United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Water Resources Division
Mountain View Office Park
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West Trenton, New Jersey 08628

May 3, 1995

Mr. Stan Lulewicz
Project Engineer
Corps of Engineers, Philadelphia District
Department of the Army
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107-3391

Dear Mr. Lulewicz:

Enclosed please find a preliminary draft of our report on ground-water flow from the dredged-material disposal sites. As we agreed, this draft would primarily include the information on the Channel-Deepening Project sites. This is so that you can preview the findings and conclusions. Please be aware that the drafting is not final and that some of the verbage will expanded. By mid-May, a final draft will be sent to you including information on all of the sites. Please review this draft. Contact me if you have any question or comments.

Sincerely,

Anthony S. Navoy, Ph.D.
Supervisory Hydrologist

enclosure

Evaluation of Ground-Water Flow from Dredged-Material Disposal Sites in Gloucester and Salem Counties, New Jersey

Anthony S. Navoy and Robert Rosman
U.S. Geological Survey
West Trenton, N.J.

INTRODUCTION

The U.S. Army Corps of Engineers, Philadelphia District, routinely dredges to maintain specified depths in the Delaware River ship channel. The Corps of Engineers is also evaluating the feasibility of improvements to the main navigational channel of the Delaware River, that could include deepening the channel from the existing depth of about 40 ft below mean low water to about 45 ft, from deep water in Delaware Bay to Philadelphia, Pa. and Camden, N.J. The disposal of dredged material from these projects onto sites in Gloucester and Salem Counties has raised concerns that contaminants contained in the spoil may leach and may adversely affect nearby ground-water supplies derived from the Coastal-Plain aquifers of New Jersey.

Many public and private ground-water supplies have been developed adjacent to the Delaware River. The Potomac-Raritan-Magothy aquifer system is of particular interest as it is the primary source of water supply for Gloucester and Salem Counties, and crops out along the river, where the disposal sites are located. A previous ground-water investigation (Navoy, 1994) has indicated that much of the Potomac-Raritan-Magothy aquifer system outcrop in Gloucester County contributes water as recharge to the many commercial, industrial, and public-supply wells in the area.

The purpose of this report is to evaluate the possible connection between ground-water recharge, originating at the dredged-material disposal sites, and nearby water supply wells. This was accomplished using ground-water modeling techniques, where available, to delineate the contributing areas of the water-supply wells. For those sites where a ground-water flow model is not available, ground-water level data was collected and the potentiometric surface of the relevant aquifers were evaluated to determine the direction of ground-water flow.

Location of Disposal Sites

Four disposal sites, located near or adjacent to the Delaware River (see figure 1 for locations), are being considered. All of these are adjacent to sites that have been previously used for disposal of dredged material:

Site Name	Location
	Proposed disposal sites for channel-deepening
15G	South side of Oldmans Creek near Pedricktown, Salem County, N.J., approximately 1 mile inland from the Dela-

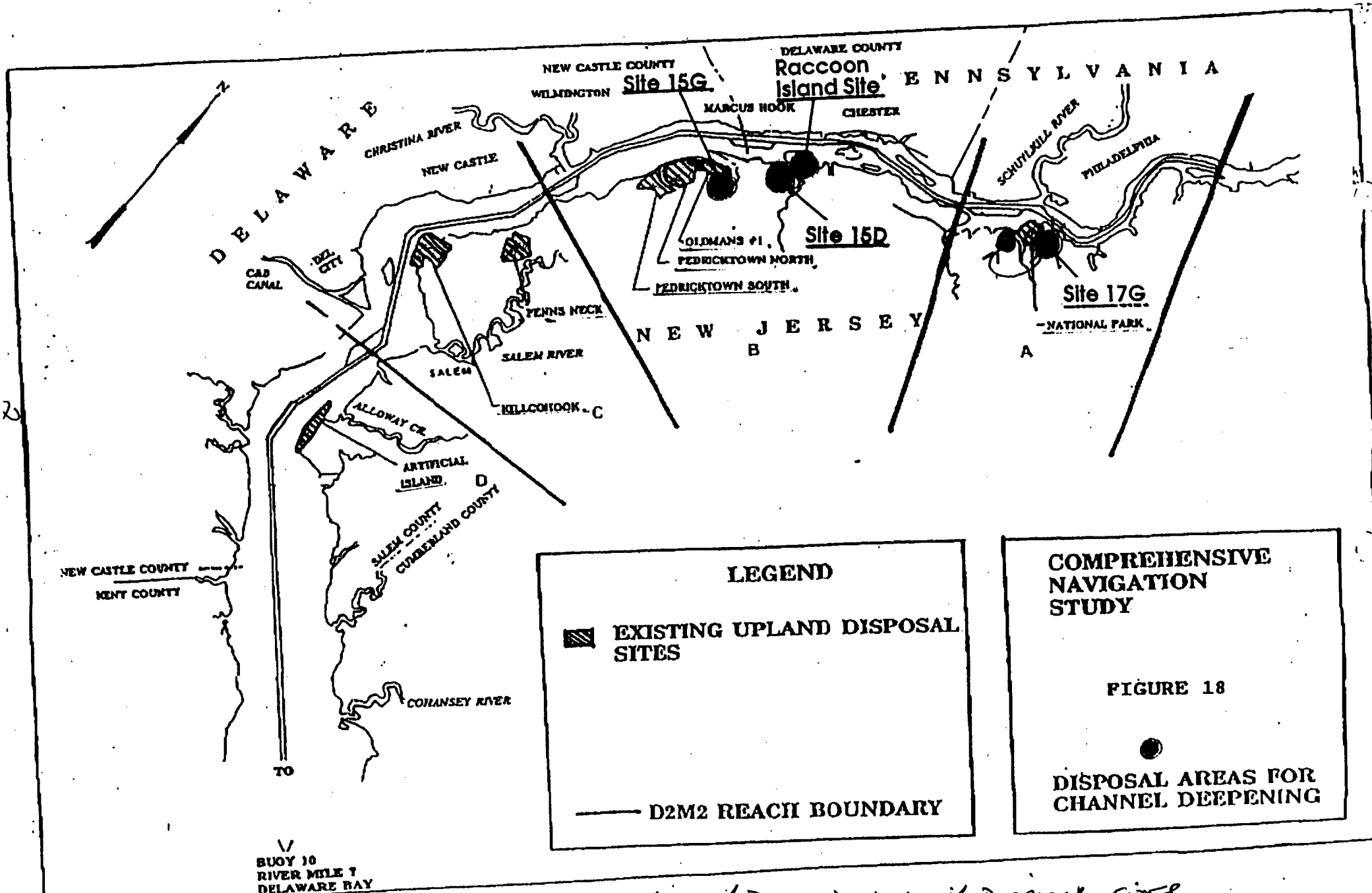


FIGURE 1 -- Location of Dredged-Material Disposal Sites

	ware River
15D	South side of Raccoon Creek near Bridgeport, Gloucester County, N.J., at the Delaware River
Raccoon Island	North side of Raccoon Creek near Bridgeport, Gloucester County, N.J., at the Delaware River
17G	South side of Woodbury Creek near National Park, Gloucester County, N.J., at the Delaware River
	Disposal sites used for channel maintenance
National Park	North side of Woodbury Creek near National Park, Gloucester County, N.J., at the Delaware River
Oldmans #1	Adjacent to the Delaware River, south of Oldmans Creek, near Pedricktown, Salem County,N.J.
Pedricktown North	Adjacent to the Delaware River, south of Oldmans Creek, near Pedricktown, Salem County,N.J.
Pedricktown South	Adjacent to the Delaware River, south of Oldmans Creek, near Pedricktown, Salem County,N.J.
Penns Neck	Adjacent to Salem River, Pennsville, Salem County, N.J.
Killcohook	Adjacent to the Delaware River at Killcohook National Wildlife Refuge, Salem County, N.J.
Artificial Island	Adjacent to Delaware River, at Artificial Island, Salem County, N.J.

