING INSTALLED:

- Spill Fund Case
- ECRA Case
- CERCLA (Superfund) Site
- RCRA Site
- Underground Storage Tank
- NJPDES Municipal Discharge Permit
- NJPDES Industrial Discharge Permit
- Water and Hazardous Waste Enforcement Case
- Water Supply Aquifer Test Observation Well
- Other (explain) _____

Case I.D. Number _____

This Space for Approval Stamp

WELL PERMIT APPROVED
N.J.D.E.P.

NOV 7 1996

BUREAU OF WATER ALLOCATION

FOR D.E.P.E. USE Issuance of this permit is subject to the conditions attached. (see next page) For monitoring purposes only

The well(s) may not be completed with more than 25 feet of total screen or uncased borehole.

SEE REVERSE SIDE FOR IMPORTANT PROVISIONS AND REGULATIONS PERTAINING TO THIS PERMIT.
In compliance with N.J.S.A. 58:4A-14, application is made for a permit to drill a well as described above.

Date _____ Signature of Driller [Signature] License # M-1152

job # 25069 Signature of Owner [Signature] ROBERT MIDWELL

COPIES: Water Allocation — White and Pink Health Dept. — Yellow Owner — Blue WELPMT 008 2899

Figure 5. Well 2 monitoring well permit.



MONITORING WELL RECORD

Well Permit No. 36 20855
Atlas Sheet Coordinates 36 06 251

OWNER IDENTIFICATION - Owner NJDEP DIV. OF FISH, GAME
Address CN 400
City TRENTON State NJ Zip Code _____

WELL LOCATION - If not the same as owner please give address. Owner's Well No. OBS-96
County OCEAN Municipality LITTLE EGGS HARB Lot No. 42 Block No. 326
Address GREAT BAY BLVD. Date well started 1 / 2 / 97

TYPE OF WELL (as per Well Permit Categories) MONITORING Date well completed 1 / 19 / 97
Regulatory Program Requiring Well AT OBS WELL Case I.D. # _____
CONSULTING FIRM/FIELD SUPERVISOR (if applicable) _____ Tele. # _____

WELL CONSTRUCTION

Total depth drilled 1012.0' ft.
Well finished to 880.0 ft.
Borehole diameter:
Top 8.0 in.
Bottom 8.0 in.

Well was finished: above grade
 flush mounted

If finished above grade, casing height (stick up) above land surface 4.5 ft.

Was steel protective casing installed?
 Yes No

Static water level after drilling 12' 8" ft.

Water level was measured using M Scope

Well was developed for 9 hours at 60 gpm

Method of development air lift

Was permanent pumping equipment installed? Yes No

Pump capacity _____ gpm

Pump type: _____

Drilling Method rotary

Drilling Fluid water Type of Rig D-9

Name of Driller ~~XXXXXXXXXX~~ James F. Schultes, Jr.

Health and Safety Plan submitted? Yes No

Level of Protection used on site (circle one) None D C B A

N.J. Registration No. M-1152

Name of Drilling Company A.C. SCHULTES INC.

	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Type and Material
Inner Casing	0.0	860.0	4.0	Std. steel
Outer Casing (Not Protective Casing)				
Screen (Note slot size)	860.0	880.0	4.0	Stainless .020 slot
Tail Piece				
Gravel Pack	820.0	880.0		#1 Moric
Annular Seal/Grout	0.0	820.0		Cement
Method of Grouting	Tremie Pipe			

GEOLOGIC LOG (Copies of other geologic logs and/or geophysical logs should be attached.)

Brown and white sand	0 - 20'
Gray clay	20 - 46'
Gray clay and fine gray sand	46 - 85'
Medium gray sand	85 - 228'
Silty gray sand and gray clay	228 - 255'
Dark gray clay	255 - 367'
Medium gray and white sand	367 - 427'
Brown clay	427 - 534'
Fine sand and brown clay	534 - 567'
Medium course sand with shells	567 - 649'
Gray clay and shells	649 - 775'
Gray and white sand	775 - 800'
Hard pan	800 - 805'
Medium to fine gray/white sand	805 - 873'
Gray clay	873 - 893'
Green sand and green clay	893 - 985'
Hard gray clay	985 - 1012'

I certify that I have drilled the above-referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Driller's Signature James F. Schultes, Jr. Date 3 / 3 / 97

COPIES: White - DEP Canary - Driller Pink - Owner Goldenrod - Health Dept.

Figure 6. Well 2 monitoring well record.

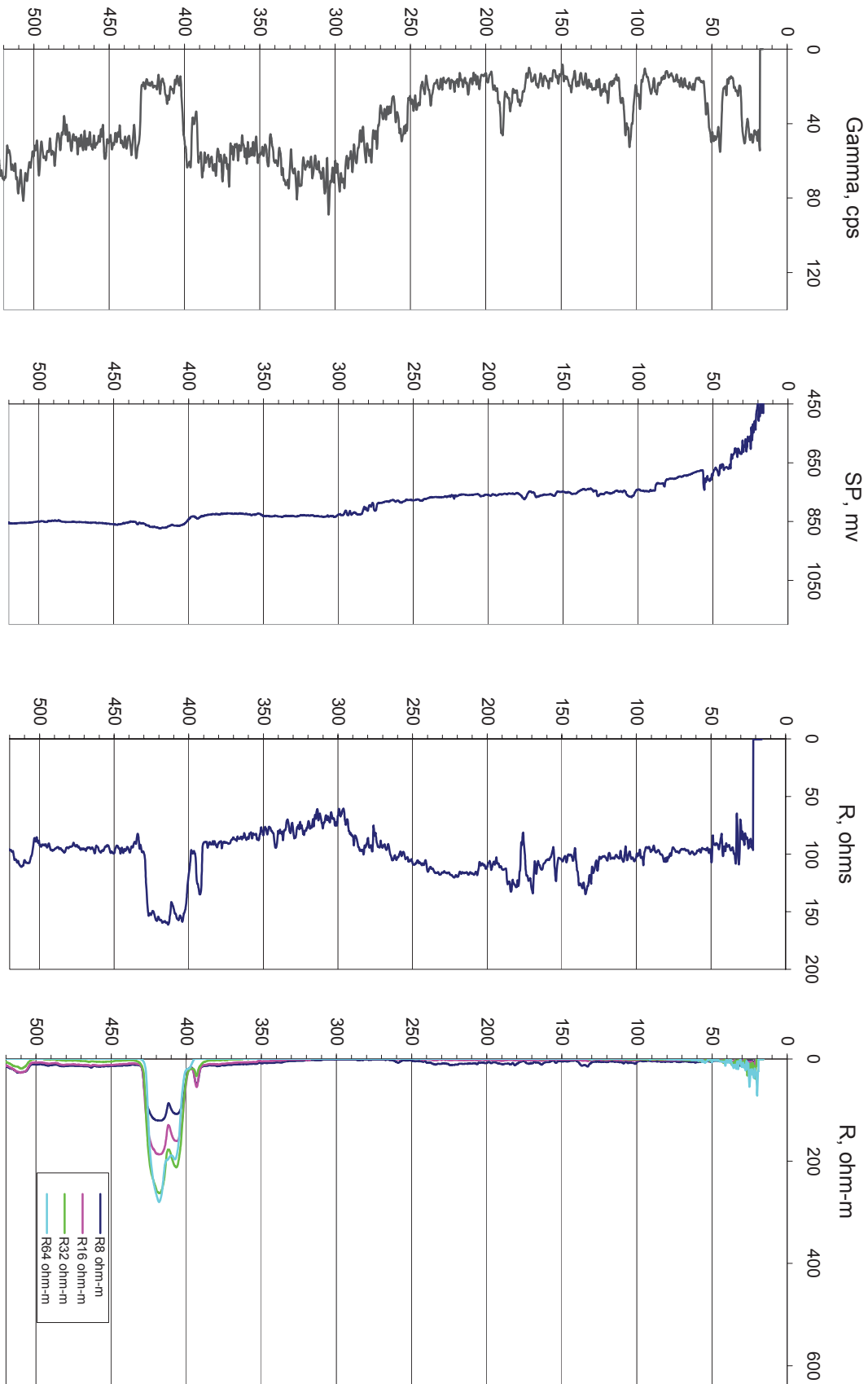


Figure 7. Well 2 geophysical logs

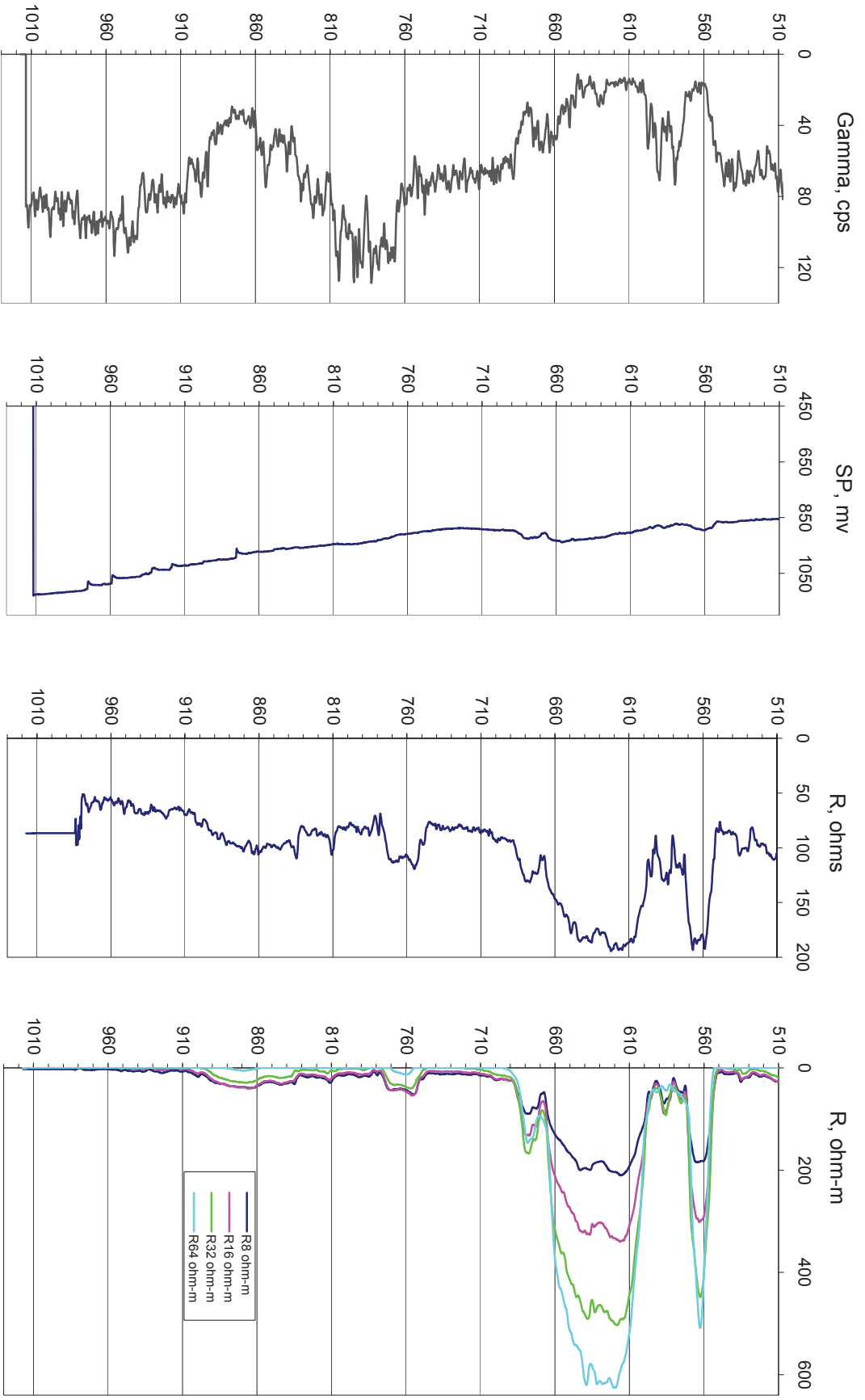


Figure 7. Well 2 geophysical logs (continued)

Wells 3 and 4

Well 3

New Lisbon Developmental Center Site Details

On NJ Department of Human Services, New Lisbon Developmental Center property, southwest of cemetery, in a clearing, 100 feet south of entrance to Camp Cottontail, in northern part of property, and 23 feet north of observation well screened in Magothy Formation (upper aquifer).

Location: 39° 53' 08.447" N 74° 35' 22.315" W

Elevation (land surface): 107.3 feet

Elevation (top of casing): 110.7 feet

Well permit no.: 32-21804

Atlas Sheet Coordinate no.: 32.12.319

Depth drilled (below land surface): 935 feet

Aquifer screened: Englishtown aquifer system

Formation screened: Englishtown Formation

Screen interval: 615-635 feet below land surface, with 0.020-inch, 304-stainless steel

Casing: 4-inch black steel, extending to 3.5 feet above land surface, with no tail piece below screen

Gravel pack: Morie grade no. 1 well gravel

Driller: Dennis Gaughan, A.C. Schultes, Inc.

Drilling method: Mud rotary

Borehole geophysically logged: 02/14/97, by John Curran, NJGS, witnessed by Lloyd Mullikin, NJGS

Well development: completed 03/18/97, witnessed by Lloyd Mullikin, Richard Shim Chim and Steven Johnson, NJGS

Date well completed: 03/20/97

Well 4

New Lisbon Developmental Center Site Details

On NJ Department of Human Services, New Lisbon Developmental Center property, southwest of cemetery, in a clearing, 100 feet south of entrance to Camp Cottontail, in northern part of property, and 23 feet north of observation well screened in Englishtown aquifer

Location: 39° 53' 08.397" N 74° 35' 22.031" W

Elevation (land surface): 107.0 feet

Elevation (top of casing): 109.2 feet

Well permit no.: 32-22005

Atlas Sheet Coordinate no.: 32.12.319

Depth drilled (below land surface): 1,049 feet

Aquifer screened: upper aquifer Potomac-Raritan-Magothy aquifer system (upper PRM)

Formation screened: Magothy Formation

Screen interval: 900-920 feet below land surface, with 0.020-inch, 304-stainless steel

Casing: 4-inch black steel, extending to 3 feet above land surface, with no tail piece below screen

Gravel pack: Morie grade no. 1 well gravel

Drillers: Dennis Gaughan and Frank Steffens, A.C. Schultes, Inc.

Drilling method: Mud rotary

Borehole geophysically logged: 02/26/97, by John Curran, NJGS, witnessed by Lloyd Mullikin, NJGS

Well development: completed 03/18/97, witnessed by Lloyd Mullikin, Richard Shim Chim and Steven Johnson, NJGS

Date well completed: 03/20/97

Wells 3 and 4

Composite Sample Descriptions¹

A composite log of samples collected from two boreholes, spaced 20 feet apart; well permits 32-21804 and 32-22005

Depth (feet)	Recovery (feet)	Lithology
0-35	Ditch Sample	Sand, coarse to very coarse, light-brownish-gray (2.5Y 6/2), quartz; gravel, up to 7 mm, some iron-stained; some clay, white (2.5Y 8/2); some mica
35-55	Ditch Sample	Same as previous interval; gravel and very coarse sand, increasing to 30 percent; some chert; trace heavy mineral
55-75	Ditch Sample	Gravel and sand; gravel, up to 1.5 cm, 50 percent, quartz, chert, clear to white, some iron-stained grains; sand, very coarse to coarse pale-yellow (2.5y 7/4), quartz; bog iron, friable, especially 72-to-75-foot depth; clay, white (2.5Y 8/2)
75-77	0.75	Gravel, sand and clay, top 0.30-foot; gravel, up to 1.5 cm, quartz; sand, very coarse to coarse, quartz; clay, white (2.5Y 8/2); sand, 0.30-0.75 feet from top, very coarse to coarse; yellowish-brown (10YR 5/8), 0.35-0.7-foot from top; dark-reddish-brown (5YR 3/4), very iron-stained, 0.25-0.35-feet from top
95-97	0.85	Sand, medium to coarse, brownish-yellow (10YR 6/6); some gravel and bog iron, top 0.40-foot
135-137	0.50	Sand, fine to very fine, dark-olive-gray (5Y 3/2); mica, fine to very fine
155-157	0.85	Sand, fine to very fine, dark-olive-gray (5Y 3/2), uniform; mica, fine

Wells 3 and 4
Composite Sample Descriptions¹
A composite log of samples collected from two boreholes, spaced 20 feet apart; well permits 32-21804 and 32-22005