Hydrogeology of the Disposal Sites

The dredge-spoil disposal sites are located on the Coastal Plain of New Jersey. The hydrogeology of the Coastal Plain is composed of interbedded sand and gravel aquifers separated by leaky silt and clay confining units. The hydrogeologic units of the Coastal Plain are listed on table 1. Of particular interest is the Potomac-Raritan-Magothy aquifer system, which can be differentiated into three composite members, the upper, middle and lower aquifers. The Potomac-Raritan-Magothy aquifer system crops out in the vicinity of most of the disposal sites and is also used as a substantial source of water supply in the area.

GROUND-WATER FLOW IN THE VICINITY OF THE SITES

The primary aim of this investigation is to determine whether nearby water-supply wells could be hydraulically connected to the dredged-material disposal sites. This was accomplished using a ground-water flow model of the Potomac-Raritan-Magothy aquifer system for the sites in Gloucester County. Because a ground-water flow model of the aquifer system in Salem count is not currently available, potentiometric surface measurement were used to determine flow directions and thus the possible destinations for recharge occurring in the disposal sites.

Table 1. --Geologic and hydrogeologic units in the Coastal Plain of New Jersey

[Modified from Zapecza, 1989, table 2.]

SYSTEM	SERIES	GEOLOGIC UNIT	LITHOLOGY	HYDROGEOLOGIC UNIT		HYDROLOGIC CHARACTERISTICS
Quaternary	Holocene	Alluvial deposits	Sand, silt and black mud.	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.
		Beach sand and gravel	Sand, quartz, light-colored, medium- to coarse-grained pebbly.			
	Pleistocene	Cape May Formation	Sand, quartz, light-colored, heterogeneous, clayey, pebbly.			
Tertiary	Miocene	Pennsauken Formation		Kirkwood-Cohansey aquifer system		A major aquifer system. Ground water occurs generally under water-table conditions. In Cape May County, the Cohansey Sand is under artesian conditions.
		Bridgeton Formation				
		Beacon Hill Gravel	Gravel, quartz, light-colored, sandy.			
		Cohansey Sand	Sand, quartz, light-colored, medium- to coarse-grained, pebbly, local clay beds.			
		Kirkwood Formation	Sand, quartz, gray and tan, very fine to medium-grained, micaceous, and dark-colored diatomaceous clay.	Confining unit		Thick diatomaceous clay bed occurs along coast and for a short distance inland. A thin water-bearing sand is present in the middle of this unit.
				Rio Grande water-bearing zone		
				Confining unit		
				Atlantic City 800-foot sand		A major aquifer along the coast.
	Oligocene	Piney Point Formation / Shark River Formation	Sand, quartz and glauconite, fine- to coarse-grained.	Composite confining unit		Poorly permeable sediments.
	Eocene				Piney Point aquifer	Yields moderate quantities of water.
		Manasquan Formation	Clay, silty and sandy, glauconitic, green gray, and brown, contains fine-grained quartz.			Poorly permeable sediments.
	Paleocene	Vincentown Formation	Sand, quartz, gray and green, fine- to coarse-grained, glauconitic, and brown clayey, very fossiliferous, glauconite and quartz calcarenite.		Vincentown aquifer	Yields small to moderate quantities of water in and near its outcrop area.
		Hornerstown Sand	Sand, clayey, glauconitic, dark-green, fine- to coarse-grained.			Poorly permeable sediments.
Cretaceous	Upper Cretaceous	Tinton Sand	Sand, quartz, glauconitic, brown and gray, fine- to coarse-grained, clayey, micaceous.		Red Bank Sand	Yields small quantities of water in and near its outcrop area.
		Red Bank Sand				
		Navesink Formation	Sand, clayey, silty, glauconitic, green and black, medium- to coarse-grained.			Poorly permeable sediments.
		Mount Laurel Sand	Sand, quartz, brown and gray, fine- to coarse-grained, slightly glauconitic.	Wenonah-Mount Laurel aquifer		A major aquifer.
		Wenonah Formation	Sand, very fine- to fine-grained, gray and brown, silty, slightly glauconitic.			
		Marshalltown Formation	Clay, silty, dark-greenish-gray; contains glauconitic quartz sand.	Marshalltown-Wenonah confining unit		A leaky confining unit.
		Englishtown Formation	Sand, quartz, tan and gray, fine- to medium-grained; local clay beds.	Englishtown aquifer system		A major aquifer. Two sand units in Monmouth and ocean Counties.
		Woodbury Clay	Clay, gray and black, and micaceous silt.	Merchantville-Woodbury confining unit		A major confining unit. Locally the Merchantville Formation may contain a thin water-bearing sand.
		Merchantville Formation	Clay, glauconitic, micaceous, gray and black; locally very fine grained quartz and glauconitic sand are present.			
		Magothy Formation	Sand, quartz, light-gray, fine- to coarse grained. Local beds of dark gray lignitic clay. Includes Old Bridge Sand Member.	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 equivalent to the Farrington aquifer. In the Delaware River Valley, three aquifers are recognized. in the deeper subsurface, units below the upper aquifer are undifferentiated.
		Raritan Formation	Sand, quartz, light-gray, fine- to coarse-grained, poorly arkosic; contains red, white, and variegated clay. Includes Farrington Sand Member.		Confining unit	
					Middle aquifer	
					Confining unit	
	Lower Cretaceous	Potomac Group	Alternating clay, silt, sand, and gravel.		Lower aquifer	
Pre-Cretaceous		Bedrock	Precambrian and lower Paleozoic crystalline rocks, schist and gneiss; locally Triassic sandstone and shale, and Jurassic diabase are present.	Bedrock confining unit		No wells obtain water from these consolidated rocks, except along Fall line.