Depth (feet)	Recovery (feet)	Lithology
175-177	0.90	Silty sand, very fine to silty, black (5Y 2.5/2), uniform; mica, fine
192	--	Drilling became harder, noted by driller
195-197	1.75	Silty clay, grayish-olive-green (5GY 3/2), uniform, hard; shell fragments, fine, very weathered; glauconite, very fine to fine, black
215-217	1.95	Sandy silty clay, grayish-olive-green (5GY 3/2), uniform, hard, dry; glauconite, fine to coarse, black; shell fragments
235-237	1.75	Clay, dusky-yellow-green (5GY 5/2), uniform hard; glauconite, fine to very fine, black; some shell fragments, fine, thin
255-257	1.40	Clay, grayish-olive-green (5GY 3/2), uniform, hard, dry; some glauconite, very fine
295-297	0.70	Silty glauconite and clay; glauconite, coarse to fine, black; clay, olive-gray (5Y 5/2), lens in top 0.15-0.20-foot; shell fragment, 2.5 cm, in top 0.10-0.15-foot
315-317	1.70	Clay, greenish-gray (5GY 6/1), uniform, hard; some glauconite, fine to very fine, black; trace shell fragments, fine
395-397	1.70	Silty clay, dark-greenish-gray (5GY 4/1), uniform, hard, dry; sand, medium to fine, quartz and glauconite
414-416	0.80	Glauconitic clay, dark-olive-gray (5Y 3/2), hard; glauconite, coarse to medium, black, 40 percent of sample
415-417	1.40	Glauconitic clay, uniform, hard; clay, very dark-gray (5Y 3/1); glauconite, coarse to medium, black
417-419	0.90	Same as previous core interval
425-427	1.20	Glauconitic clay, black (5Y 2.5/2), uniform, softer and sandier than last core interval; glauconite, coarse to medium, 40 percent
475-495	--	Borehole took on some water, noted by driller
515-517	0.70	Sand, medium to fine, black (5Y 2.5/1), quartz and glauconite
535-537	0.15	Sand, fine to medium, dark-gray (5Y 4/1), quartz and glauconite; clay, greenish-gray (5GY 6/1), soft, silty; shell fragments, thick, up to 2 cm
835-837	0.75	Glauconitic clay, olive-gray (5Y 4/1), uniform, hard; glauconite, fine to very fine, black; some silty inclusions, olive (5Y 5/4), up to 2 mm
875-877	0.40	Clay, greenish-black (5G 2/1), hard; glauconite, fine to very fine, black
879	--	Change to alternating sand and clay, borehole took on water, noted by driller
895-897	1.20	Sand and gravel, dark-gray (5Y 4/1) and black (5Y 2.5/1), quartz; sand, very coarse to coarse; gravel, up to 6 mm; clay, grayish-yellow-green (5GY 7/2); silty clay, very dark-gray (5Y3/1); some cemented sand, medium, quartz; glauconite, coarse to medium
920-922	0.35	Sand, medium to coarse, some fine and very coarse, dark-olive-gray (5Y 3/2), equal amounts of quartz and glauconite; sand, quartz, coarse to medium, some very coarse; glauconite, medium to fine, black; trace pyrite nodules, olive (5Y 5/4), fine to very fine, metallic luster; some silty clay, black (5Y 2.5/2)
925-927	2.00	Sand, coarse to very coarse, quartz; glauconite, very fine to medium, black; silty clay lenses throughout, black (5Y 2.5/2); pyrite nodules, very fine to coarse, olive (5Y 4/3), metallic luster; trace gravel, quartz, up to 6 mm
930-942	--	Hard clay, noted by driller
942-953	--	Softer clay, noted by driller
925-940	Ditch Sample	Clay, dark-greenish-gray (5GY 4/1), hard, dry, hard drilling, brittle; some silty clay, olive-yellow (5Y 6/6) and red (2.5YR 4/6) near bottom of interval
945-947	0.60	Silty sand, in lower 0.35-foot of interval, fine to very fine, light-gray (10YR 7/1), quartz, very hard; silty clay and silty sand, in upper 0.25-foot of interval, dark-grayish-brown (10YR 4/2) with streaks of reddish-brown (5YR 4/4) and moderate-reddish-brown (10YR4/6), very soft
965-967	0.35	Silty sand, light-gray (5Y 7/1), with streaks of iron staining; sand, very fine to fine, quartz
970-975	--	Shell layer noted by driller
985-987	0.85	Silty clay, gray (5Y 4.5/1), hard, uniform; some sand, very fine, quartz; small shell fragments, trace pyrite; lignite?, very fine, black

**Wells 3 and 4
Composite Sample Descriptions¹**
A composite log of samples collected from two boreholes, spaced 20 feet apart; well permits 32-21804 and 32-22005

Depth (feet)	Recovery (feet)	Lithology
1,005-1,007	0.50	Silty clay, gray (5Y 4.5/1), softer than previous core; increased shell fragments; some sand, very fine to fine, quartz and glauconite in laminations
1,025-1,027	0.35	Silty clay, similar to previous core; increasing shell fragments and sand laminations
1,049-1,051	0.05	Cemented zone, very hard, destroyed roller drill bit, medium-gray (N5); quartz matrix, with imbedded glauconite, medium to fine; shell fragments, one over 1 cm; some pyrite nodules, very fine

¹ Lloyd Mullikin, NJGS

**Wells 3 and 4
Driller's Composite Log¹**

Depth (ft)	Lithology
0-20	Sand, brown; clay, white
20-35	Sand, white and brown
35-70	Sand, medium, white
70-95	Sand, white, brown and red
95-115	Sand, fine, red, brown and white
115-127	Sand, brown and white
127-135	Clay, brown; sand, gray
135-155	Sand, fine; clay, gray
155-195	Clay, gray
195-215	Clay, green
215-235	Clay, green, 80-percent; sand, fine, black and green
235-275	Clay, green; hard at 255-275 feet
275-295	Silty clay, green
295-355	Clay, green; sand, fine, greenish-black, at 315-335 feet
355-375	Silty sand, greenish-black; sand, fine; clay, green
375-395	Clay, gray; sand, fine
395-455	Clay, black; sand, fine, black; 90-percent clay at 415-435 feet
455-528	Sand, black and green; fine at 495-528 feet
528-808	Silty clay, gray, soft
808-815	Sand
815-825	Sand, fine; clay, gray
825-875	Clay, gray
875-895	Sand, whitish gray; driller noted borehole took on much water
895-930	Sand, white

¹Modified by Lloyd Mullikin, NJGS

Wells 3 and 4
Geologic and Hydrogeologic Units and Analysis of Cuttings and Split-Spoon Cores¹

Elevation (land surface): 107.3 feet

Depth below sea level (ft)	Formation	Age
+5	Cohansey Sand	Miocene
-82	Kirkwood Formation	Miocene
-192	Shark River Formation	lower Eocene
-237	Manasquan Formation	lower Eocene
-307?	Vincentown Formation	Paleocene
-317	Hornerstown Formation	Paleocene
-354	Navesink Formation	upper Cretaceous
-432	Mount Laurel Sand	upper Cretaceous
-487	Wenonah Formation	upper Cretaceous
-509	Marshalltown Formation	upper Cretaceous
-587	Englishtown Formation/Kc2 cycle	upper Cretaceous
-610?	Englishtown Formation/Kc1 cycle	upper Cretaceous
-647	Woodbury Clay	upper Cretaceous
-699	Merchantville Formation	upper Cretaceous
-777	Cheesequake Formation	upper Cretaceous
-825	Magothy Formation	upper Cretaceous
	Raritan Formation	upper Cretaceous

¹James V. Browning, Rutgers University (2000) and Peter Sugarman, NJGS

Wells 3 and 4
Elevation and Thickness of Hydrogeologic Units¹

Depth above and below Sea level (ft)		Thickness of unit (feet)	Hydrogeologic Unit
Top	Bottom		
+107.3	-19.7	127	Kirkwood-Cohansey aquifer system
-358	-433	75	Wenonah-Mount Laurel aquifer
-508	-533	25	Englishtown aquifer system/upper sand
-772	-823	51	Potomac-Raritan-Magothy aquifer system/upper aquifer

¹Lloyd Mullikin, NJGS

Analysis of Cuttings and Split-Spoon Cores¹
New Lisbon Borehole

Sample depth	Formation	Description	
--	--	Several samples were analyzed from the New Lisbon Borehole drilled on February 26, 1997. Samples were washed through a 63- μ m sieve to remove the clay and silt, and the sand fraction was examined to determine its gross mineral content and, benthic and planktonic foraminiferal content.	
155-157 and 175-177	Kirkwood	These were not analyzed for their microfossil content. A visual analysis reveals them to be chocolate brown clays typical of this Miocene formation.	
195-197	Upper Shark River	61 percent sand. The sand fraction is dominated by fine to very fine quartz sand with approximately 15 percent fine glauconite and 15 percent broken shells. Foraminifers are rare in the sample and they were concentrated by floating. Very few planktonic foraminifers were noted. They include <i>Acarinina</i> and <i>Subbotina</i> indicative of a middle Eocene or older age. Benthic foraminifera include ? <i>Ceratobulimina</i> and <i>Hanzawaia</i> . It is likely this fauna has been affected by dissolution. Water depths are probably less than 50m.	
215-217	Upper Shark River	These two samples correlate with, and are lithologically similar to, the upper Shark River Formation. The upper contact with the Kirkwood Formation may be indicated by the "kick" on the gamma log at 188 feet. The lower contact with the lower Shark River Formation may be indicated by the "kick" on the gamma log at 230 feet.	39 percent sand. The sand fraction is dominated by coarse to very coarse glauconite sand (~80 percent) with approximately 10 percent fine to very fine quartz sand and 10 percent carbonate grains (mostly shell fragments). Foraminifera more common than at 195 feet but were still sufficiently rare that they were concentrated by floating. Planktonic foraminifera are very rare, consisting of small specimens of <i>Acarinina</i> , <i>Guem-belitria</i> , and <i>Pseudohastigerina</i> . One larger specimen may be <i>Truncorotalia topilensis</i> . This may indicate a middle Eocene age. The benthic foraminiferal assemblage is dominated by <i>Gyroidinoides octocameratus</i> , <i>Cibicidina</i> , <i>Ceratobulimina</i> , <i>Guttulina</i> and <i>Pararotalia inconspicua</i> . This indicates water depths of ~75m or less.
235-237	Lower Shark River	22 percent sand. The sand fraction contains ~60 percent fine to very fine quartz sand, ~30 percent foraminifers and ~10 percent fine to very fine glauconite. Mica is common and echinoid spines and sponge spicules are noted. Planktonic foraminifers are common and include <i>Subbotina</i> (including <i>S. frontosa</i>), <i>Acarinina</i> (including <i>A. bullbrookii</i>), and <i>Pseudohastigerina</i> . The most likely age is lower middle Eocene. Benthic foraminifers are dominated by <i>Cibicidoides subspiratus</i> (typical of lower middle Eocene faunas) and include <i>Cibicidoides pippeni</i> , <i>Melonis</i> , <i>Lenticulina</i> , <i>Alabamina</i> and <i>Hanzawaia</i> . Water depths were probably ~135 m.	
255-257	Lower Shark River	10 percent sand. The sand fraction contains 10 percent fine grained glauconite, 40 percent foraminifer tests and 50 percent fine to very fine quartz. Mica is common. The sample is richly fossiliferous and includes echinoid spines, ostracods, radiolarians, sponge spicules, and fragments of bivalve shells. Planktonic foraminifers dominate the assemblage (I did not actually count a planktonic/benthic ratio but I estimate that 70 percent of the foram tests are from plankton). The assemblage is made up of <i>subbotinids</i> , <i>acarininids</i> (<i>A. bullbrookii</i>), <i>pseudohastigerinids</i> , <i>turborotalids</i> (? <i>T. griffinae</i>), and <i>morozovellids</i> (? <i>M. spinulosa</i>). The most likely age is lower middle Eocene. Benthic foraminifers are diverse and are dominated by <i>Cibicidoides subspiratus</i> , <i>C. pippeni</i> , <i>C. cocoaensis</i> , and include <i>Gyroidinoids</i> , <i>Spiroplectammina</i> , <i>Anomalinoidea</i> , <i>Hanzawaia</i> , <i>Lenticulina</i> , and <i>Globobulimina</i> . Water depths were probably ~135 m.	
295-297	Lower Shark River	Contains lithified chunks and did not fully disaggregate. The sample is (very approximately) 70 percent glauconite very fine to coarse, 20 percent foram tests and 10 percent quartz. Foram preservation is poor. Most specimens are recrystallized and encrusted. Plankton is uncommon. Specimens of <i>Acarinina bullbrookii</i> , <i>Subbotina frontosa</i> , <i>S. linaperta</i> , and <i>Pseudohastigerina</i> are tentatively identified. The benthic fauna was dominated by <i>Cibicidoides subspiratus</i> , <i>C. pippeni</i> , <i>C. cocoaensis</i> , and includes <i>Gyroidinoids</i> , <i>Spiroplectammina</i> , <i>Anomalinoidea</i> among others. These three samples are consistent with the Lower Shark River Formation (early middle Eocene). Other localities with which I am familiar are not as quartz rich or as micaceous. The upper contact is probably indicated by the gamma log kick at 230 feet. The lower contact is probably indicated by the gamma kick at 300 feet.	

Analysis of Cuttings and Split-Spoon Cores¹
New Lisbon Borehole

Sample depth	Formation	Description
315-317	Manasquan Formation This sample correlates with the Manasquan Formation (lower Eocene) based upon the age, lithology, log characteristics, and the benthic foram assemblage. The upper contact of the Manasquan Formation is at 300 feet, and the lower contact is at 345 feet.	5 percent sand. The sand fraction contains 90 percent foraminifers and radiolarians, and 10 percent fine to very fine quartz. Glauconite is present. Radiolarians are nearly as common as foraminifers. Planktonic foraminifers include <i>Pseudohastigerina sharkriverensis</i> , <i>Turborotalia griffiniae</i> , <i>Acarinina soldadoensis</i> , and <i>Subbotina eocena</i> . No morozovellids were found making precise age determinations difficult. This assemblage is typical of the late early Eocene in New Jersey. The benthic foraminifers are dominated by <i>Siphonina claibornensis</i> , and <i>Cibicidoides pseudoungeriana</i> . Also present are <i>C. eocena</i> , <i>Eponides</i> , <i>Gyroidinoides</i> , <i>Spiroplectammia spectabilis</i> , and <i>Lenticulina</i> . Water depths were probably ~125 m.
395-397	Vincetown Formation This is believed to be equivalent to the Vincetown Formation. The upper contact is at 345 feet and the lower contact is uncertain but may be at 405 feet.	43 percent sand. The sand fraction contains 45 percent quartz, 45 percent fine glauconite, and 10 percent mica. A single foraminifer was noted (?? <i>Subbotina crociapertura</i>).
417-419	Hornerstown Formation	45 percent sand. The sand fraction is nearly all glauconite with a small amount of very fine quartz, mica and foram tests. The small but well preserved planktonic fauna is assigned to Zone P1c. It includes <i>Globoconus daubjergensis</i> , <i>S. pseudobulloides</i> and <i>P. inconstans</i> .
425-427	Hornerstown Formation	Examined by Richard Olsson, Rutgers University The sand fraction is dominated by glauconite and contains a planktonic fauna assigned to P1a. Based upon correlation to the Bass River borehole it is likely that K/T Cretaceous/Tertiary boundary is within 2 feet of this sample.

¹James V. Browning, Rutgers University

SERIAL # 53809

DWR-133M (8/95)

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
TRENTON, NJ

Mail to
NJDEP
Bureau Water Allocation
CN 426
Trenton, NJ 08625-0426

MONITORING WELL PERMIT
VALID ONLY AFTER APPROVAL BY THE D.E.P.

Permit No. 3-221804

COORD #: 32 . 12.319

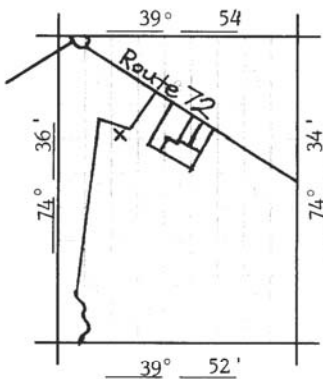
Owner NJ Dept. of Human Services Driller A. C. Schultes, Inc.
Address Capital Place One - 222 So. Warren St., Address 664 S. Evergreen Ave.
CN 700, Trenton, NJ 08625 Woodbury, NJ 08096
Name of Facility New Lisbon Dev. Center
Address Route 72
New Lisbon, NJ 08064

Diameter of Well(s)	4	Inches	Proposed Depth of Well(s)	1100	Feet
# of Wells Applied for (max. 10)	1		Will pumping equipment be installed?	YES <input type="checkbox"/> NO <input type="checkbox"/>	
Type of Well (see reverse)	Monitoring/OBS			If Yes, give pump capacity cumulative GPM	

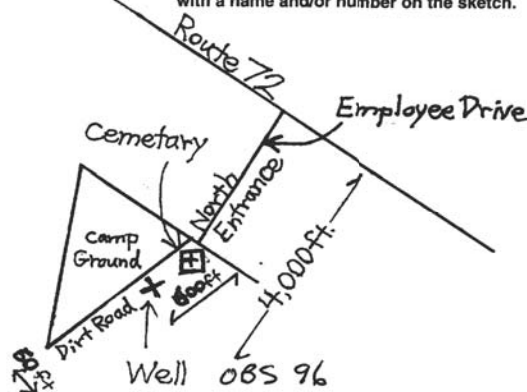
LOCATION OF WELL(S)

Lot #	Block #	Municipality	County
12	601	Woodland Twp.	Burlington

State Atlas Map No. 32



Draw sketch of well(s) nearest roads, buildings, etc. with marked distances in feet. Each well MUST be labeled with a name and/or number on the sketch.



N39°53'01" W74°35'33"

FOR MONITORING WELLS, RECOVERY WELLS, OR PIEZOMETERS, THE FOLLOWING MUST BE COMPLETED BY THE APPLICANT. PLEASE INDICATE WHY THE WELLS ARE BEING INSTALLED:

- Spill Site
- ISRA Site
- CERCLA (Superfund) Site
- RCRA Site
- Underground Storage Tank Site
- Operational Ground Water Permit Site
- Pretreatment and Residuals Site
- Water and Hazardous Waste Enforcement Case
- Water Supply Aquifer Test Observation Well
- Other (explain) _____

CASE I.D. Number _____

This Space for Approval Stamp

WELL PERMIT APPROVED
N.J.D.E.P.

NOV 7 1996

BUREAU OF WATER ALLOCATION

FOR D.E.P. USE For monitoring purposes only For monitoring purposes only

ISSUANCE OF THIS PERMIT IS SUBJECT TO THE CONDITIONS ATTACHED. (SEE NEXT PAGE)

THE WELL(S) MAY NOT BE COMPLETED WITH MORE THAN 25 FEET OF TOTAL SCREEN OR UNCASED BOREHOLE.

SEE REVERSE SIDE FOR IMPORTANT PROVISIONS AND REGULATIONS PERTAINING TO THIS PERMIT.

In compliance with N.J.S.A. 58:4A-14, application is made for a permit to drill a well as described above.

Date 9- Signature of Driller A. C. Schultes Registration No. M-1152
job # 25069 Signature of Owner Robert J. Bellan ROBERT J. BELLAN
BUREAU OF ENVIRON./SAFETY

COPIES: Water Allocation — White Health Dept. — Yellow Owner — Blue WELPMT 033 1578

Figure 8. Well 3 monitoring well permit.