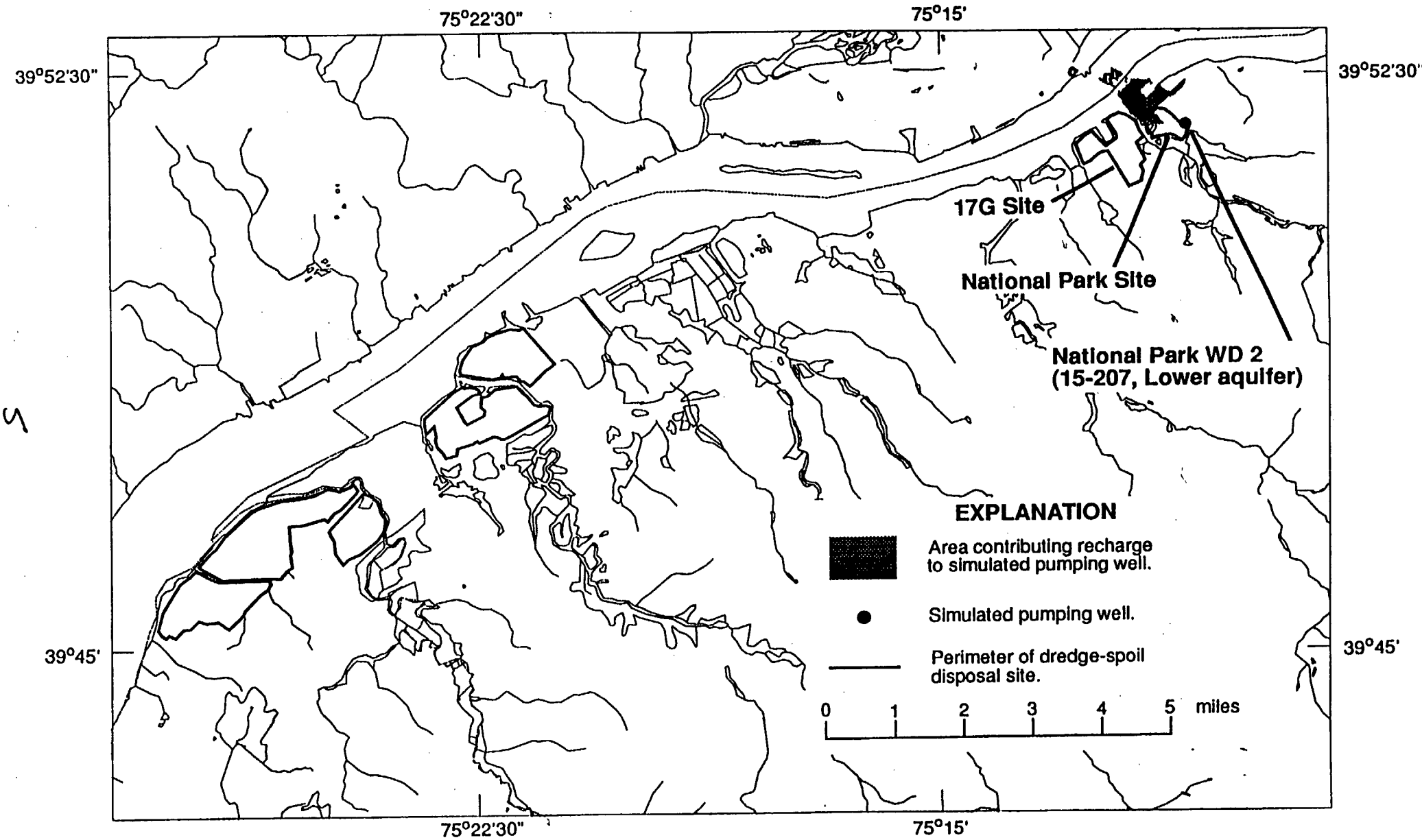
Evaluation of National Park and 17G Sites

The National Park and 17G sites are located on the outcrop area of the upper Potomac-Raritan-Magothy aquifer in Gloucester County adjacent to the Delaware River. This outcrop includes a veneer of post-Cretaceous sands that are hydraulically connected to the upper aquifer. Underlying the site, at depth, are the middle and lower Potomac-Raritan-Magothy aquifers. These underlying units are used for water-supply in the area. The intervening confining units are leaky, allowing recharge to move vertically towards pumpage. The elevations of the aquifers, in the vicinity of the National Park and 17G sites, are listed in table 2.

Table 2. --Top and bottom altitude of Potomac-Raritan-Magothy aquifer system units in the vicinity of the National Park and 17G disposal sites

Aquifer	Altitude (sea level)
top of the upper aquifer	land surface
bottom of the upper aquifer	-45 to -80
top of the middle aquifer	-100 to -120
bottom of the middle aquifer	-130 to -150
top of the lower aquifer	-160 to -180
bottom of the lower aquifer	-180 to -250

The effects of withdrawals from the ground-water system in the vicinity of the National Park and 17G disposal sites were simulated using the ground-water flow model developed by Navoy and Carleton (in press). Seven of the significant production wells in the area (greater than 10,000 gal./year) were found to be drawing recharge water from the disposal sites. The contributing areas of these wells were determined using a particle-tracking model post processor (Pollock, 1989) and are shown on figures 2 through 8. The procedure for particle tracking involved a process where 2,400 simulated particles were started in the pumped wells and the model post processor backed the particles up through the ground-water flow system to delineate the points of origin or recharge. These points of recharge were intersected with the disposal areas using a Geographic Information System. In this manner, the recharge originating from the disposal areas was identified and also can lead to indication of the proportion of the amount of flow from the disposal sites that will be contributed to the wells. The particle-tracking analysis also yields information about the velocity or travel time of the simulated particles. The minimum, mean, and maximum simulated travel times, and percentage of flow originating at a disposal site, for each of the wells found