New Jersey Department of Environmental Protection
Bureau of Water Allocation



MONITORING WELL RECORD

Well Permit No. 32-21804
Atlas Sheet Coordinates 32 12 319

OWNER IDENTIFICATION - Owner NJ DEPT. OF HUMAN SERVICE
Address CAPITAL PLACE 1 222 S. WARRREN
City TRENTON State NJ Zip Code _____
WELL LOCATION - If not the same as owner please give address
County BURLINGTON Municipality WOODLAND TWP Owner's Well No. OES-96 (b)
Address ROUTE 72 Lot No. 12 Block No. 601
Date well started 4 / 3 / 97
TYPE OF WELL (as per Well Permit Categories) MONITORING Date well completed 4 / 4 / 97
Regulatory Program Requiring Well AT OES WELL Case I.D. # _____
CONSULTING FIRM/FIELD SUPERVISOR (if applicable) _____ Tele. # _____

WELL CONSTRUCTION

Total depth drilled 635.0 ft.
Well finished to 635.0 ft.
Borehole diameter:
Top 14.0 in.
Bottom 8.0 in.

Well was finished: above grade
 flush mounted

If finished above grade, casing height (stick up) above land surface 4.0 ft.

Was steel protective casing installed?
 Yes No

Static water level after drilling 94 ft.

Water level was measured using M. Scope

Well was developed for n/a hours at n/a gpm

Method of development N/A

Was permanent pumping equipment installed? Yes No

Pump capacity N/A gpm

Pump type: _____

Drilling Method rotary

Drilling Fluid water Type of Rig rotary

Name of Driller F. Steffen

Health and Safety Plan submitted? Yes No

Level of Protection used on site (circle one) None (D) C B A

N.J. Registration No. J-1619

Name of Drilling Company A.C. SCHULTES INC.

	Depth to Top (ft.) (From land surface)	Depth to Bottom (ft.)	Diameter (inches)	Type and Material
Inner Casing	0.0	615.0	4.0	Std. Steel
Outer Casing (Not Protective Casing)	0.0	20.0	10.0	Std. steel
Screen (Note slot size)	15.0	635.0	4.0	304 Stainless .020 slot
Tail Piece				
Gravel Pack	600.0	635.0		#1 Marie
Annular Seal/Grout	0.0	600.0		Portland Cement
Method of Grouting	Tremie Pipe			

GEOLOGIC LOG (Copies of other geologic logs and/or geophysical logs should be attached.)

Brown & white medium sand	0 - 127'
Gray fine sand & gray clay	127 - 195'
Green clay & fine black sand	195 - 375'
Fine black sand	375 - 395'
Black clay and fine silty black sand	395 - 455'
Black and green sand	455 - 578'
Fine gray sand and white sand	578 - 600'
Soft gray clay	600 - 610'
White and gray medium sand	610 - 635'

I certify that I have drilled the above-referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Driller's Signature F. Steffen jfs Date 4 / 28 / 97

COPIES: White - DEP Canary - Driller Pink - Owner Goldenrod - Health Dept.

WELREC 167 3647

Figure 9. Well 3 monitoring well record.

SERIAL # 53419

DWR-133M (8/95)

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
TRENTON, NJ

Mail to
NJDEP
Bureau Water Allocation
CN 426
Trenton, NJ 08625-0426

MONITORING WELL PERMIT

39

Permit No. 3222005

VALID ONLY AFTER APPROVAL BY THE D.E.P.

COORD #: 32 . 12 . 319

Owner NI Dept. of Human Services
Address Capital Place One - 222 So. Warren St.
CN 700, Trenton, NJ 08625

Driller A.C. Schultes, Inc.
Address 664 S. Evergreen Ave.
Woodbury, NJ 08096

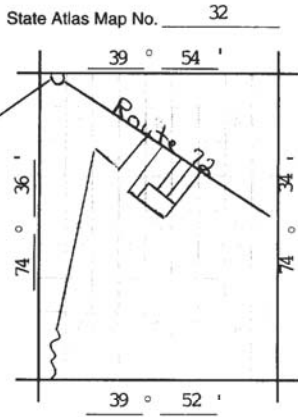
Name of Facility New Lisbon Dev. Center
Address Route 72
New Lisbon, NJ 08064

Diameter of Well(s)	4 Inches	Proposed Depth of Well(s)	1100 Feet
# of Wells Applied for (max. 10)	1	Will pumping equipment be installed? YES <input type="checkbox"/> NO <input checked="" type="checkbox"/>	
Type of Well (see reverse)	Monitoring/OBS	If Yes, give pump capacity	cumulative GPM

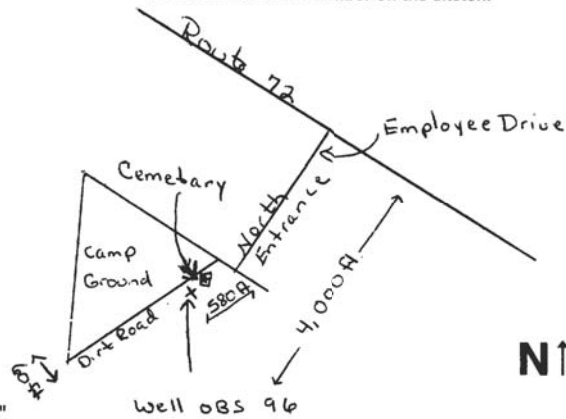
LOCATION OF WELL(S)

Lot #	12	Block #	601	Municipality	Woodland Twp	County	Burlington
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Draw sketch of well(s) nearest roads, buildings, etc. with marked distances in feet. Each well MUST be labeled with a name and/or number on the sketch.



N39°53'01" W74°35'33"

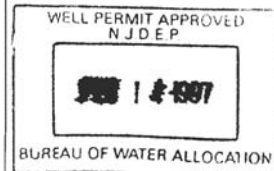


FOR MONITORING WELLS, RECOVERY WELLS, OR PIEZOMETERS, THE FOLLOWING MUST BE COMPLETED BY THE APPLICANT. PLEASE INDICATE WHY THE WELLS ARE BEING INSTALLED:

- Spill Site
- ISRA Site
- CERCLA (Superfund) Site
- RCRA Site
- Underground Storage Tank Site
- Operational Ground Water Permit Site
- Pretreatment and Residuals Site
- Water and Hazardous Waste Enforcement Case
- Water Supply Aquifer Test Observation Well
- Other (explain) _____

CASE I.D. Number _____

This Space for Approval Stamp



FOR D.E.P. USE Issuance of this permit is subject to the conditions attached. (see next page) For monitoring purposes only The well(s) may not be completed with more than 25 feet of total screen or uncased borehole.

SEE REVERSE SIDE FOR IMPORTANT PROVISIONS AND REGULATIONS PERTAINING TO THIS PERMIT.

In compliance with N.J.S.A. 58:4A-14, application is made for a permit to drill a well as described above.

Date 02/14/97 Signature of Driller [Signature] Registration No. M-1152

Job # 25069 Signature of Owner [Signature] Robert J. Bellan
COPIES: Water Allocation — White Health Dept. — Yellow Owner — Blue
Bureau of Water Allocation
Comp WELPMT 033 1790

Figure 10. Well 4 monitoring well permit.

DWR-138 M
11/96

New Jersey Department of Environmental Protection
Bureau of Water Allocation
MONITORING WELL RECORD

Well Permit No. 32- 22005

Atlas Sheet Coordinates 32 : 12 : 319

OWNER IDENTIFICATION - Owner NJ DEPT. OF HUMAN SERVICE
Address CAPITAL PLACE ONE 222 S. WARRR
City TRENTON State NJ Zip Code _____

WELL LOCATION - If not the same as owner please give address. Owner's Well No. CBS-96(a)
County BURLINGTON Municipality WOODLAND TWP Lot No. 12 Block No. 601
Address ROUTE 72

TYPE OF WELL (as per Well Permit Categories) MONITORING DATE WELL STARTED 4 / 3 / 97
DATE WELL COMPLETED 4 / 4 / 97
Regulatory Program Requiring Well WATER/HAZ ENF Case I.D.# _____

CONSULTING FIRM/FIELD SUPERVISOR (if applicable) _____ Tele. # _____

WELL CONSTRUCTION

Total depth drilled 1016.0 ft.
Well finished to 920.0 ft.

Borehole diameter:
Top 8.0 in.
Bottom 8.0 in.

Well was finished: above grade
 flush mounted

If finished above grade, casing height (stick up) above land surface 4.0 ft.

Was steel protective casing installed?
 Yes No

Static water level after drilling 120 ft.

Water level was measured using m Scope

Well was developed for N/A hours
at _____ gpm

Method of development N/A

Was permanent pumping equipment installed? Yes No

Pump capacity N/A gpm

Pump type: _____

Drilling Fluid water Type of Rig rotary

Health and Safety Plan submitted? Yes No

Level of Protection used on site (circle one) None D C B A

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A.C. SCHULTES INC.

Well Driller (Print) F. Steffen

Driller's Signature F. Steffen

Registration No. J-1619 Date 4 / 28 / 97

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	0.0	900.0	4.0	Steel	Std.
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used <u>1</u>)	900.00	920.0	4.0	Stainless	304 .020 slot
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	890.0	920.0		Morie	#1
Grout	0.0	890.0		Neat Cement Bentonite	24000 lbs.

Grouting Method Tremie Pipe

Drilling Method Mud rotary

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations.

Brown & white medium sand	0 - 127'
Gray fine sand & gray clay	127 - 195'
Green clay, fine black sand	195 - 375'
Fine black sand	375 - 395'
Black clay, fine silty black sand	395 - 455'
Black and green sand	455 - 578'
Fine gray sand and white sand	578 - 600'
Soft gray clay	600 - 610'
White & gray medium sand	610 - 635'
Gray silty clay	635 - 808'
Fine gray sand	808 - 825'
Gray clay	825 - 875'
White medium sand	875 - 1005'
Gray clay	1005 - 1015'
Hard pan	1015 - 1016'

COPIES: White - DEP Canary - Driller Pink - Owner Goldenrod - Health Dept.

WELREC 167 3648

Figure 11. Well 4 monitoring well record.

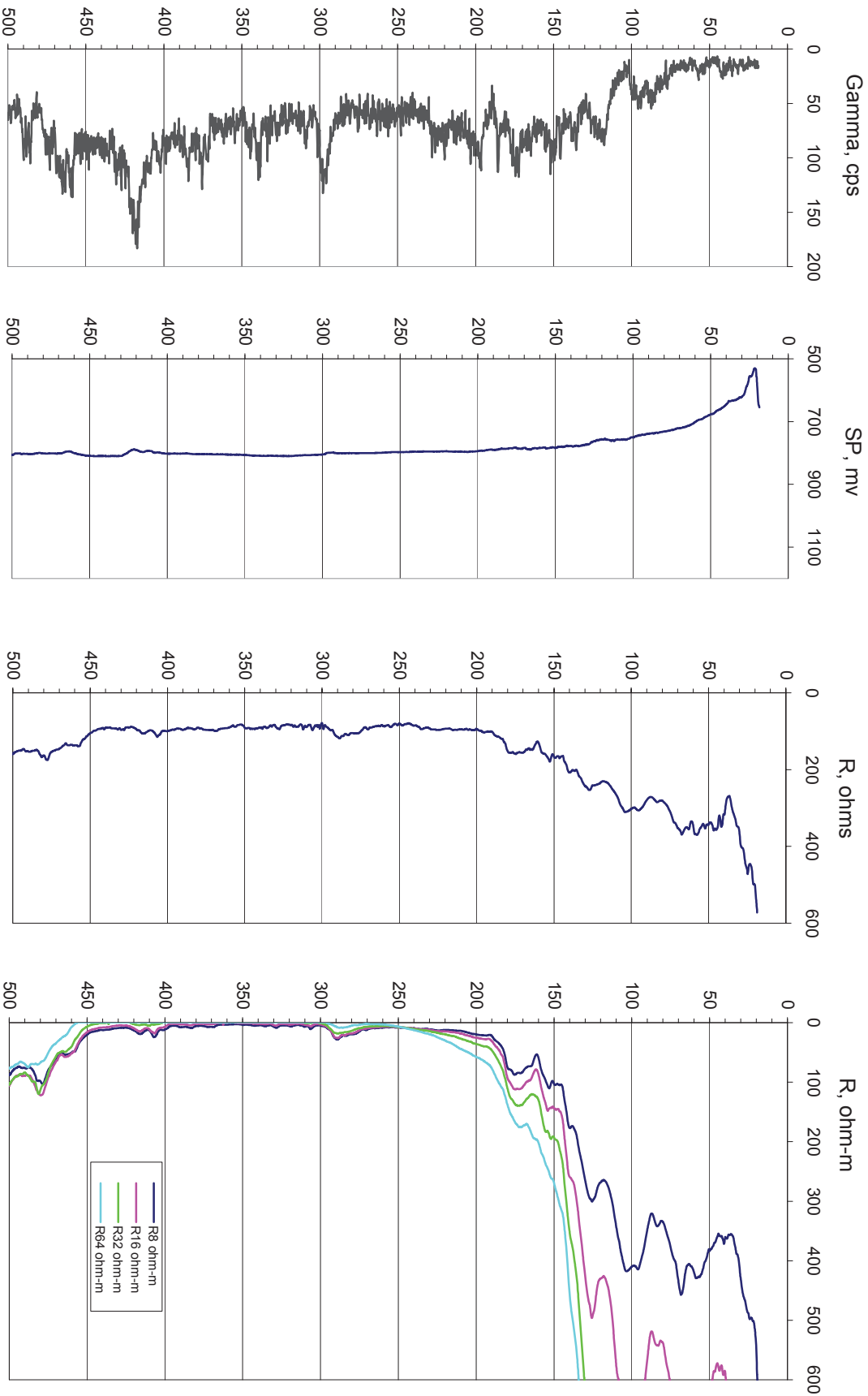


Figure 12. Wells 3 and 4 geophysical logs

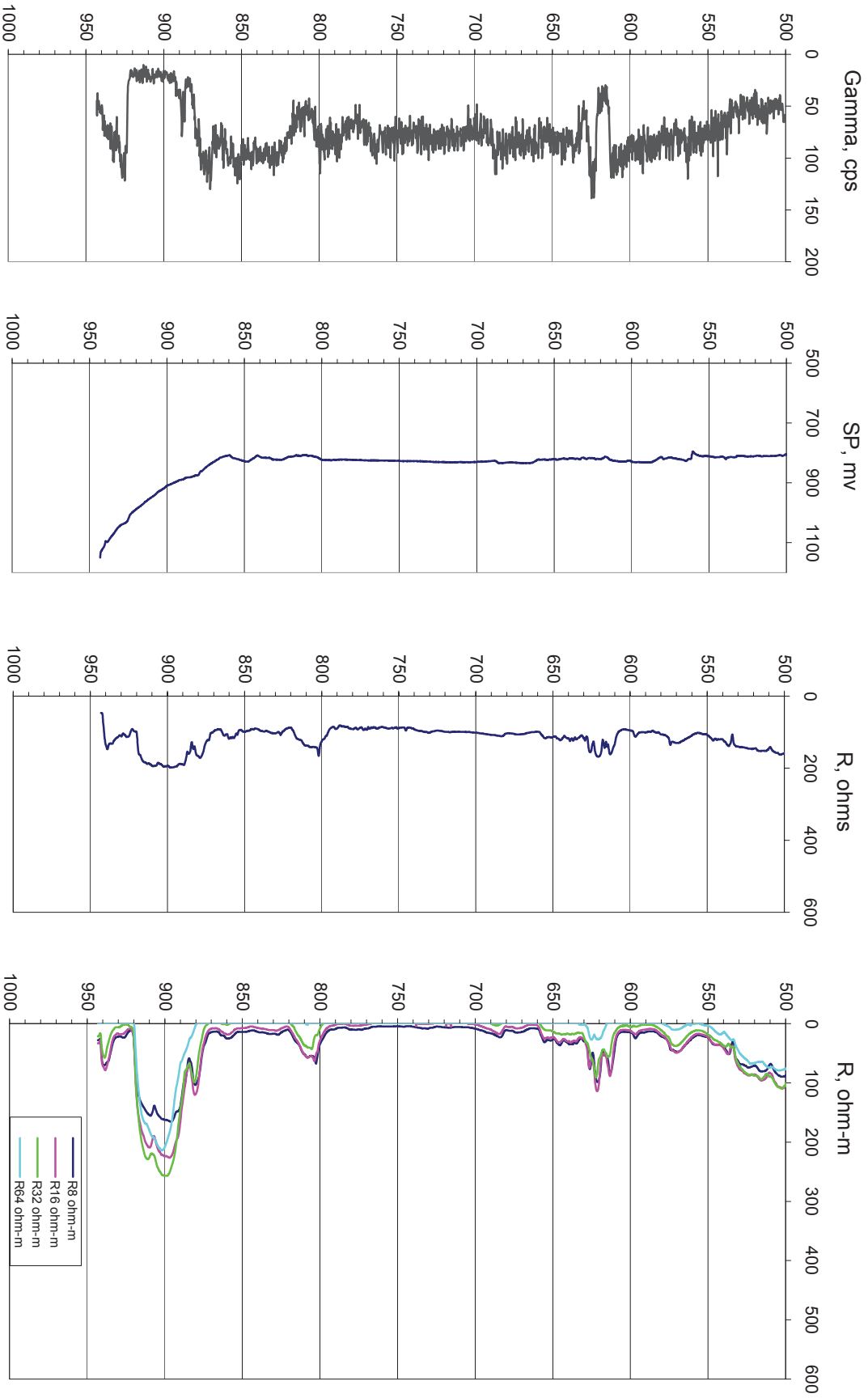


Figure 12. Wells 3 and 4 geophysical logs (continued)

Wells 5 and 6

**Well 5
Parvin State Park Site Details**

At NJDEP, Division of Parks and Forestry, State Park Service, Parvin State Park, in Pittsgrove Township, Salem County. The well is at the south end of the Park Maintenance Facility parking lot, 78.5 feet south of the observation well screened in the Magothy Formation (upper aquifer)
 Location: 39° 30' 55.731" N 75° 08' 36.440" W
 Elevation (land surface): 76.6 feet
 Elevation (top of casing): 78.0 feet
 Well permit no.: 35-17374
 Atlas Sheet Coordinate no.: 35.01.256
 Depth drilled (below land surface): 756 feet
 Aquifer screened: Wenonah-Mount Laurel aquifer
 Formation screened: Mount Laurel Sand
 Screen interval: 675-695 feet below land surface, with 0.020 inch, 304-stainless steel
 Casing: 4-inch black steel, extending to 1.4 feet above land surface, with no tail piece below screen
 Gravel pack: Morie grade no. 1 well gravel
 Driller: Dennis Gaughan, A.C. Schultes, Inc.
 Drilling method: Mud rotary
 Borehole geophysically logged: 05/06/97 by John Curran, NJGS, witnessed by Lloyd Mullikin, NJGS
 Well development: completed 06/97, witnessed by Lloyd Mullikin
 Date well completed: 06/1/97

**Well 6
Parvin State Park Site Details**

At NJDEP, Division of Parks and Forestry, State Park Service, Parvin State Park, in Pittsgrove Township, Salem County. The well is at the southeast end of the Park Maintenance Facility parking lot, 78.5 feet north of the observation well screened in the Wenonah-Mount Laurel aquifer.
 Location: 39° 30' 56.302" N 75° 08' 35.838" W
 Elevation (land surface): 77.2 feet
 Elevation (top of casing): 80.4 feet
 Well permit no.: 35-17766
 Atlas Sheet Coordinate no.: 35.01.256
 Depth drilled (below land surface): 1,137 feet
 Aquifer screened: upper aquifer Potomac-Raritan-Magothy aquifer system (upper PRM)
 Formation screened: Magothy Formation
 Screen interval: 1,005-1,025 feet below land surface, with 0.020 inch, 304-stainless steel
 Casing: 4-inch black steel, extending to 3.2-feet above land surface, with no tail piece below screen
 Gravel pack: Morie grade no. 1 well gravel
 Driller: Dennis Gaughan, A.C. Schultes, Inc.
 Drilling method: Mud rotary
 Borehole geophysically logged: 06/05/97, by John Curran, NJGS
 Well development: completed 06/13/97, witnessed by Lloyd Mullikin, NJGS
 Date well completed: 06/27/97

**Wells 5 and 6
Composite Sample Descriptions¹**

A composite log of samples collected from two boreholes spaced 72 feet apart; well permits 35-17374 and 35-17766

Depth (feet)	Recovery (feet)	Lithology
0-28	Ditch sample	Sand, coarse to very coarse, strong-brown (7.5 YR 5/8), quartz, iron-stained; trace clay, white; trace mica; less than 1 percent heavy mineral
28-30	--	Driller noted very hard drilling, probably due to bog iron
30-35	Ditch sample	Clay, dark-gray (10YR 4/1) and light-yellowish-brown (10YR6/4), less hard; sand, coarse to very coarse, quartz; bog iron, friable
35-55	Ditch sample	Clay, yellow (10YR 7/6) and some dark-gray (10YR 4/1); sand, medium to very coarse, quartz, iron-stained
55-75	Ditch sample	Clay, 70 percent strong-brown (7.5YR 5/8) and 30 percent dark-olive-gray (5Y 3/2); sand, medium to coarse, quartz; some shell fragments; trace chert, black
75-77	2.00	Silty sandy clay, black (5Y 2.5/2); silt to medium quartz sand; trace mica; shell fragments, and iron-stained quartz gravel up to 6 mm, in top 0.30 and bottom 0.60 foot
86	--	Increase in clay, dark-olive-gray (5Y 3/2), noted by driller
75-95	Ditch sample	Clay and sand; clay, dark-olive-gray (5Y 3/2); sand, medium to fine, olive-gray (5Y 4/2), quartz; increasing shell fragments

**Wells 5 and 6
Composite Sample Descriptions¹**

A composite log of samples collected from two boreholes spaced 72 feet apart; well permits 35-17374 and 35-17766

Depth (feet)	Recovery (feet)	Lithology
95-97	0.60	Shells, gravel and sand; shell fragments up to 4 mm across and very thin, some up to 2 mm thick; gravel, quartz; sand, very coarse, some coarse to medium, quartz, iron-stained; some clay, black (5Y 2.5/2)
95-115	Ditch sample	Clay, dark-olive-gray (5Y 3/2); sand, medium to fine, quartz; greatly increased shell fragments, up to 1 cm across, 1-2 mm thick
105-107	0.95	Sand, coarse to medium, dark-gray (5Y 4/1), quartz; shell and gravel lenses, 0-0.20 and 0.40-0.55 foot from top; gravel up to 4 mm; sand, very coarse to coarse, iron-stained; some bog iron; trace clay, pale-yellow (5Y 6/3)
115-117	1.05	Shells and gravel, similar to 95-97 foot core, some black quartz up to 1 cm, in top 0.45 foot of core; sand, coarse to medium, olive-gray (5Y 3/2), quartz, in bottom 0.60 foot of core; shell fragments, up to 2-mm thick, in bottom 0.10 foot of core
115-135	Ditch sample	Clay and shells; clay, 80 percent dark-olive-gray (5Y 3/2) and 20 percent dark-gray (5Y 4/1); shell fragments, about 10 percent of interval, similar in size to previous interval; sand, medium to very fine, quartz; some sand, medium, black; trace chert, black
135-137	0.75	Clay, shells and gravel, interbedded, very dark-grayish-brown (10YR 3/2), uniform; shell fragments and gravel, bottom 0.10 foot, 0.40 to 0.50 foot from top, and top 0.30 foot; gravel, quartz, iron-stained, some black; some bog iron
135-155	Ditch sample	Clay, black (5Y 2.5/2), hard, dry; shell fragments, 10 percent of interval, up to 1 cm across, 2-3 mm thick
142	--	Drilling got harder, noted by driller
155-157	2.20	Clay and shells; clay, very dark-grayish-brown (10YR 3/2); shell fragments, some over 1 cm
155-175	Ditch sample	Clay, black (5Y 2.5/2); shell fragments, less than 5 percent of interval
175-195	Ditch sample	Clay, gray (5Y 5.5/1); some sand; color change noted at 180 foot depth
195-197	1.30	Clay, variegated, black (5Y 2.5/2) and olive-gray (5Y 5/1), soft; shell fragments, up to 1 cm; some gravel, quartz, iron-stained
195-215	Ditch sample	Clay, gray (5Y 5.5/1); very hard drilling
215-217	1.45	Clay, olive-gray (5Y 4/1) and dark-olive-gray (5Y 3/2) in top 0.30 foot, dark-olive-gray (5Y 3/2) and olive-black (5Y 2/1) in lower 1.15 feet, uniform, hard; shell fragments, fine; forams; some sand, fine to very fine, quartz
227	--	Borehole took on water, noted by driller
215-235	Ditch sample	Clay, gray (5Y 5.5/1) and dark-olive-gray (5Y 3/2) in equal amounts, very hard; some very fine shell fragments, in clay chips, dark-olive-gray (5Y 3/2)
235-237	1.70	Clay, very dark-grayish-brown (2.5Y 3/2), uniform, hard; shell fragments, fine to very fine; forams
248	--	Change to easier drilling, increasingly sandy, noted by driller
255-257	0.55	Clay, dark-gray (5Y 4/1) and black (5Y 2.5/1), soft, and shell fragments, fine to very fine in top 0.15 foot; bottom 0.40 foot is clayey sand; clay, greenish-gray (5GY 6/1); sand, medium to fine, some coarse, with near equal amounts of quartz, black glauconite, and green chlorite
275-277	0.85	Sand, medium to coarse, olive-gray (5Y 5/1), quartz; glauconite, medium to fine, black; chlorite, medium to fine, green; shell fragments, very fine
295-297	0.65	Sand and shells, olive-gray (5Y 5/1); sand, medium to coarse, quartz; glauconite, medium to fine, black; chlorite, fine to coarse, green; shell fragments, very fine, up to 35 percent of core; some silt
315-317	0.90	Sand and shells, similar to 295-297 foot core; increased silt and glauconite; decreased shell fragments
335-337	0.70	Silty clay, sandy, shelly, olive-gray (5Y 5/1), uniform; sand, 50 percent of fraction is glauconite, fine black, and quartz, medium to coarse, and chlorite, fine, green; increasing shell fragments, very fine
355-357	0.80	Clay, dusky-yellow-green (5GY 6/2), uniform, hard; glauconite, fine to very fine, black; some sand, fine to medium, quartz; some shell fragments, very fine
395-397	0.50	Glauconitic clay, light-olive-gray (5Y 5/2); 40 percent glauconite, fine to coarse, black
415-417	1.20	Silty glauconitic clay, light-olive-gray (5Y 5/2), soft; glauconite, coarse to fine, black; glauconite grains cemented in a silica matrix at 0.45 to 0.70 foot from top
435-437	1.60	Clay, dusky-yellow-green (5GY 5/2), uniform; some glauconite, very fine to fine, black; trace shell fragments, very fine

**Wells 5 and 6
Composite Sample Descriptions¹**

A composite log of samples collected from two boreholes spaced 72 feet apart; well permits 35-17374 and 35-17766

Depth (feet)	Recovery (feet)	Lithology
475-477	0.95	Clay, grayish-olive-green (5GY 4/2), uniform, hard; mica, very fine; some sand, very fine, quartz; some shell fragments, very fine
495-497	1.10	Clay, olive-gray (5Y 4/2), uniform, soft, malleable
515-517	1.45	Clay, dark-gray (5Y 4/1), uniform, hard
555-557	1.10	Clay, dark-greenish-gray (5GY 4/1), uniform, hard; glauconite, fine, black; chlorite, fine, greenish; sand, fine, quartz; trace pyritic laminations, very fine
595-597	1.15	Clay, dark-greenish-gray (5GY 4/1), top 0.75 foot is uniform and hard, bottom 0.40 foot is fractured; glauconite, coarse to medium, black, 5 percent
612-614	1.00	Clayey glauconite, dark-greenish-gray (5GY 4/1), uniform; glauconite, coarse to medium, black, 70 percent; chlorite, medium, translucent green, less than 1 percent; forams
614-616	1.40	Clayey glauconite, same as 612-614-foot core
616-618	0.95	Glauconitic clay, dark-gray (5Y 4/1), uniform; glauconite, coarse to medium, black, 50 percent of core
618-620	1.00	Glauconitic clay, dark-gray (5Y 4/1), soft, uniform; clay, 50 percent of core; glauconite, coarse to medium, black; some sand, medium, quartz
620-622	0.92	Glauconitic clay, black (5Y 2.5/1), hard, uniform; clay, 60 percent of core; glauconite, medium to coarse, black; sand, medium, quartz, 5 percent of sand fraction; shell fragments, 2 cm thick, at top of core
622-624	1.10	Glauconitic clay, black (5Y 2.5/1); glauconite, medium, black, 50 percent of core
624-626	1.35	Glauconitic clay; Cretaceous-Tertiary Boundary, 0.60-0.90 foot below top of core, comprising a clay clast, dark-grayish-brown (2.5Y 4/2), containing forams, with glauconite, coarse to medium, black; glauconitic clay, black (5Y 2.5/1), with glauconite, medium to coarse, in top 0.60 foot; glauconitic clay, black (5Y 2.5/2), uniform, with glauconite, coarse to medium in bottom 0.45 foot
626-628	1.40	Glauconitic clay, black (5Y 2.5/2), containing some burrow structures filled with pyrite; glauconite, medium to fine, black, less than 25 percent
632	--	Change to easier drilling, increasingly sandy formation, noted by driller
655-657	0.85	Sandy clay, olive-gray (5Y 5/2), uniform, malleable; sand, 40 percent of core; glauconite, medium to fine, black, 60 percent of sand fraction; sand, coarse to medium, some very coarse, quartz, 15 percent of sand fraction; chlorite, medium to coarse, translucent and various other shades of green, 15 percent of sand fraction
675-677	0.80	Sandy clay, olive-gray (5Y 4/1), uniform; sand, 40 percent of core, with near equal amounts of quartz, medium to coarse, glauconite, medium to fine, black, and chlorite, fine to very fine, in green masses
685-687	1.75	Sandy clay, gray (5Y 5/1), uniform, hard; sand, medium to fine, 40 percent of core, mostly glauconite, less quartz, and some chlorite
695-697	0.85	Glauconitic clay, grayish-brown (2.5Y 5/2); glauconite, medium to fine, some coarse, black, 40 percent of core; some quartz and chlorite, medium to fine; shell fragments; forams
715-717	1.30	Silty sand, very dark-gray (5Y 3/1), uniform; sand, medium to very fine, quartz; glauconite, fine to very fine; some chlorite, fine to very fine; micaceous
735-737	0.75	Silty sandy clay, greenish-black (5G 2/1); sand, fine to very fine, quartz; chlorite, fine to very fine, green; glauconite, fine to very fine, black; shell fragments, fine, very thin; lignite, black (10YR 2/1), at 0.20 foot from top of core
755-757	0.95	Clay, black (5Y 2.5/1), hard; mica, medium to very fine; sand, very fine to fine, quartz; some very thin shell fragments
775-777	1.05	Clay, olive-black (5Y 2/1), uniform, hard; sand laminations, very fine to medium, quartz; mica, fine to very fine
795-797	1.10	Clay, very dark-gray (5Y 3/1), uniform, hard; sand, quartz and glauconite, fine to very fine; shell material, very fine; trace pyrite
815-817	0.95	Clay, olive-black (5Y 2/1), uniform, hard; shell fragments, very fine shells, large fragments in bottom 0.15 foot, showing some pearly luster; sand, fine to medium, quartz; some pyrite, very fine
855-857	1.10	Clayey glauconite, olive-gray (5Y 4.5/2), uniform, hard; glauconite, medium to coarse, black, 50 percent of core; chlorite, green, less than 1 percent of core; some shell fragments, very fine
915-917	0.60	Gravel, cemented silica chips and sandy clay, very hard; clay, reddish-brown (5YR 4/3) and black (5Y 2.5/1), soft; sand, very coarse to coarse, quartz; glauconite, coarse to fine, black; gravel, up to 5 mm, quartz, glauconite and chlorite; cemented silica chips, brown (7.5YR 5/2)

Wells 5 and 6
Composite Sample Descriptions¹
A composite log of samples collected from two boreholes spaced 72 feet apart; well permits 35-17374 and 35-17766

Depth (feet)	Recovery (feet)	Lithology
935-937	1.10	Clay, dark-gray (5Y 3.5/1), very hard, uniform; sand, fine to very fine, quartz; some shell fragments, fine, very thin
955-957	1.20	Clay, dark-gray (5Y 4/1), very hard, uniform; sand, very fine to fine, quartz; trace glauconite, very fine to fine; mica, fine to very fine; pyrite; some shell fragments, fine to very fine
975-977	0.55	Clay, dark-gray (5Y 4/1), hard, uniform; sand, very fine, quartz; greatly increased shells and shell fragments, very fine to fine, some with pearly luster
995-997	0.22	Sand, fine to very fine, dark-gray (5Y 4/1), quartz; some shell fragments, fine; chlorite, fine, green; trace glauconite, fine, black
1,015-1,017	0.60	Clay and sand; clay, very dark-gray (5Y 3/1), with shell fragments, sand laminations, medium to fine, quartz, and fine mica in top 0.35 foot of core; sand, medium to fine, gray (5Y 4.5/1), quartz in bottom 0.25 foot of core

Wells 5 and 6¹
Geologic and Hydrogeologic Units

Elevation (land surface): 77 feet

Depth below sea level (ft)	Formation	Age
+40?	Bridgeton Formation	Miocene
+21?	Cohansey Sand	Miocene
-170	Kirkwood Formation	Miocene
-342?	Shark River Formation	lower Eocene
-467?	Manasquan Formation	lower Eocene
-525	Vincentown Formation	Paleocene
-542	Hornerstown Formation	Paleocene
-607	Navesink Formation	upper Cretaceous
	Mount Laurel Sand	upper Cretaceous

¹Peter Sugarman, NJGS

Wells 5 and 6
Elevation and Thickness of Hydrogeologic Units¹

Depth above and below Sea level (ft)		Thickness of unit (feet)	Hydrogeologic Unit
Top	Bottom		
+77	-39	116	Kirkwood-Cohansey aquifer system
-167	-232	65	Piney Point aquifer/upper sand
-592	-612	20	Wenonah-Mount Laurel aquifer (poor producer)
-795	-839	44	Englishtown aquifer system (?)
-922	-943	21	Potomac-Raritan-Magothy aquifer system/upper aquifer
-1,029	-1,043	14	Potomac-Raritan-Magothy aquifer system/lower aquifer (?)

¹Lloyd Mullikin, NJGS

Wells 5 and 6
Strontium Isotope Age Estimates¹

Formation	Depth (feet)	Sr^{87}/Sr^{86}	Age (Ma)
Kirkwood-Shiloh Marl Member	75-77	0.708558	±0.000017
Kirkwood-Shiloh Marl Member	95-97	0.708569	±0.000009
Kirkwood-Shiloh Marl Member	105-107	0.708572	±0.000007
Kirkwood-Shiloh Marl Member	195-197	0.708550	±0.000010
Kirkwood-Shiloh Marl Member	235-236	0.708502	±0.000006

¹Peter Sugarman, NJGS

SERIAL # 53811
 DWR-133M (8/95)
 Mail to
 NJDEP
 Bureau Water Allocation
 CN 426
 Trenton, NJ 08625-0426

STATE OF NEW JERSEY
 DEPARTMENT OF ENVIRONMENTAL PROTECTION
 TRENTON, NJ

MONITORING WELL PERMIT 10

VALID ONLY AFTER APPROVAL BY THE D.E.P.