CONTRIBUTING AREA NP6-EP-UTMI

Figure 2

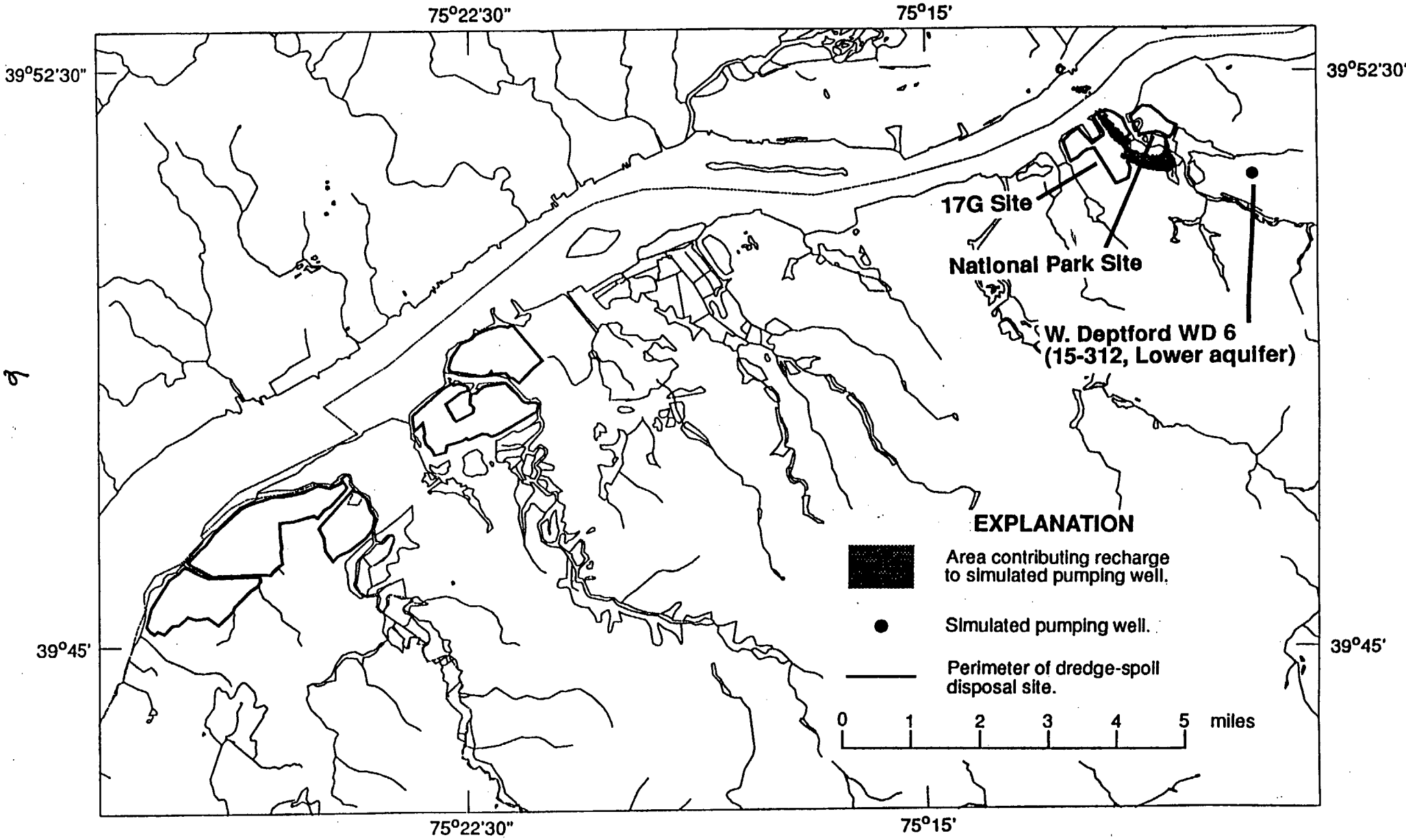


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FIGURE 3

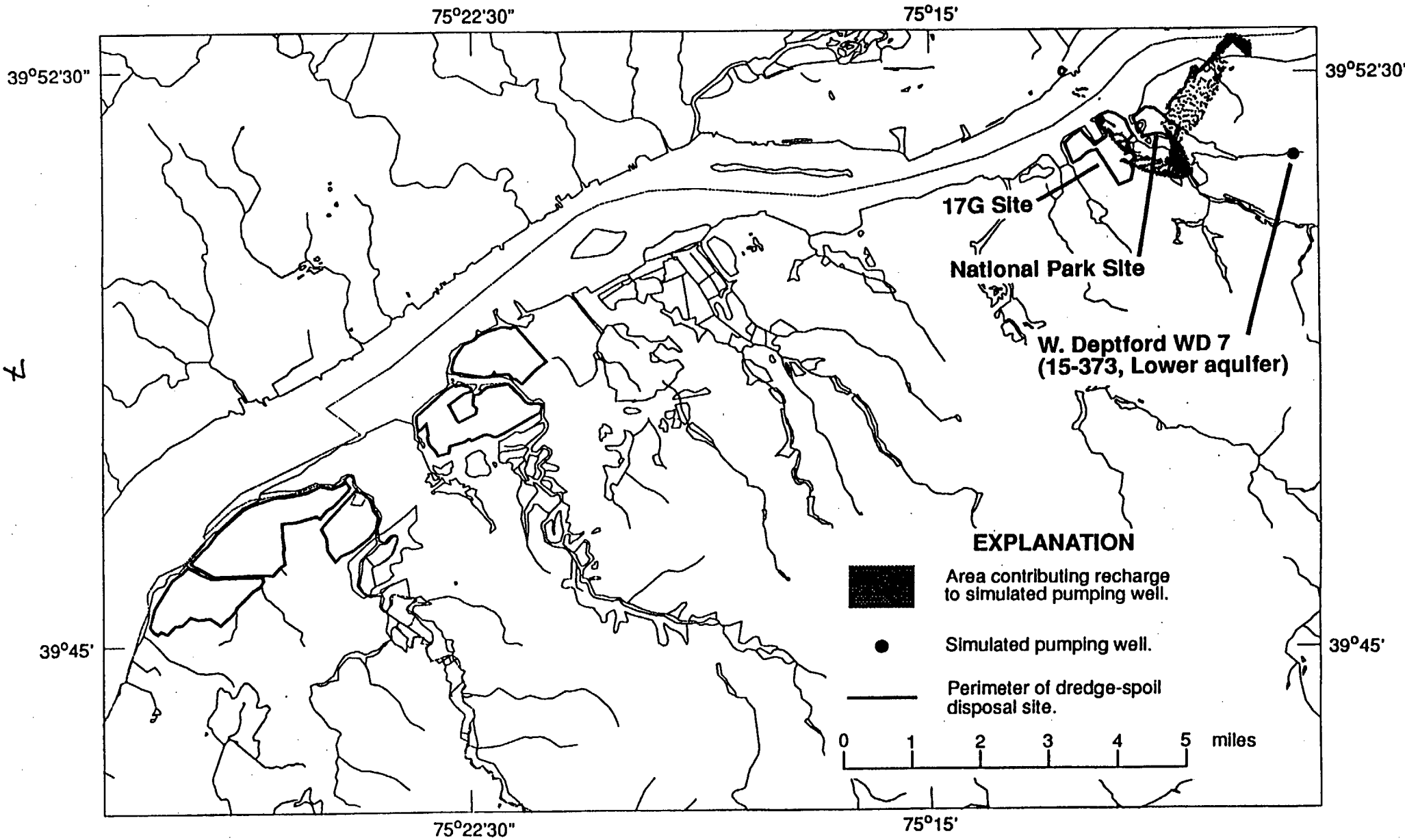

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FIGURE 4

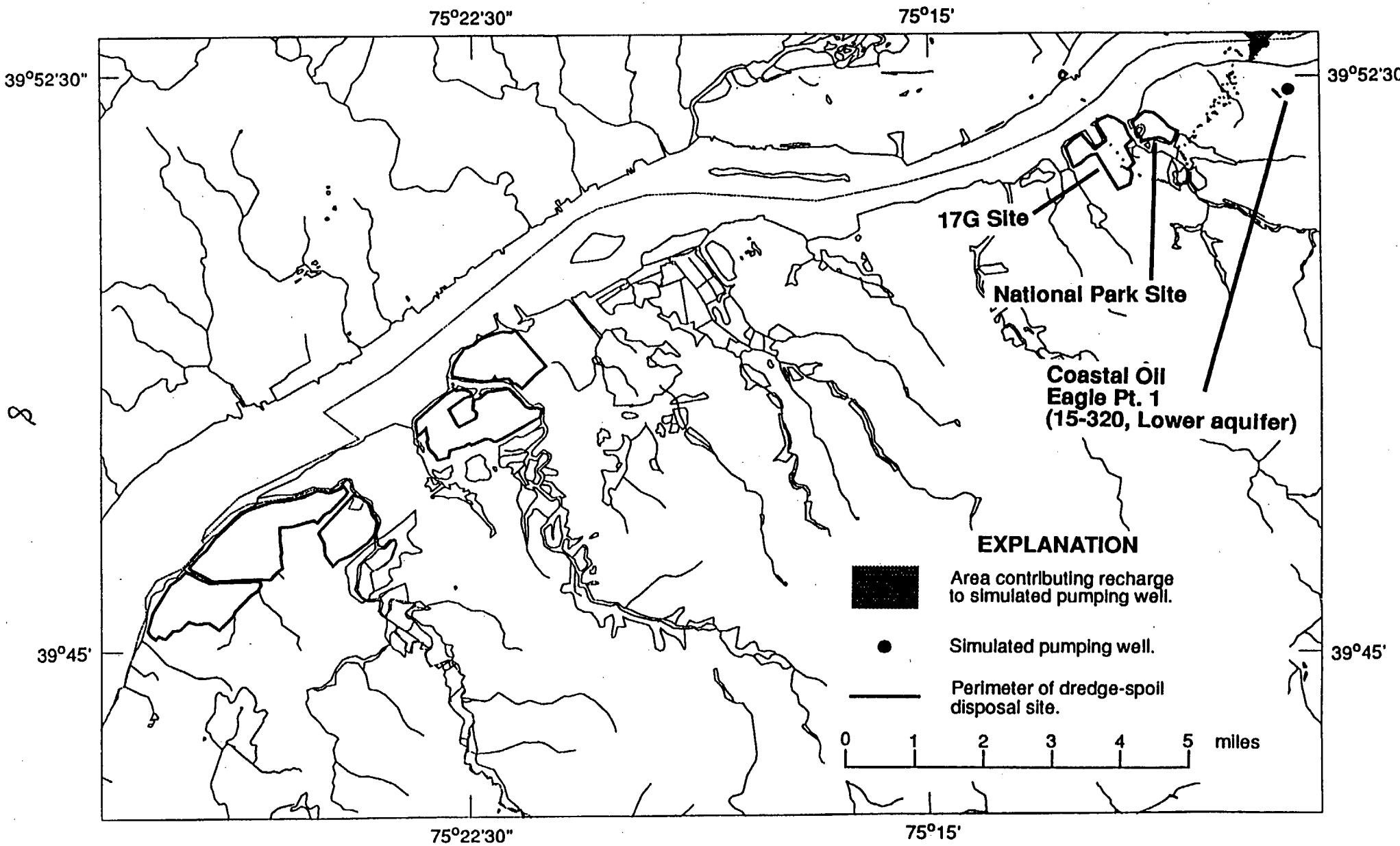

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FIGURE 5

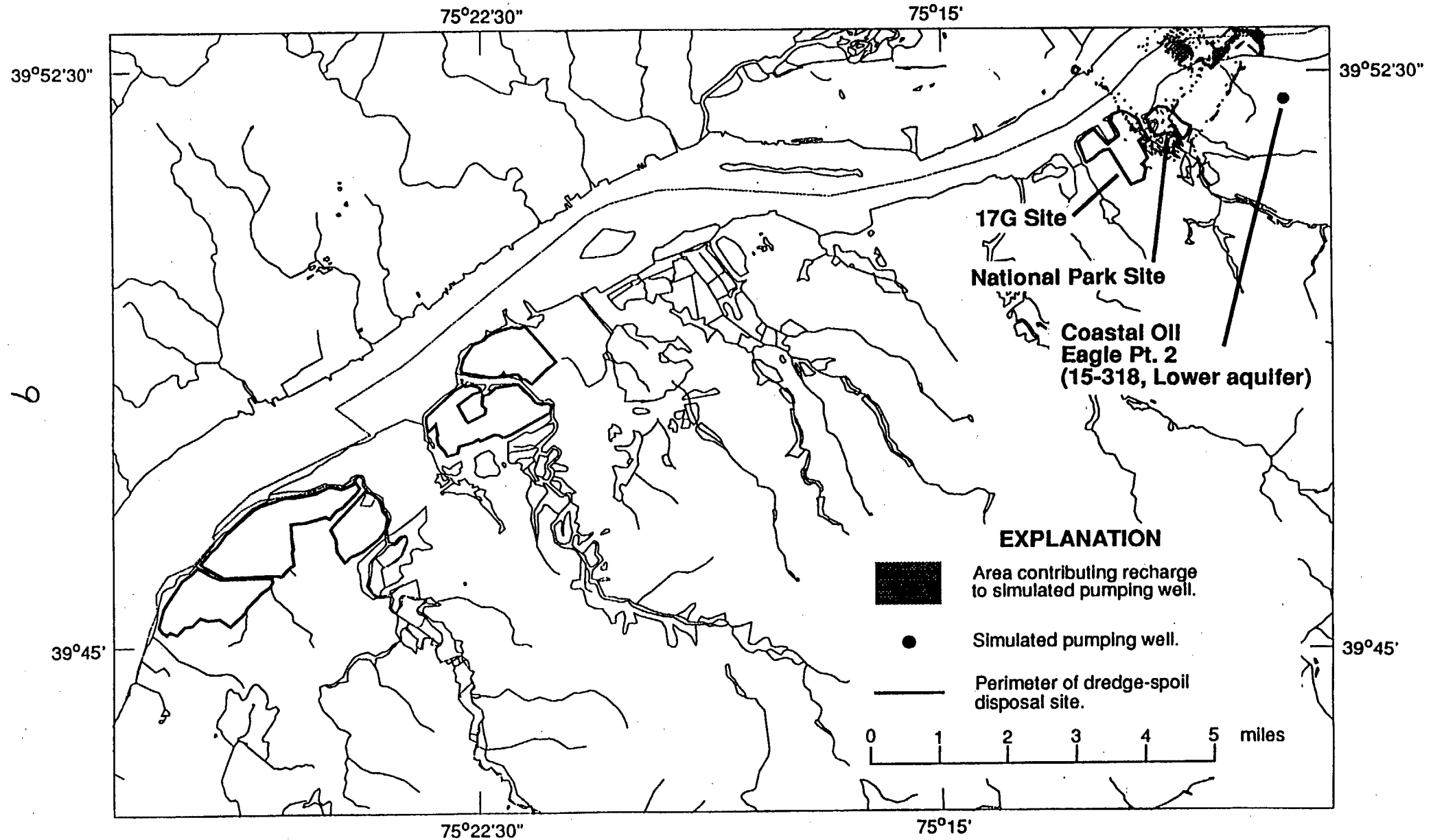

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Figure 6

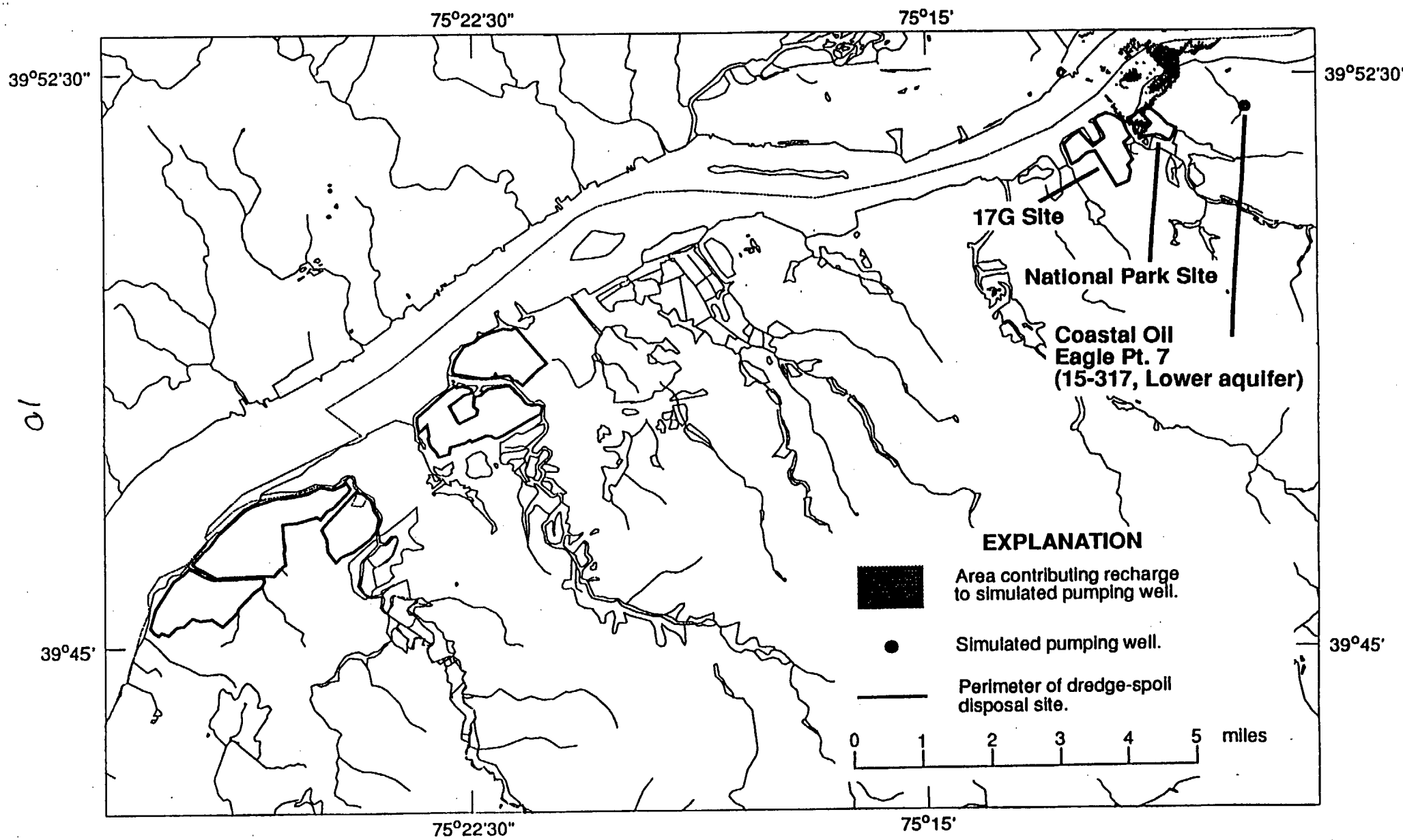

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Figure 7

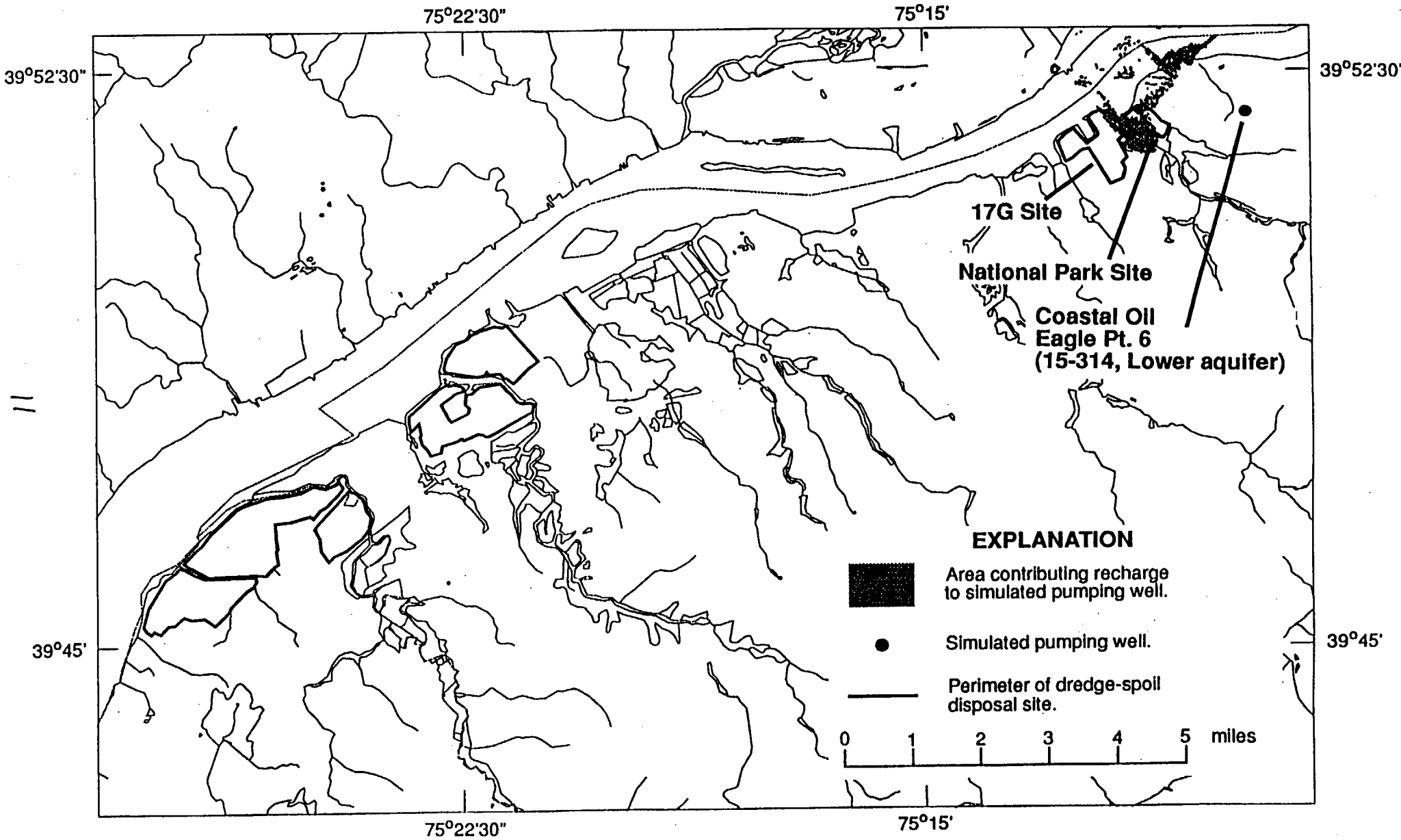

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Figure 8

to be receiving water from the disposal sites are listed on table 3.

Table 3. --Simulated ground-water flow contributed from disposal sites near National Park, N.J. to nearby withdrawal wells

Well Name and USGS Well Identifier	Disposal Site	Percentage of Flow from Site to Well	Mean Travel Time (years)	Minimum Travel Time (years)	Maximum Travel Time (years)
National Park WD 2 (15-207)	National Park	14%	23	15	63
W. Deptford WD 6 (15-312)	17G	26%	1,300	48	10,562
W. Deptford WD 7 (15-373)	17G	8%	1,352	58	10,600
W. Deptford WD 7 (15-373)	National Park	2%	122	93	162
Coastal Oil Eagle Pt. 1 (15-320)	17G	1%	6,406	120	10,628
Coastal Oil Eagle Pt. 2 (15-318)	National Park	2%	121	43	170
Coastal Oil Eagle Pt. 2 (15-318)	17G	3%	846	58	10,575