Permit No. 3517374

COORD #: 35 . 01 . 256

Owner NJDEP, Div. of Parks & Forestry
 State Park Service
 Address CN404
 Trenton, NJ 08625
 Name of Facility Parvin State Park
 Address 701 Almond Road
 Pittsgrove, NJ 08318-3928

Driller A.C. Schultes, Inc.
 Address 664 S. Evergreen Ave.
 Woodbury, NJ 08096

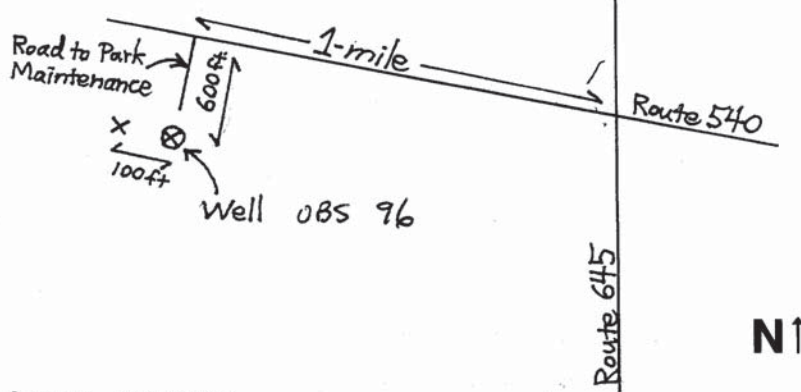
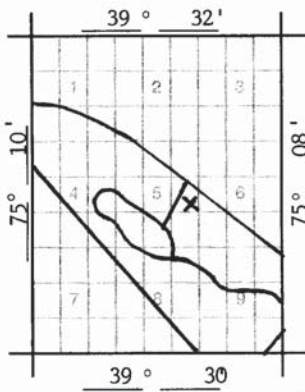
Diameter of Well(s)	4	Inches	Proposed Depth of Well(s)	750	Feet
# of Wells Applied for (max. 10)	1		Will pumping equipment be installed?	YES <input type="checkbox"/> NO <input checked="" type="checkbox"/>	
Type of Well (see reverse)	Monitoring/OBS		If Yes, give pump capacity cumulative GPM		

LOCATION OF WELL(S)

Lot #	Block #	Municipality	County
2	2801	Pittsgrove	Salem

Draw sketch of well(s) nearest roads, buildings, etc. with marked distances in feet. Each well MUST be labeled with a name and/or number on the sketch.

State Atlas Map No. 35



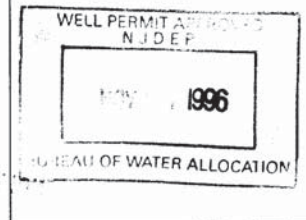
N39° 30' 55" W75° 08' 42"

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- Water and Hazardous Waste Enforcement Case
- Water Supply Aquifer Test Observation Well
- Other (explain) _____

CASE I.D. Number _____

This Space for Approval Stamp



FOR D.E.P. USE

Issuance of this permit is subject to the conditions attached. (see next page)
 For monitoring purposes only

The well(s) may not be completed with more than 25 feet of total screen or uncased borehole.

SEE REVERSE SIDE FOR IMPORTANT PROVISIONS AND REGULATIONS PERTAINING TO THIS PERMIT.

In compliance with N.J.S.A. 58:4A-14, application is made for a permit to drill a well as described above.

Date 9/18/96 Signature of Driller [Signature] Registration No. M-1152
 Signature of Owner [Signature]

job # 25069

COPIES: Water Allocation — White
 CARL R. NORDSTROM, DEPUTY DIRECTOR
 Health Dept. — Yellow Owner — Blue WELPMT 013 3230

Figure 13. Well 5 monitoring well permit.

MONITORING WELL RECORD

Well Permit No. 35-17374
Atlas Station Coordinates 35-01-256

OWNER IDENTIFICATION - Owner NJDEP DIV. OF PARKS & FOR
CN 404
Address TRENTON State NJ
City _____ Zip Code _____
WELL LOCATION - If not the same as owner please give address. Owner's Well No. CBS-96-B
County SALISBURY Municipality PITTSBORO TWP. Lot No. 2 Block No. 2801
Address 701 ALMOND ROAD Date well started 5 / 1 / 97
TYPE OF WELL (as per Well Permit Categories) MONITORING Date well completed 6 / 1 / 97
Regulatory Program Requiring Well AT OBS WELL Case I.D. # _____
CONSULTING FIRM/FIELD SUPERVISOR (if applicable) _____ Tele. # _____

WELL CONSTRUCTION

Total depth drilled 755.0 ft.
Well finished to 695.0 ft.
Borehole diameter:
Top 4.0 in.
Bottom 4.0 in.

Well was finished: above grade
 flush mounted

If finished above grade, casing height (stick up) above land surface 3.0 ft.

Was steel protective casing installed?
 Yes No

Static water level after drilling 60.0 ft.

Water level was measured using M Scope

Well was developed for N/A hours at _____ gpm

Method of development N/A

Was permanent pumping equipment installed? Yes No

Pump capacity N/A gpm

Pump type: _____

Drilling Method rotary

Drilling Fluid mud Type of Rig D-9

Name of Driller K. Kreidler

Health and Safety Plan submitted? Yes No

Level of Protection used on site (circle one) None (D) C B A

N.J. Registration No. M-1583

Name of Drilling Company A.C. SCHULTES INC.

	Depth to Top (ft.) (From land surface)	Depth to Bottom (ft.)	Diameter (inches)	Type and Material
Inner Casing	0.0	675.0	4.0	Steel, Std.
Outer Casing (Not Protective Casing)				
Screen (Note slot size)	675.0	695.0	4.0	Stainless Steel .020 slot
Tail Piece				
Gravel Pack	655.0	695.0		#1 Moric
Annular Seal/Grout	0.0	655.0		Cement
Method of Grouting	Tremie Pipe			

GEOLOGIC LOG (Copies of other geologic logs and/or geophysical logs should be attached.)

Iron, sand	0 - 30'
Gray and yellow clay	30 - 55'
Gray clay	55 - 75'
Gray clay, fine black sand with shells	75 - 135'
Black clay	135 - 215'
Shells, fine gray sand and clay	215 - 435'
Green clay	435 - 475'
Hard gray clay	475 - 620'
Glauconitic sand, black fine gray clay, some shells	620 - 630'
Fine sand and gray clay	630 - 700'
Fine black sand	700 - 735'
Gray clay	735 - 755'

I certify that I have drilled the above-referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Driller's Signature K Kreidler Date 7 / 21 / 97

COPIES: White - DEP Canary - Driller Pink - Owner Goldenrod - Health Dept.

Figure 14. Well 5 monitoring well record.

SERIAL # 57197
DWR-133M (8/95)

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
TRENTON, NJ

Mail to
NJDEP
Bureau Water Allocation
CN 426
Trenton, NJ 08625-0426

MONITORING WELL PERMIT

Permit No. 3517766

VALID ONLY AFTER APPROVAL BY THE D.E.P.

COORD #: 35.01.256

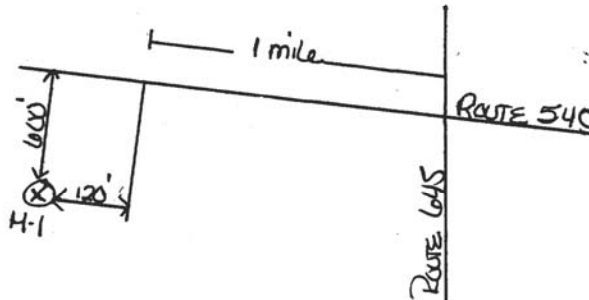
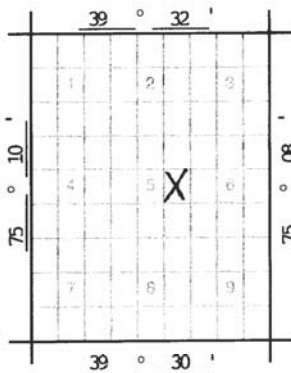
Owner	NJDEP, Div. of Parks & Forestry State Park Service	Driller	A.C. Schultes, Inc.
Address	CN 404 Trenton, NJ 08625	Address	664 S. Evergreen Avenue Woodbury, NJ 08096
Name of Facility	Parvin State Park	Diameter of Well(s)	4 Inches
Address	701 Almond Road Pittsgrove, NJ 08318-3928	Proposed Depth of Well(s)	1200 Feet
		# of Wells Applied for (max. 10)	1
		Will pumping equipment be installed?	YES <input type="checkbox"/> NO <input checked="" type="checkbox"/>
		Type of Well (see reverse)	Monitoring
		If Yes, give pump capacity	cumulative GPM

LOCATION OF WELL(S) M-1

Lot #	Block #	Municipality	County
2	2801	Pittsgrove	Salem

Draw sketch of well(s) nearest roads, buildings, etc. with marked distances in feet. Each well MUST be labeled with a name and/or number on the sketch.

State Atlas Map No. 35



N ↑

N39 30'55" W75 08'42" No water/sewer within 50'

FOR MONITORING WELLS, RECOVERY WELLS, OR PIEZOMETERS, THE FOLLOWING MUST BE COMPLETED BY THE APPLICANT. PLEASE INDICATE WHY THE WELLS ARE BEING INSTALLED:

- Spill Site
- ISRA Site
- CERCLA (Superfund) Site
- RCRA Site
- Underground Storage Tank Site
- Operational Ground Water Permit Site
- Pretreatment and Residuals Site
- Water and Hazardous Waste Enforcement Case
- Water Supply Aquifer Test Observation Well
- Other (explain) _____

CASE I.D. Number _____

This Space for Approval Stamp

WELL PERMIT APPROVED
N.J.D.E.P.

MAY 30 1997

BUREAU OF WATER ALLOCATION

<p>FOR D.E.P. USE</p>	<input type="checkbox"/> Issuance of this permit is subject to the conditions attached. (see next page)	<input checked="" type="checkbox"/> The well(s) may not be completed with more than 25 feet of total screen or uncased borehole.
	<input checked="" type="checkbox"/> For monitoring purposes only	

SEE REVERSE SIDE FOR IMPORTANT PROVISIONS AND REGULATIONS PERTAINING TO THIS PERMIT.

In compliance with N.J.S.A. 58:4A-14, application is made for a permit to drill a well as described above.

Date 5.30.97 Signature of Driller James F. Schultes, Jr. Registration No. M-1152
022009 Signature of Owner Carol E. Ueberstrom

COPIES: Water Allocation — White Health Dept. — Yellow Owner — Blue WELPMT 014 0296

Figure 15. Well 6 monitoring well permit.

DWR-138 M
11/96

New Jersey Department of Environmental Protection
Bureau of Water Allocation
MONITORING WELL RECORD

Well Permit No. 35-17766

Atlas Sheet Coordinates 35-01-256

OWNER IDENTIFICATION - Owner NJDEP DIV PARKS & FORESTRY
Address CN 404
City TRENTON State NJ Zip Code _____

WELL LOCATION - If not the same as owner please give address. Owner's Well No. CBS-A
County SALEM Municipality PITTSBORO TWP. Lot No. 2 Block No. 2801
Address 701 ALMOND RD

DATE WELL STARTED 6 / 2 / 97
DATE WELL COMPLETED 6 / 27 / 97
TYPE OF WELL (as per Well Permit Categories) MONITORING
Regulatory Program Requiring Well AT OBS WELL Case I.D.# _____

CONSULTING FIRM/FIELD SUPERVISOR (if applicable) _____ Tele. # _____

WELL CONSTRUCTION
Total depth drilled 1135.0 ft.
Well finished to 1025.0 ft.
Borehole diameter:
Top 8.0 in.
Bottom 8.0 in.

Well was finished: above grade
 flush mounted
If finished above grade, casing height (stick up) above land surface 3.0 ft.
Was steel protective casing installed?
 Yes No
Static water level after drilling 100.0 ft.
Water level was measured using M Scope
Well was developed for airlift hours at 10 gpm

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	0.0	1005.0	4.0	Steel	Std.
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used <u>1</u>)	1005.0	1025.0	4.0	Stainless St.	304 / .020 slot
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	960.0	1025.0		Morie Gravel	#1
Grout	0.0	960.0		Neat Cement Bentonite	3000 lbs.

Method of development airlift
Was permanent pumping equipment installed? Yes No
Pump capacity N/A gpm
Pump type: _____
Drilling Fluid mud Type of Rig D-9
Health and Safety Plan submitted? Yes No
Level of Protection used on site (circle one) None (D) C B A

Grouting Method Tremie Pipe
Drilling Method Rotary

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.
Drilling Company A.C. SCHULTES INC.
Well Driller (Print) F. Steffen
Driller's Signature F. Steffen
Registration No. J-1619 Date 7/21/97

GEOLOGIC LOG	
Note each depth where water was encountered in consolidated formations.	
<u>Iron sand, white sand</u>	<u>0 - 30'</u>
<u>Gray and yellow clay</u>	<u>30 - 55'</u>
<u>Gray clay</u>	<u>55 - 75'</u>
<u>Gray clay, fine black sand with shells</u>	<u>75 - 135'</u>
<u>Black clay with shells</u>	<u>135 - 215'</u>
<u>Gray clay with shells</u>	<u>215 - 435'</u>
<u>Fine gray sand and green clay</u>	<u>435 - 475'</u>
<u>Hard gray clay</u>	<u>475 - 620'</u>
<u>Glaucopititic sand, gray clay</u>	<u>620 - 630'</u>
<u>Fine black sand and black clay</u>	<u>630 - 700'</u>
<u>Fine black sand</u>	<u>700 - 735'</u>
<u>Gray clay, hard</u>	<u>735 - 915'</u>
<u>Cemented zone, hard clay with shells</u>	<u>915 - 995'</u>
<u>Fine gray sand and gray clay</u>	<u>995 - 1035'</u>
<u>Gray clay, some red clay</u>	<u>1035 - 1075'</u>
<u>Gray clay, fine gray sand</u>	<u>1075 - 1105'</u>
<u>Red clay, yellow clay, gray clay</u>	<u>1105 - 1135'</u>

COPIES: White - DEP Canary - Driller Pink - Owner Goldenrod - Health Dept.

WELREC 175 0227

Figure 16. Well 6 monitoring well record.

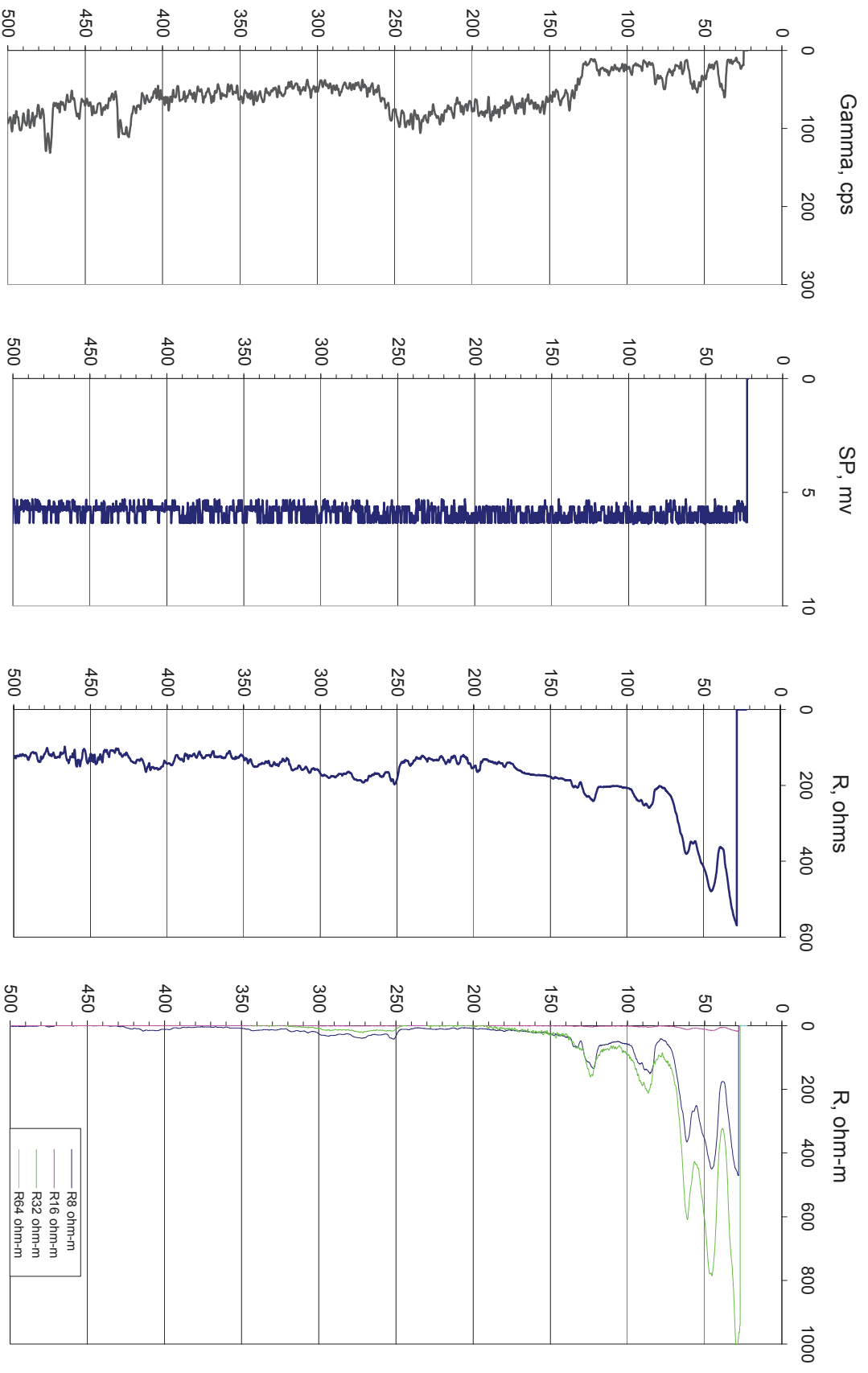


Figure 17. Wells 5 and 6 geophysical logs.