Coastal Oil Eagle Pt. 7 (15-317)	National Park	7%	56	35	88
Coastal Oil Eagle Pt. 6 (15-314)	National Park	9%	76	35	161
Coastal Oil Eagle Pt. 6 (15-314)	17G	4%	67	48	100

As can be seen from table 3, the percentage of flow from the National Park and 17G disposal sites to the nearby wells is low. All have about a quarter or less of their flow originating as recharge from the disposal sites. Also, the mean travel times are generally in excess of 50 years, with the exception of the nearby National Park water-supply well, where the mean travel time is about 20 years. It must be recognized that these figures are the result of a simulation, which is subject to a degree of uncertainty and error. The location and construction characteristics of the significant water-supply wells are listed in table 4 (located at the back of this report).

Evaluation of Raccoon Island, 15D, Oldmans #1, Pedricktown North, Pedricktown South, and 15G Sites

The Raccoon Island, 15D, Oldmans #1, Pedricktown North, Pedricktown South, and 15G sites are located on the outcrop area of the middle Potomac-Raritan-Magothy aquifer, adjacent to the Delaware River in Gloucester and Salem Counties. This outcrop may include a veneer of post-Cretaceous sands that is hydraulically connected to the middle aquifer. Underlying the site, at depth, is the lower Potomac-Raritan-Magothy aquifer. Nearby, to the southeast, the upper Potomac-Raritan-Magothy aquifer crops out and is hydraulically connected through leaky confining units to the middle and lower Potomac-Raritan-Magothy aquifers. These aquifers are used for water-supply in the area. The leaky confining units allow recharge to move vertically towards pumpage. In the vicinity of these sites, the middle Potomac-Raritan-Magothy aquifer can be subdivided into two parts with an intervening confining leaky unit (Lewis and others, 1991, pg. 16), but for the purposes of this report the subdivision will not be considered. The elevations of the aquifers, in the vicinity of the sites, are listed in table 5 (from Lewis and others, 1991, Plates 2a

through 5a).

Table 5. --Top and bottom altitude of Potomac-Raritan-Magothy aquifer system units in the vicinity of the Raccoon Island, 15D, Oldmans #1, Pedricktown North, Pedricktown South, and 15G sites

Aquifer	Altitude (sea level) at Raccoon Is./ 15D Sites	Altitude (sea level) at Pedricktown N.&S., Oldmans #1, and 15G Sites
top of the middle aquifer	land surface	land surface
bottom of the middle aquifer	-40 to -80	-40 to -100
top of the lower aquifer	-70 to -100	-90 to -120
bottom of the lower aquifer	-100 to -150	-100 to 200

The effects of withdrawals on ground-water system for the areas, particularly in the vicinity of the Raccoon Island, 15D, Oldmans #1, and 15G sites, were simulated using the ground-water flow model developed by Navoy and