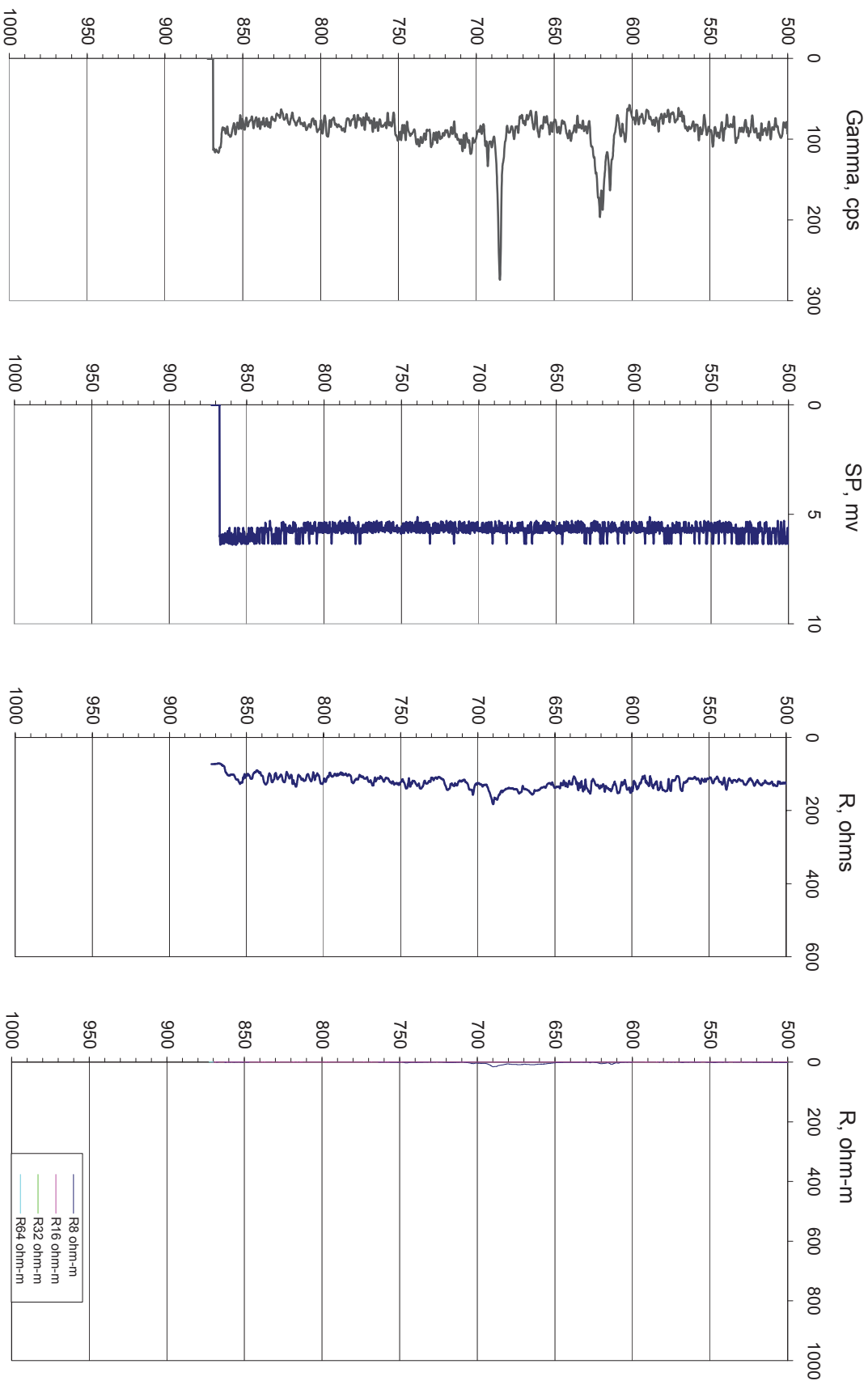


Figure 17. Wells 5 and 6 geophysical logs (continued).

**Well 7
Coyle Field Site Details**

At NJDEP, Division of Parks and Forestry, State Forest Fire Service, Facility at Coyle Field, Woodland Township, Burlington County. The well is at the southwestern end of the Maintenance Facility, in the surplus materials storage area. The facility is 0.5-mile east of mile marker 10, on the south side of Route 72.
 Location: 39° 49' 04.175" N 74° 25' 35.387" W
 Elevation (land surface): 186.8 feet
 Elevation (top of casing): 190.5 feet
 Well permit no.: 32-21805
 Atlas Sheet Coordinate no.: 32.14.845
 Depth drilled (below land surface): 1,779 feet
 Aquifer screened: upper aquifer Potomac-Raritan-Magothy aquifer system (upper PRM)
 Formation screened: Magothy Formation
 Screen interval: 1,420-1,440 feet below land surface, with 0.020 inch, 304-stainless steel
 Casing: 4-inch black steel, extending to 3 feet above land surface, with no tail piece below screen
 Gravel pack: Morie grade no. 1 well gravel
 Driller: James Steffen, A.C. Schultes, Inc.
 Drilling method: Mud rotary
 Borehole geophysically logged: 06/20/97, by John Curran, NJGS, witnessed by Lloyd Mullikin, NJGS
 Well development: completed 07/15/97, witnessed by Lloyd Mullikin and Steven Johnson, NJGS
 Date well completed: 07/15/97

**Well 7
Coyle Field Sample Descriptions¹
24-inch split-spoon cores and ditch samples**

Depth (feet)	Recovery (feet)	Lithology
0-30	Ditch sample	Sand and gravel, quartz, iron-stained, reddish-yellow (7.5YR 6/6); sand, very coarse to coarse, some medium; gravel, mostly 5 to 10 mm, some over 5 cm; clay, white (10YR 8/1) and reddish-yellow (5YR 7/6)
30-75	Ditch sample	Sand and gravel, quartz; sand, very coarse to medium, light-gray (10YR 7/2); gravel, mostly 3 to 6 mm, some up to 1 cm, white to yellow (10YR 8/6) and light-reddish-brown (5YR 6/3), iron-stained, some transparent grains; clay, white (10YR 8/1) to yellow (10YR 8/6), iron-stained; some bog iron; trace shell fragments
85	--	Change to sand, noted by driller
75-105	Ditch sample	Sand, coarse to medium, very pale-brown (10YR 7/4), quartz, subround to subangular; some clay, white (10YR 8/1) to yellow (10YR 8/6); heavy minerals, less than 0.5 percent
105-141	Ditch sample	Sand, very coarse to fine, mostly coarse, pale-brown (10YR 6/3), quartz; some clay, light-yellowish-brown (10YR 6/4) to white (10YR 8/2); some lignite; heavy minerals, less than 1 percent
141-171	Ditch sample	Clay, sand and gravel; clay, light-yellowish-brown (10YR 6/4) to white (10YR 8/2) and some light-brown (7.5YR 6/4); sand, very coarse to medium, light-yellowish-brown (10YR 6/4), quartz; gravel, up to 3-mm, white to clear, iron-stained, quartz; trace bog iron; heavy minerals, less than 1 percent
171-173	1.50	Clay, light-yellowish-brown (10YR 6/4) to white (10YR 8/2), soft; sand, very coarse to medium, quartz
215	--	Borehole took a lot of water, noted by driller
232-234	0.65	Clay and sand; clay, sandy, very dark-brown (10YR 2/2) in top 0.20 foot, pale-brown (10YR 6/3) and very dark-brown (10YR 2/2) 0.50 to 0.60 foot from top; lignite in very dark-brown (10YR 2/2) clay; sand, medium to very coarse, yellowish-brown (10YR 5/4), quartz
263-265	0.50	Sand and clay; sand, coarse to medium, brownish-yellow (10YR 6/6), quartz; clay, dark-gray (10YR 4/1), top 0.12 foot
293-295	0.40	Sand, coarse to medium, pale-brown (10YR 6/3), quartz, subround; heavy mineral, medium to fine, black, 1 percent
305	--	Possible change to clay, noted by driller
323-325	0.75	Sand, medium to fine, dark-gray (5Y4/1), quartz, uniform; micaceous; some heavy mineral
355-357	0.65	Sand, medium to fine, dark-gray (5Y4/1), quartz, uniform; micaceous; some heavy mineral
386-388	1.00	Sand and clay; sand, medium to fine, dark-olive-gray (5Y 3/2), quartz, uniform; micaceous; clay, dark-gray (5Y 4/1), soft, top 0.15 foot
417-419	2.00	Clay, dark-olive-gray (5Y 3/2), hard, dry, uniform; sand, fine to medium, quartz; micaceous; shell fragments, thin, friable
448-450	0.90	Clayey sand, light-olive-gray (5Y 6/2); sand, coarse to very coarse, quartz; glauconite, medium to coarse, black; chlorite, coarse to medium, greenish; shell fragments; micaceous
479-481	0.60	Sand, less clayey, coarse to medium, light-olive-gray (5Y 5/2), quartz; glauconite, medium to coarse, black

**Well 7
Coyle Field Sample Descriptions¹
24-inch split-spoon cores and ditch samples**

Depth (feet)	Recovery (feet)	Lithology
511-513	1.95	Sand, increasingly clayey matrix, coarse to medium, olive-gray (5Y 4/2), quartz, uniform; glauconite, medium to coarse, black; micaceous; shell fragments, thin
541-543	1.67	Sandy clay, olive-gray (5Y 4/2), hard, uniform; sand, coarse to medium, some very coarse, quartz; glauconite, medium to coarse, black; some chlorite, greenish; shell fragments, very friable, fine
572-574	1.65	Glauconitic clay, light-olive-gray (5Y 5/2), hard, uniform; glauconite, fine to medium, black; sand, fine to medium, quartz and chlorite; shell fragments, up to 2 mm, thin; forams
603-605	1.80	Sandy glauconitic clay, grayish-olive-green (5GY 4/2), hard; glauconite, quartz and chlorite, in near equal amounts, medium to fine; shell fragments, very fine, thin, up to 5 percent; forams
634-636	1.70	Clay, grayish-olive-green (5GY 4/2) and olive-gray (5Y 3/1) in top 0.20 foot and bottom 0.30 foot, and some olive-gray (5Y 3/1) inclusions, very hard; micaceous; forams; shell fragments, very fine; some pyritic replacement, up to 1mm
666-668	0.65	Clay, light-olive-gray (5Y 5/2), hard, uniform; sand, fine to medium, quartz; glauconite, fine to medium, black; some chlorite, fine to medium, greenish; some shell fragments, very fine; forams
696-698	1.20	Clay, grayish-olive (10Y 5/2) in top 0.45 foot, hard; forams; glauconite, fine to very fine; glauconitic clay, light-olive-gray (5Y 5/2), in bottom 0.20 foot; glauconite, medium to fine, some coarse, black; chlorite, medium to fine, greenish; forams
727-729	1.60	Clay, dusky-yellow-green (5GY 5/2), hard, uniform; sand, very fine to fine, quartz; forams
758-760	1.65	Clay, dusky-yellow-green (5GY 6/2), hard, uniform; forams; some shell fragments, thin, friable; some sand, very fine to fine, quartz; some glauconite, very fine, black
789-791	2.00	Clay, greenish-gray (5GY 5/1), hard, uniform; forams; some pyrite, very fine, along vertical fractures
810-812	1.55	Clay, greenish-gray (5GY 5/1), hard, uniform; sand, fine to medium, quartz, glauconite and some chlorite; some shell fragments, very fine to fine; some pyritic inclusions, fine
841-843	1.70	Clay, olive-gray (5Y 3/2), hard, uniform; sand, very fine to fine, quartz; some glauconite, very fine, black; mica, fine to medium
872-874	1.40	Glauconitic clay, olive-black (5Y 2/1), hard, uniform; glauconite, coarse to medium, black; some chlorite, coarse to medium, greenish; some sand inclusions, medium, quartz
903-905	1.20	Clay, black (5Y 2.5/2) and dark-olive-gray (5Y 3/2), hard, uniform; glauconite, medium to fine, black; some chlorite, medium, greenish
908-910	1.35	Glauconitic clay, dark-gray (5Y 4/1), hard, uniform; glauconite, medium to fine, some coarse, black; chlorite, medium to fine, trace coarse, greenish; some mica, very fine
910-912	0.95	Glauconitic clay, dark-gray (5Y 4/1), hard; glauconite, fine to coarse, black; some chlorite, fine to medium; trace shell fragments, fine
934-936	0.50	Sand, medium to coarse, olive-gray (5Y 4/1), quartz, glauconite and some chlorite; clay, olive-gray (5Y 4/1), soft, in top 0.15 foot
966-968	0.60	Sand, very dark-gray (5Y 3/1), medium quartz, fine glauconite, medium to fine chlorite; micaceous
997-999	1.55	Clayey sand, very dark-gray (5Y 3/1), uniform; sand, medium to fine, quartz; glauconite, fine to medium, black; chlorite, fine to medium, greenish; mica, very fine
1,026-1,028	1.20	Clay, very dark-gray (5Y 3/1), hard, uniform; micaceous; sand, fine to medium, quartz and some chlorite; some shell fragments, very fine to fine
1,057-1,059	1.20	Clayey sand and clay; clayey sand, dark-greenish-gray (5GY 4/1); sand, very fine to medium, glauconite, quartz and chlorite; shell fragments, thin, friable; some mica; clay, olive-black (5Y 2/1), soft, malleable, in top 0.15 foot
1,088-1,090	1.00	Clay, very dark-gray (5Y 3/1), hard, dry, uniform; shell fragments, thin; sand inclusions, medium to very fine, quartz; micaceous
1,119-1,121	0.90	Clayey sand, very dark-gray (5Y 3/1), with sand laminations; sand, medium to fine, quartz; some chlorite, medium to fine, greenish; micaceous
1,150-1,152	1.55	Clay, black (5Y 2.5/1), hard, uniform; mica, fine to very fine; sand, fine to very fine, quartz, some in laminations; some chlorite, fine to very fine; shell fragments, fine, thin
1,181-1,183	1.10	Clay, black (5Y 2.5/1), very hard, uniform; sand, very fine to fine, quartz; mica, fine to medium, some coarse; shell fragments, fine to medium, very thin
1,211-1,213	1.15	Clay, black (5Y 2.5/1), very hard, uniform; sand, very fine to fine, quartz; mica, fine to very fine; shell fragments, very fine to large, thin
1,244-1,246	1.90	Clay, black (5Y 2.5/1), very hard, uniform; mica, fine to medium; shell fragments, increasing in quantity and size, very thin, pearly luster, up to 1-cm; sand, very fine to fine and silt, quartz

Well 7
Coyle Field Sample Descriptions¹
24-inch split-spoon cores and ditch samples

Depth (feet)	Recovery (feet)	Lithology
1,275- 1,277	0.85	Clay, black (5Y 2.5/2), very hard, uniform; sand, fine to medium, quartz and glauconite; micaceous, fine to very fine; shell fragments, thin, fine; trace pyrite
1,306- 1,308	0.58	Glauconitic clay, black (5Y 2.5/1), hard; with dark-gray inclusions (5Y 4/1) which are much less glauconitic and fossiliferous; glauconite, medium to very fine, black; trace chlorite, fine to very fine, greenish; shell fragments, fine to very fine, thin; trace mica, fine to very fine
1,312- 1,314	1.10	Glauconitic clay, very dark-gray (5Y 3/1) to black (5Y b2.5/1), hard; glauconite, very fine to medium, black; increased chlorite and quartz, very fine to fine, some medium; some shell fragments, fine to very fine, thin; mica, fine to very fine
1,337- 1,339	0.56	Clay, black (5Y 2.5/2), soft, in top 0.18 foot; clay, light-gray (5Y 7/1) with alterations and inclusions of red (2.5YR 5/6), hard, in bottom 0.38 foot
1,368- 1,370	1.05	Clayey sand, light-brownish-gray (10YR 6/2); sand, medium to fine, quartz; some mica, medium to fine; some pyrite, medium; sand, at 0.20-0.40 foot from top
1399-1401	0.65	Sand, coarse to medium, grayish-brown (10YR 5/2), quartz; trace mica
1,430- 1,432	0.50	Sand and gravel, grayish-brown (10YR 5/2); sand, very coarse to medium, quartz; glauconite, coarse to medium, black, 15 percent of top 0.25 foot; gravel, up to 1 cm, quartz, some iron staining, in top 0.25 foot; sand, very coarse to medium, quartz, in bottom 0.25 foot
1,461- 1,463	0.50	Clay and gravel, olive-gray (5Y 3/1), very hard; gravel, quartz, up to 1.5-cm, subround; sand, medium to very fine, quartz; some glauconite and chlorite, fine to very fine; abundant shell fragments, thin, friable
1,491- 1,493	1.00	Silty clay, dark-gray (5Y 4/1), hard, uniform; sand, very fine to fine, quartz; mica, fine to very fine; shell fragments
1,522- 1,524	0.80	Clay, black (5Y 2.5/2), hard, uniform; shell fragments, thin, some with pearly luster; forams, well preserved; sand, very fine to fine, quartz; mica, fine to very fine; silt
1,553- 1,555	0.86	Silty sand, gray (5Y 5/1); sand, medium to coarse, quartz; some chlorite, medium, greenish; some shell fragments, medium to fine, thin; some glauconite, fine, black
1,583- 1,585	0.50	Sandy silt, gray (5Y 5/1); sand, very fine to medium, quartz; chlorite, very fine to medium, greenish; glauconite, fine to medium, some coarse, black; mica, medium to coarse; shell fragments, thin, friable, up to 1 cm
1,615- 1,617	1.45	Sandy silt, dark-gray (5Y 4/1), hard, uniform; sand, very fine to medium, quartz; very micaceous, fine to very fine; shell fragments, thin
1,646- 1,648	1.13	Silty sand, dark-gray (5Y 4/1); sand, medium to very fine, quartz; very micaceous, fine to coarse; chlorite, fine to medium, greenish; glauconite, fine, black; abundant shell fragments, thin, friable; gravel, shells and clay, in top 0.3 foot, appears to represent a zone immediately above; gravel, quartz, up to 8 mm; shell fragments, up to 1 cm, much thicker; clay chips, dusky-yellow-green (5GY 3/2), hard, brittle
1,676- 1,678	1.10	Sandy clay, gray (5Y 4.5/1), hard; sand, medium to fine, quartz
1,707- 1,709	1.20	Clay, very dark-gray (5Y 3/1), hard, uniform; pyritic inclusions
1,739- 1,741	0.90	Clay, very dark-gray (5Y 3/1), very hard, dense, uniform; shell fragments, fine to very fine; some sand laminations, fine to very fine, quartz, with mica, fine to very fine
1,772- 1,779	0.40	Sand, fine to very fine, some medium, gray (10YR 5/1), quartz; mica, medium to fine; glauconite, very fine to medium, black