Carleton (in press). Two wells, of the significant production wells in the area (greater than 10,000 gal/y), were found, to be drawing recharge water from the disposal sites. Additionally, the contributing area of a third well was found to be close to one of the sites. The contributing areas of these wells were determined using a particle-tracking model post processor (Pollock, 1989) in the same fashion as those described in the analysis of the National Park and 17G sites. The simulated contributing areas are shown on figures 9 through 11. The results of the particle-tracking analysis pertaining to the minimum, mean, and maximum simulated travel times are shown on table 6.

Table 6. --Simulated ground-water flow contributed from the 15D, Oldmans #1, and 15G disposal sites to nearby withdrawal wells

Well Name and USGS Well Identifier	Disposal Site	Percentage of Flow from Site to Well	Mean Travel Time (years)	Minimum Travel Time (years)	Maximum Travel Time (years)
Penns Grove WSC Bridgeport 2 (15-166)	15D	<1%	177	173	180
Monsanto Chem 35D (15-601)	15D	1%	55	44	90
Monsanto Chem 35D (15-601)	Oldmans #1	1%	54	47	64
Monsanto Chem 35D (15-601)	15G	2%	81	51	120
Monsanto Chem 1 (15-167)	15D	contributing area very close	--	--	--

The ground-water flow model developed by Navoy and Carleton ends at about the Gloucester County-Salem County line. Therefore, in order to evaluate the ground-water flow system in