¹Lloyd G. Mullikin, NJGS

**Well 7
Driller's Log¹**

Depth (ft)	Lithology
0-149	Sand and gravel; clay at 38-50 feet
149-158	Clay
158-299	Sand
299-324	Clay, brown; hard at 327-328 feet
324-327.5	Hardpan
327.5-348	Clay
348-351	Sand, hard packed
351-477	Clay, sand streaks
477-580	Silty sand; clay laminations at 544-584 feet
580-608	Clay, hard
608-699	Silty clay
699-713	Silty sand
713-758	Clay; silty laminations
758-900	Clay, hard at 762-860 and 873-904 feet; silty at 860-873 feet
900-904	Silty sand
904-918	Clay, soft; sand laminations
918-942	Sand
942-968	Silty sand
968-992	Clay; soft at 972-991 feet; hard at 991-996 feet
992-998	Sand
998-1008	Silty clay, soft
1,008-1,019	Clay
1,019-1,034	Sand
1,034-1,296	Clay; silty at 1,051-1,056, 1,074-1,102 and 1,109-1,157 feet; hard at 1,056-1,074, 1,102-1,109 and 1,157-1,300 feet
1,296-1,302	Silty sand
1,302-1,346	Silty clay, red and white, soft
1,346-1,452	Silty sand; hardpan at 1,350-1,375 feet; clay laminations at 1,375-1,456 feet
1,452-1,491	Clay
1,491-1,493	Hardpan
1,493-1,539	Silty clay, soft; hard laminations
1,539-1,552	Silty sand
1,552-1,554	Hardpan
1,554-1,576	Clay, hard
1,576-1,581	Hardpan
1581-1,626	Silty clay; hardpan
1,626-1,644	Clay; red, hard at 1,630-1,641 feet; some gravel at 1,641-1,648 feet
1,644-1,657	Sand
1,657-1,673	Clay; hard spots at 1,661-1,707 feet; gray and hardpan at 1,707-1,777 feet
1,673-1,675	Sandy clay, very hard

¹James and Frank Steffens, A.C. Schultes, Inc. Modified by Lloyd Mullikin, NJGS

**Well 7
Geologic and Hydrogeologic Units¹**

Elevation (land surface): 186.8 feet

Depth below sea level (ft)	Formation	Age
- 43	Cohansey Sand	Miocene
-233	Kirkwood Formation	Miocene
-395	Atlantic City Formation	upper Oligocene
- 493	Shark River Formation	lower Eocene
- 553	Manasquan Formation	lower Eocene
- 673	Vincentown Formation	Paleocene
- 693	Hornerstown Formation	Paleocene
- 735	Navesink Formation	upper Cretaceous
- 793	Mount Laurel Sand	upper Cretaceous
?	Wenonah Formation	upper Cretaceous
- 833	Marshalltown Formation	upper Cretaceous
- 853	Englishtown Formation	upper Cretaceous
?	Woodbury Clay	upper Cretaceous
- 1033	Merchantville Formation	upper Cretaceous
- 1141	Cheesequake Formation	upper Cretaceous
- 1263	Magothy Formation	upper Cretaceous
- 1488	Raritan Formation	upper Cretaceous
	Potomac Group	upper Cretaceous

¹Peter Sugarman, NJGS

Contacts of Geologic Units by James V. Browning, Rutgers University, Lloyd Mullikin and Peter Sugarman, NJGS

**Well 7
Elevation and Thickness of Hydrogeologic Units¹**

Depth above and below Sea level (ft)		Thickness of unit (feet)	Hydrogeologic Unit
Top	Bottom		
+186.8	-113	299.8	Kirkwood-Cohansey aquifer system
-235	-373	138	Piney Point aquifer/upper sand
-737	-773	36	Wenonah-Mount Laurel aquifer (poor producer)
-833	-853	20	Englishtown aquifer system (very poor producer)
-1,149	-1,269	120	Potomac-Raritan-Magothy aquifer system/upper aquifer
-1,356	-1,474	118	Potomac-Raritan-Magothy aquifer system/middle aquifer(alternating sand and clay)

¹Lloyd Mullikin, NJGS

Analysis of Cuttings and Split-Spoon Cores¹
Coyle Field Borehole

Sample depth	Formation	Description
--	--	Seventeen samples from the Coyle Field borehole were analyzed for lithology and foraminifers. Analysis focused on Paleogene to Maastrichtian units. An attempt was made to correlate the data obtained with the well log. Note that the well log and sample depths are not always in agreement, possibly indicating an offset in the well log. Further analysis might include strontium isotope age analysis on shells recovered at 450 feet, and possibly samples from 416 and 602 feet to help refine the affinities of the sediments.
386-388 and 417-419	Kirkwood	Typical Kirkwood lithology
479-481	upper middle Eocene to Oligocene, exact unit unknown	Sand, very coarse, 75 percent of sample, 70 percent quartz and 30 percent glauconite, green, some brownish; 1-large poorly preserved foram – possibly <i>Lenticulina</i>
511-513	upper middle Eocene to Oligocene, exact unit unknown	Sand, 68 percent of sample; 70 percent quartz, 10 percent glauconite, 20 percent heavily encrusted shells and foraminifers
541-543	probably upper middle Eocene sequence E8/9 (Browning and others, 1997)	Sand, 57 percent of sample; 50 percent quartz, 25 percent glauconite, 25 percent poorly preserved shells/forams; <i>Gyroidinoides</i> , <i>Cibicoides</i> , <i>C. aff. Praemundulus</i> , <i>Marginulina</i>
572-574	probably upper middle Eocene sequence E8/9. Entire unit from 416-602 feet may represent a single upward coarsening sequence of middle Eocene age. Alternatively, a gamma log shift at 540 feet may indicate that this unit comprises two or more sequences.	Sand, 38 percent of sample; 70 percent glauconite, 15 percent quartz, 15 percent forams/shell fragments; abundant fauna including <i>T. pomeroli</i> , <i>G. praebulloides</i> , <i>Acarinina</i> and <i>Morozovella</i> ; common benthics include <i>Globobulimina</i> , <i>Lenticulina</i> , <i>Cibicidina blanchi</i> , <i>Siphonina</i> and <i>Gyroidinoides</i>
634-636	middle Eocene, Shark River Formation, probably middle Eocene sequence E7 (Browning and others, 1997); 602 feet, probable contact with overlying unit.	Sand, 10 percent of sample, made up of mostly foraminifers and radiolarians with a small quantity of glauconite and quartz; slightly micaceous Benthic forams include <i>Cibicoides subspiratus</i> , <i>Melonis barleeianum</i> , <i>Lenticulina</i> , <i>Cibicoides spp.</i> , <i>Massilina decorata</i> , <i>Guttulina</i> , <i>Ceratocancris</i> , <i>Pyramidina subrotundata</i> , <i>Spiroplectammina</i> ; planktonic forams include <i>Pseudohastigerina</i> , <i>Acarinina</i>
666-668	Glauconite suggests sample is near the lower Shark River marl, and is near the lower/middle Eocene boundary.	Sand, 62 percent of sample, did not completely break down; 50 percent glauconite, 50 percent carbonate. Forams, mostly poorly preserved, <i>Cibicoides subspiratus</i> , <i>Gyroidinoides</i> , <i>Lenticulina</i> , some <i>Acarinina</i> ; relatively few plankton
696-698	lower Eocene, Manasquan Formation; sample possibly sequence E4 (Browning and others, 1997); contact between Manasquan Formation and Shark River Formation at gamma log peak at 660 foot depth	Sand, fine, 19 percent of sample; 50 percent quartz, 35 percent forams, 15 percent glauconite; micaceous <i>Subbotina inaequispira</i> , <i>S. linaperta</i> , <i>Acarinina spp.</i> , <i>Cibicoides spp.</i> , <i>Siphonina claibornensis</i> , <i>Gyroidinoides</i>

Analysis of Cuttings and Split-Spoon Cores¹
Coyle Field Borehole

Sample depth	Formation	Description
727-729	lower Eocene, Manasquan Formation	Sand, 9 percent of sample; 90 percent forams, 10 percent glauconite and quartz <i>C. pseudoungeriana</i> , <i>Cibicidoides</i> spp., <i>Anomalinoidea</i> , <i>Siphonina</i> , <i>Acarinina</i> spp., <i>Pseudohastigerina</i> , <i>Subbotina</i>
758-760	lower Eocene, Manasquan Formation	Sand, 6 percent of sample; 95 percent forams, 5 percent glauconite and quartz; micaceous; some radiolarians <i>Acarinina</i> spp., <i>Pseudohastigerina</i> , <i>Subbotina</i> , <i>Cibicidoides</i> aff. <i>Subspiratus</i> , <i>C. eocaenus</i> , <i>Anomalinoidea acuta</i> , <i>Lenticulina</i> . Benthic fauna and increased plankton typically indicate deeper water than does the previous sample interval.
789-791	lower Eocene, Manasquan Formation, probably sequence E2 (Browning and others, 1997)	Sand, less than 1 percent of sample, mostly forams; very well preserved, very deep water; some quartz <i>Acarinina soldadoensis</i> , <i>Morozovella questra</i> , <i>Morozovella gracilis</i> ; <i>Trifarina wilcoxensis</i> , <i>Anomalinoidea</i> . Plankton much more abundant than benthics
810-812	lower Eocene, Manasquan Formation, probably sequence E1 (Browning and others, 1997)	Sand, 20 percent of sample; 70 percent glauconite, 20 percent quartz, 10 percent forams Benthics: <i>Cibicidoides</i> , <i>C. cf. mimulus</i> , <i>Gyroidinoidea</i> , <i>Bulimina</i> , <i>Gavelinella</i> Plankton: <i>Acarinina</i> , <i>Subbotina</i>
841-843	Vincetown Formation based on lithology and position. Contact with Manasquan Formation at gamma log peak at 803 foot depth.	Sand, 5 percent of sample; equal parts dark glauconite, light green glauconite, quartz and mica barren of foraminifers
872-874	Hornerstown Formation based on lithology and position. Contact with Vincetown Formation is at gamma log peak at 861 foot depth.	Sand, 61 percent of sample, medium to coarse; glauconite; some sand, very fine, quartz; micaceous. Two benthic foraminifer specimens: <i>Cibicidoides</i> , <i>Anomalinoidea</i>
903-903.2	Navesink Formation; contact with Hornerstown Formation at gamma log peak at 870 foot depth	Sand, 27 percent of sample; 60 percent glauconite, 30 percent quartz, 10 percent forams; diverse and abundant fauna, plankton more common than benthics. Benthics: <i>Siphonina</i> , <i>Cibicidoides</i> , <i>Gyroidinoidea</i> , <i>Marginulina</i> , <i>Globobulimina</i> , <i>Trifarina</i> Plankton: <i>Racimiguembelina fructicosa</i> , <i>Globotruncana</i> and <i>Heterohelix striata</i> , <i>Heterohelix</i> spp
934.2-934.4	Mount Laurel Sand; contact with Navesink Formation at gamma log peak at 914 foot depth.	Sand, 72 percent of sample; 80 percent quartz, 20 percent glauconite; some quartz, clear, stained; some glauconite, dark green and light green, possibly indicating two sources of sediments. No foraminifers noted.
966-966.2	Mount Laurel Sand/Wenonah Formation transition	Sand, 62 percent; 85 percent quartz, 10 percent glauconite, 5 percent mica. Foraminifers are rare: <i>Hedbergella</i> , <i>Anomalinoidea</i>
997-997.2	Wenonah Formation	Sand, 47 percent; 40 percent quartz, 30 percent glauconite, 30 percent mica. Well preserved benthic fauna includes: <i>Cibicidoides</i> , <i>Marginulina</i> , <i>Lenticulina</i> , <i>?Cibicidina</i> , <i>Gavelinella</i> ; few planktonic specimens noted.

¹James V. Browning, Rutgers University

SERIAL # 53807
 DWR-133M (8/95)
 Mail to
 NJDEP
 Bureau Water Allocation
 CN 426
 Trenton, NJ 08625-0426

STATE OF NEW JERSEY
 DEPARTMENT OF ENVIRONMENTAL PROTECTION
 TRENTON, NJ

MONITORING WELL PERMIT 39

VALID ONLY AFTER APPROVAL BY THE D.E.P.

Permit No. 3221805

COORD #: 32 . 14 . 845

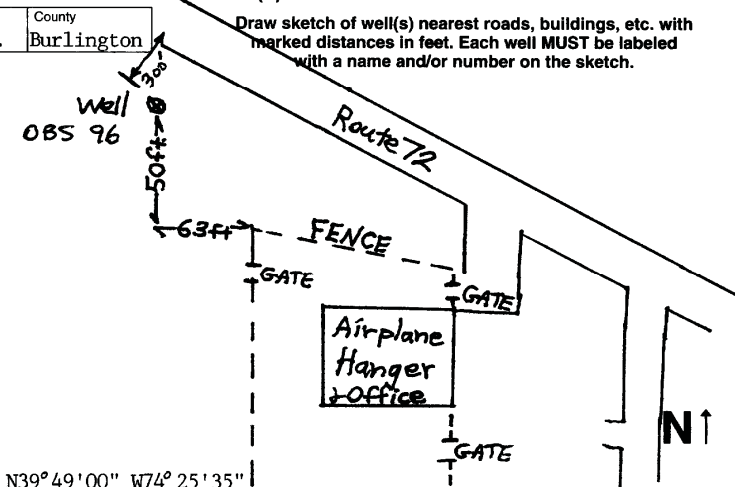
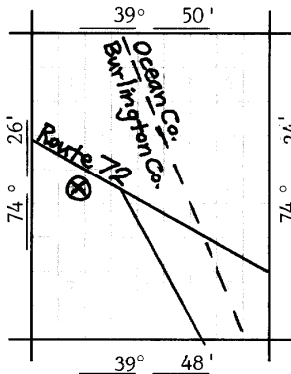
Owner NJDEP, Div. of Parks & Forestry, State Forest Fire Service
 Driller A.C. Schultes, Inc.
 Address CN404
 Address 664 S. Evergreen Ave.
 Trenton, NJ 08625
 Woodbury, NJ 08096
 Name of Facility Coyle Field
 Address Rt. 72
 Woodland Twp., NJ

Diameter of Well(s)	4" Inches	Proposed Depth of Well(s)	1600 Feet
# of Wells Applied for (max. 10)	1	Will pumping equipment be installed?	YES <input type="checkbox"/> NO <input checked="" type="checkbox"/>
Type of Well (see reverse)	Monitoring/OBS	If Yes, give pump capacity cumulative GPM	

LOCATION OF WELL(S)

Lot #	Block #	Municipality	County
101	897	Woodland Twp.	Burlington

State Atlas Map No. 32



Draw sketch of well(s) nearest roads, buildings, etc. with marked distances in feet. Each well MUST be labeled with a name and/or number on the sketch.

FOR MONITORING WELLS, RECOVERY WELLS, OR PIEZOMETERS, THE FOLLOWING MUST BE COMPLETED BY THE APPLICANT. PLEASE INDICATE WHY THE WELLS ARE BEING INSTALLED:

- Spill Site
- ISRA Site
- CERCLA (Superfund) Site
- RCRA Site
- Underground Storage Tank Site
- Operational Ground Water Permit Site
- Pretreatment and Residuals Site
- Water and Hazardous Waste Enforcement Case
- Water Supply Aquifer Test Observation Well
- Other (explain) _____

CASE I.D. Number _____

This Space for Approval Stamp

WELL PERMIT APPROVED
 N.J.D.E.P.

NOV - 7 1996

BUREAU OF WATER ALLOCATION

FOR D.E.P. USE Issuance of this permit is subject to the conditions attached. (see next page) For monitoring purposes only The well(s) may not be completed with more than 25 feet of total screen or uncased borehole.

SEE REVERSE SIDE FOR IMPORTANT PROVISIONS AND REGULATIONS PERTAINING TO THIS PERMIT.

In compliance with N.J.S.A. 58:4A-14, application is made for a permit to drill a well as described above.

Date 9/18/96 Signature of Driller [Signature] Registration No. M-1152
 job # 25069 Signature of Owner [Signature]

COPIES: Water Allocation — White CARL R. NORDSTROM, DEPUTY DIRECTOR Health Dept. — Yellow Owner — Blue WELPMT 033 1579

Figure 18. Well 7 monitoring well permit.

MONITORING WELL RECORD

Well Permit No. 32 21805
Atlas Sheet Coordinates 32 .14 845

OWNER IDENTIFICATION - Owner NJDEP DIV. OF PARKS & FOR
Address CN 404
City TRENTON State NJ Zip Code _____

WELL LOCATION - If not the same as owner please give address. Owner's Well No. OBS-96
County BURLINGTON Municipality WOODLAND TWP Lot No. 101 Block No. 897
Address RT. 72 Date well started 6 / 1 / 97

TYPE OF WELL (as per Well Permit Categories) MONITORING Date well completed 7 / 15 / 97
Regulatory Program Requiring Well AT OBS WELL Case I.D. # _____
CONSULTING FIRM/FIELD SUPERVISOR (if applicable) _____ Tele. # _____

WELL CONSTRUCTION

Total depth drilled 1779.5 ft.
Well finished to 1441.0 ft.
Borehole diameter:
Top 12.0 in.
Bottom 12.0 in.

Well was finished: above grade
 flush mounted

If finished above grade, casing height (stick up) above land surface 3.0 ft.

Was steel protective casing installed?
 Yes No

Static water level after drilling 215.0 ft.

Water level was measured using M Scope

Well was developed for N/A hours at 15 gpm

Method of development Air Lift

Was permanent pumping equipment installed? Yes No

Pump capacity N/A gpm

Pump type: N/A

Drilling Method Rotary

Drilling Fluid Mud Type of Rig D-1

Name of Driller J. Steffen

Health and Safety Plan submitted? Yes No

Level of Protection used on site (circle one) None (D) C B A

N.J. Registration No. M-0642

Name of Drilling Company A.C. SCHULTES INC.

	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Type and Material
Inner Casing	0.0	1416	4.0	Std. Black Steel
Outer Casing (Not Protective Casing)				
Screen (Note slot size)	1416.0	1436.0	4.0	304 Stainless .025 slot
Tail Piece	1436.0	1441.0	4.0	Std. Black Steel
Gravel Pack	1357.0	1441.0		#1 Morie
Annular Seal/Grout	0.0	1357.0		Cement
Method of Grouting	Tremie Pipe			

GEOLOGIC LOG (Copies of other geologic logs and/or geophysical logs should be attached.)

Sand and stone	0 - 34'
Sand and gravel	34 - 46'
Stones and gravel	46 - 153'
Clay	153 - 158'
Sand	158 - 299'
Brown clay	299 - 323'
Silty clay	323 - 351'
Clay and shells	351 - 478'
Silty sand and clay	478 - 581'
Hard clay	581 - 608'
Silty clay	608 - 699'
Clay and silty spots	699 - 758'
Hard clay	758 - 856'
Silty clay	856 - 869'
Silty sand	869 - 910'

CONTINUED - SEE ATTACHED

I certify that I have drilled the above-referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Driller's Signature J. Steffen Date 8, 14, 97

COPIES: White - DEP Canary - Driller Pink - Owner Goldenrod - Health Dept.

WELREC 168 0469

Figure 19a. Well 7 monitoring well record.

Permit # 32-21805
 Coordinates 32:14:845

GEOLOGIC LOG - CONTINUED	
Soft clay	910 - 918'
Sand	918 - 942'
Silty sand	942 - 972'
Hard clay	972 - 988'
Clay	988 - 1008'
Sand	1008 - 1038'
Clay	1038 - 1047'
Silty clay	1047 - 1151'
Hard clay	1151 - 1296'
Silty clay	1296 - 1371'
Sand and clay streaks	1371 - 1456'
Clay	1456 - 1492'
Hard pan	1492 - 1497'
Soft silty clay	1497 - 1543'
Hard pan	1543 - 1554'
Hard clay	1554 - 1576'
Hard pan	1576 - 1585'
Silty clay and hard pan	1585 - 1627'
Red clay	1627 - 1644'
Sand	1644 - 1661'
Red clay and hard pan	1661 - 1703'
Gray clay and hard pan	1703 - 1773'
Very hard drilling	1773 - 1777'
Very hard drilling	1777 - 1779.5'

Figure 19b. Well 7 monitoring well record.

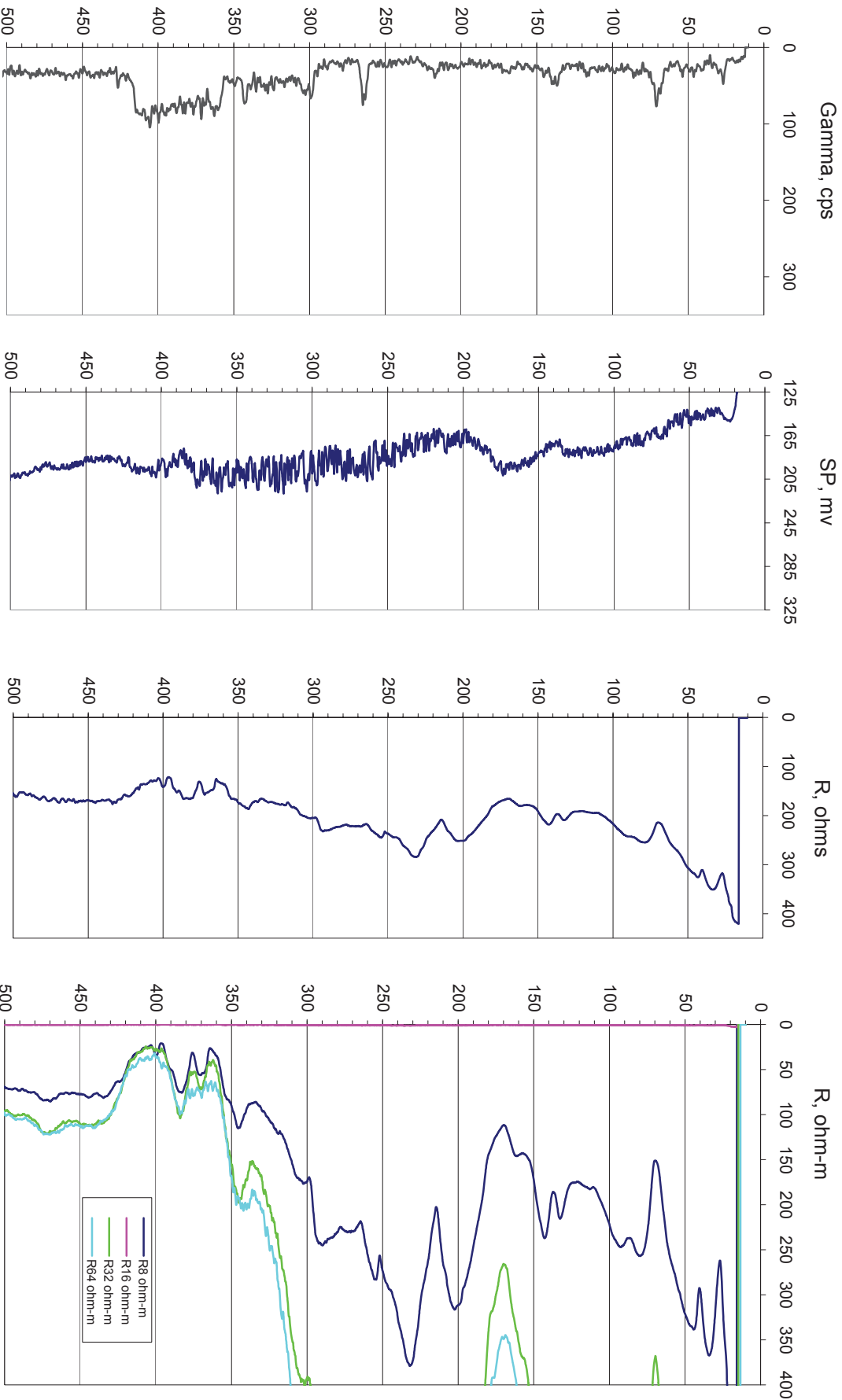


Figure 20. Well 7 geophysical logs

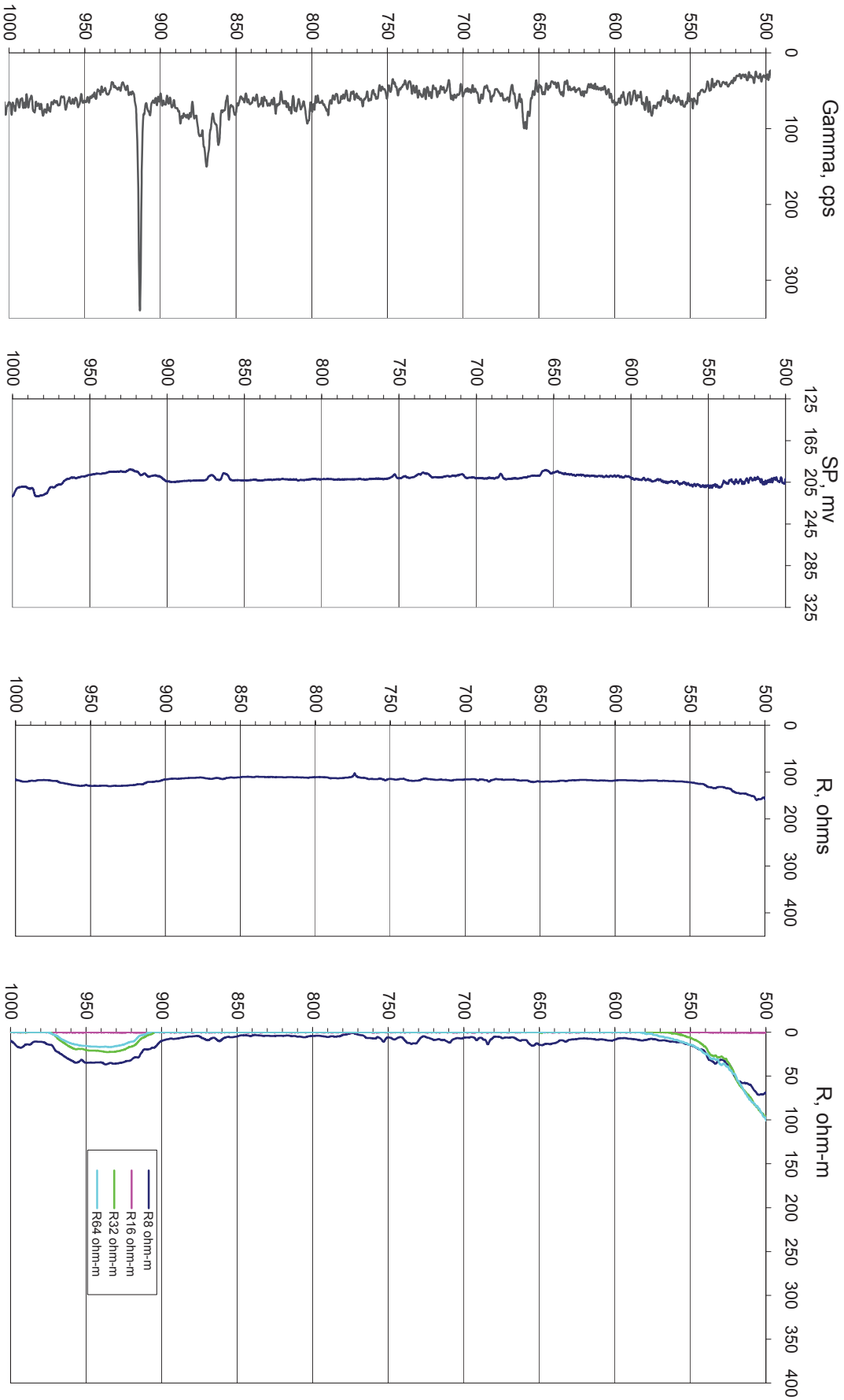


Figure 20. Well 7 geophysical logs (continued).

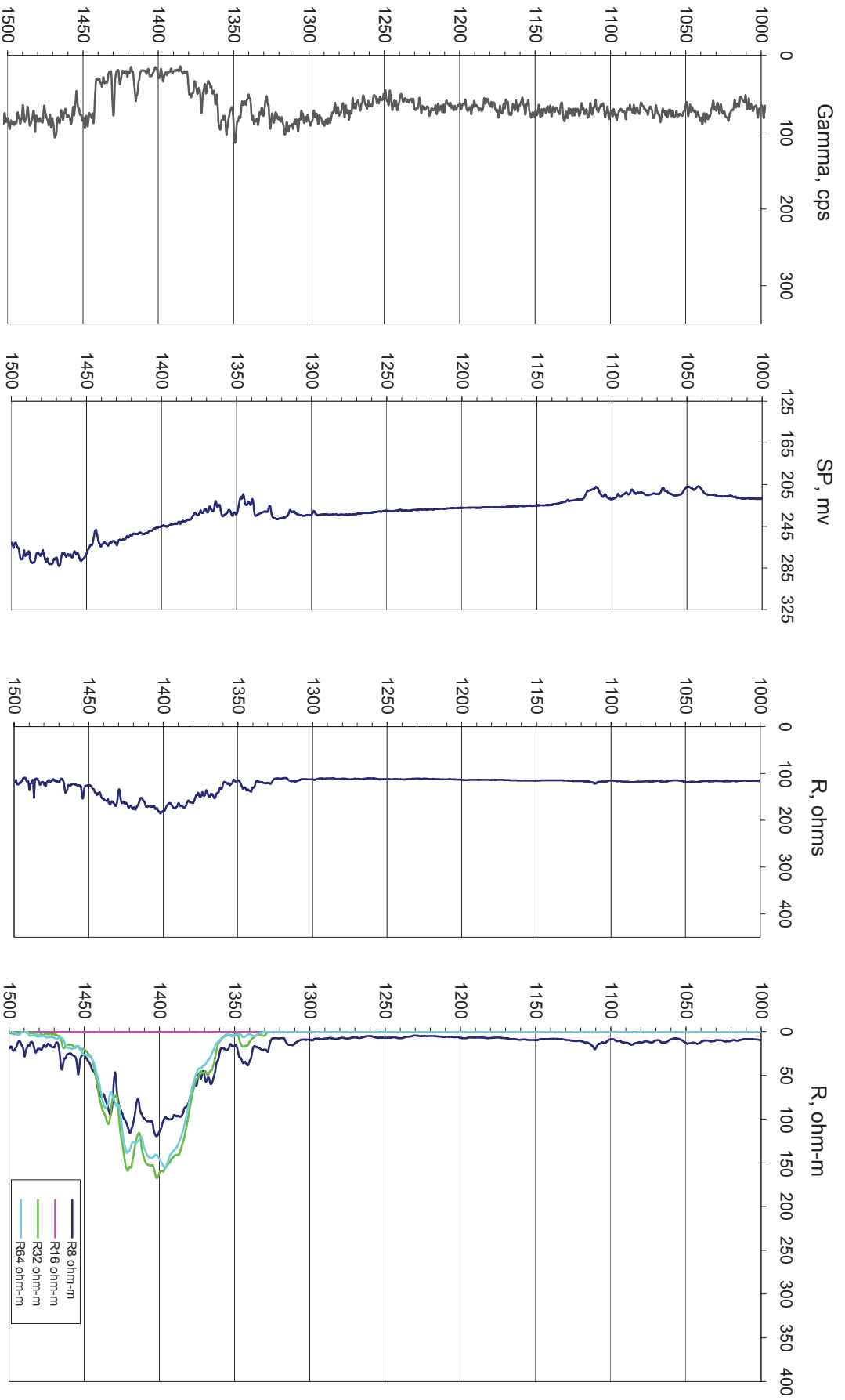


Figure 20. Well 7 geophysical logs (continued).

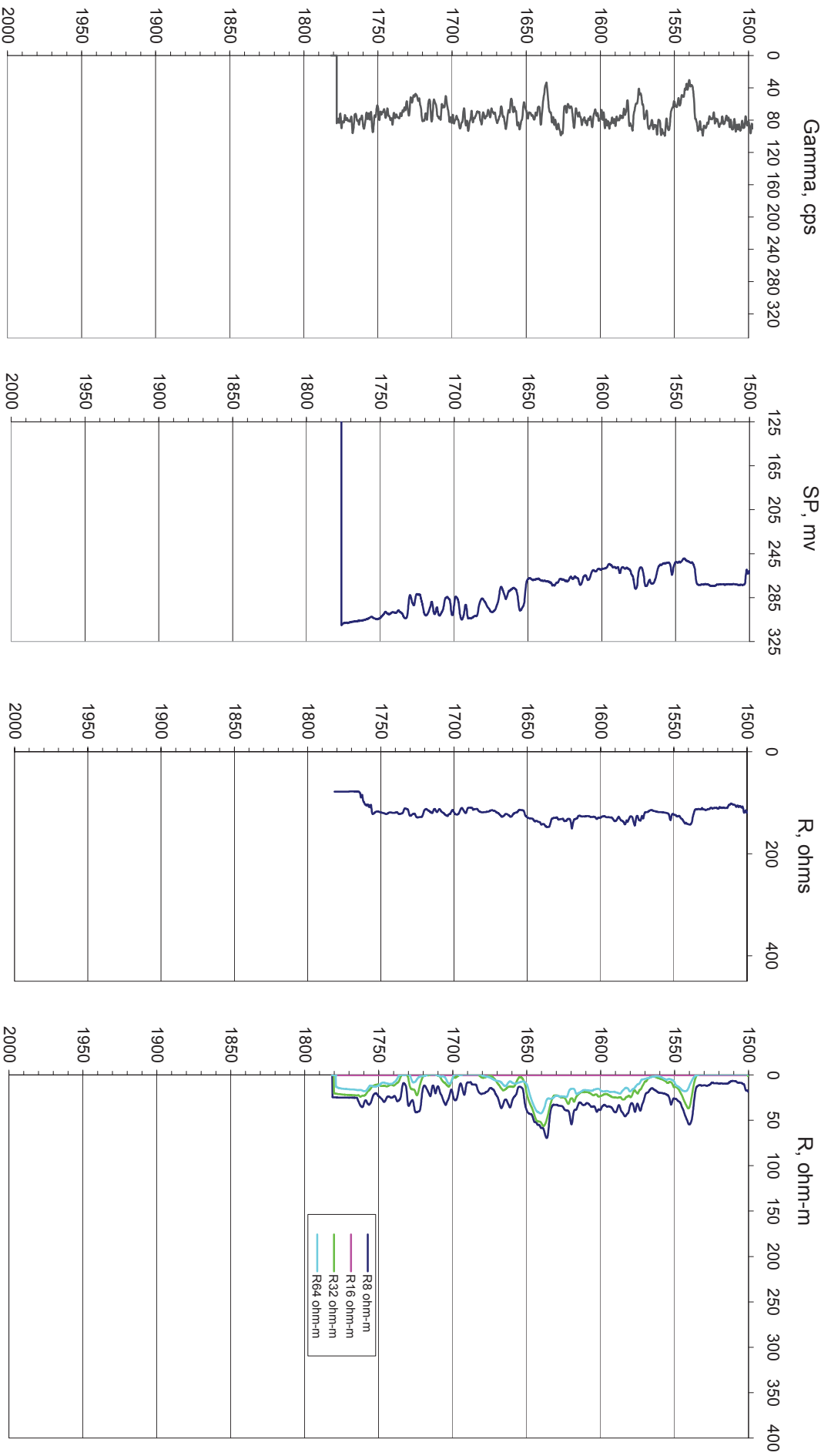


Figure 20. Well 7 geophysical logs (continued)