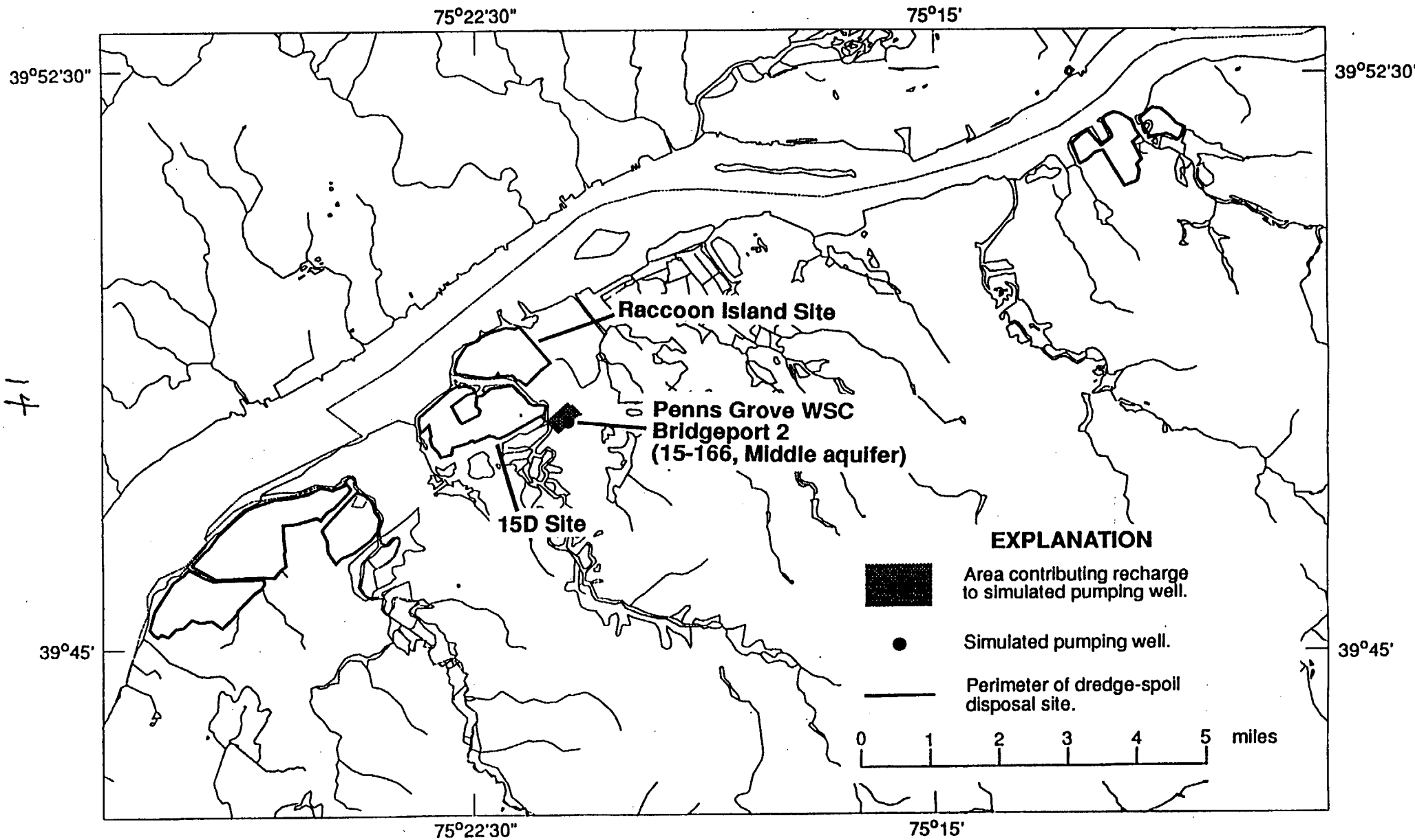

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Figure 9

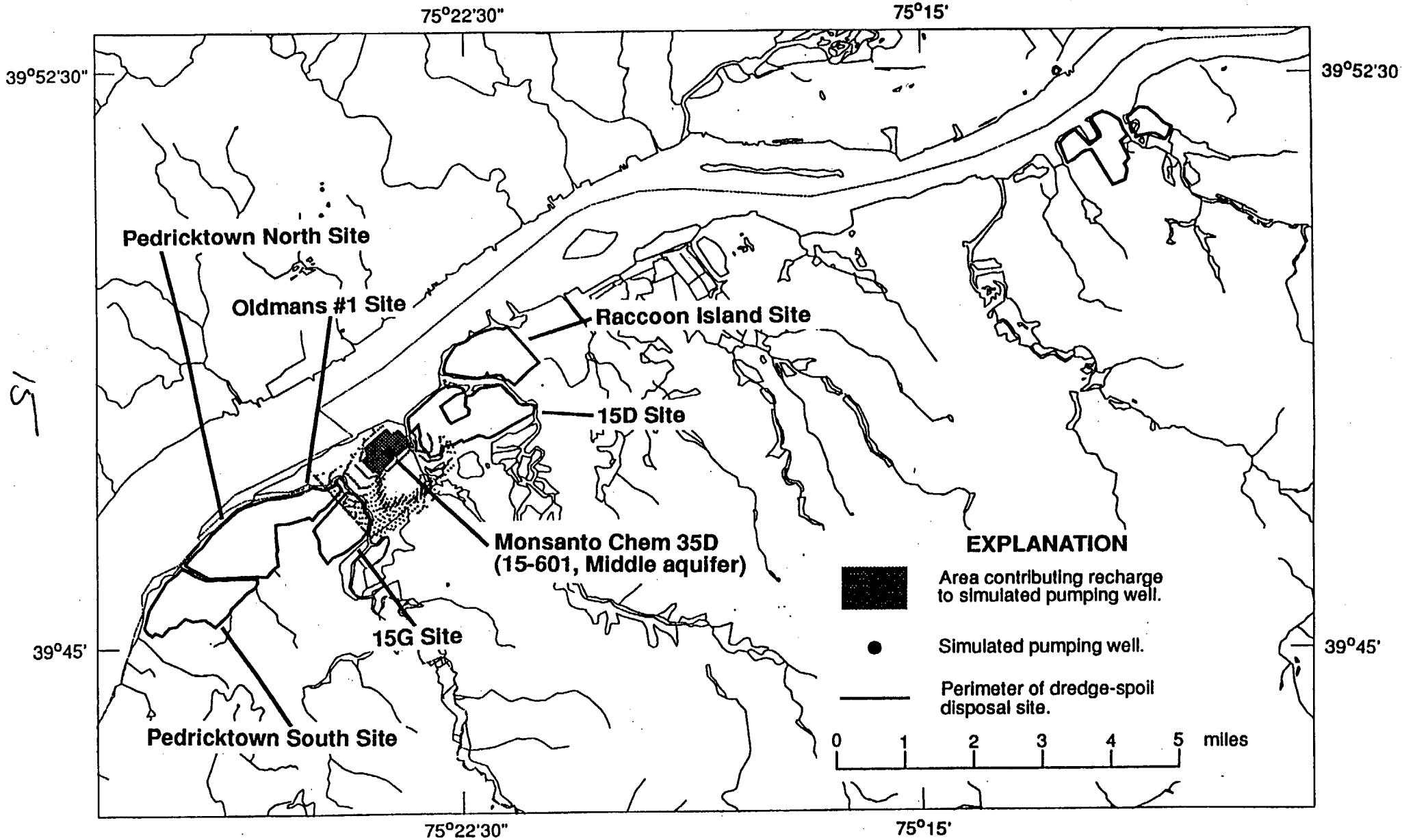

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Figure 10

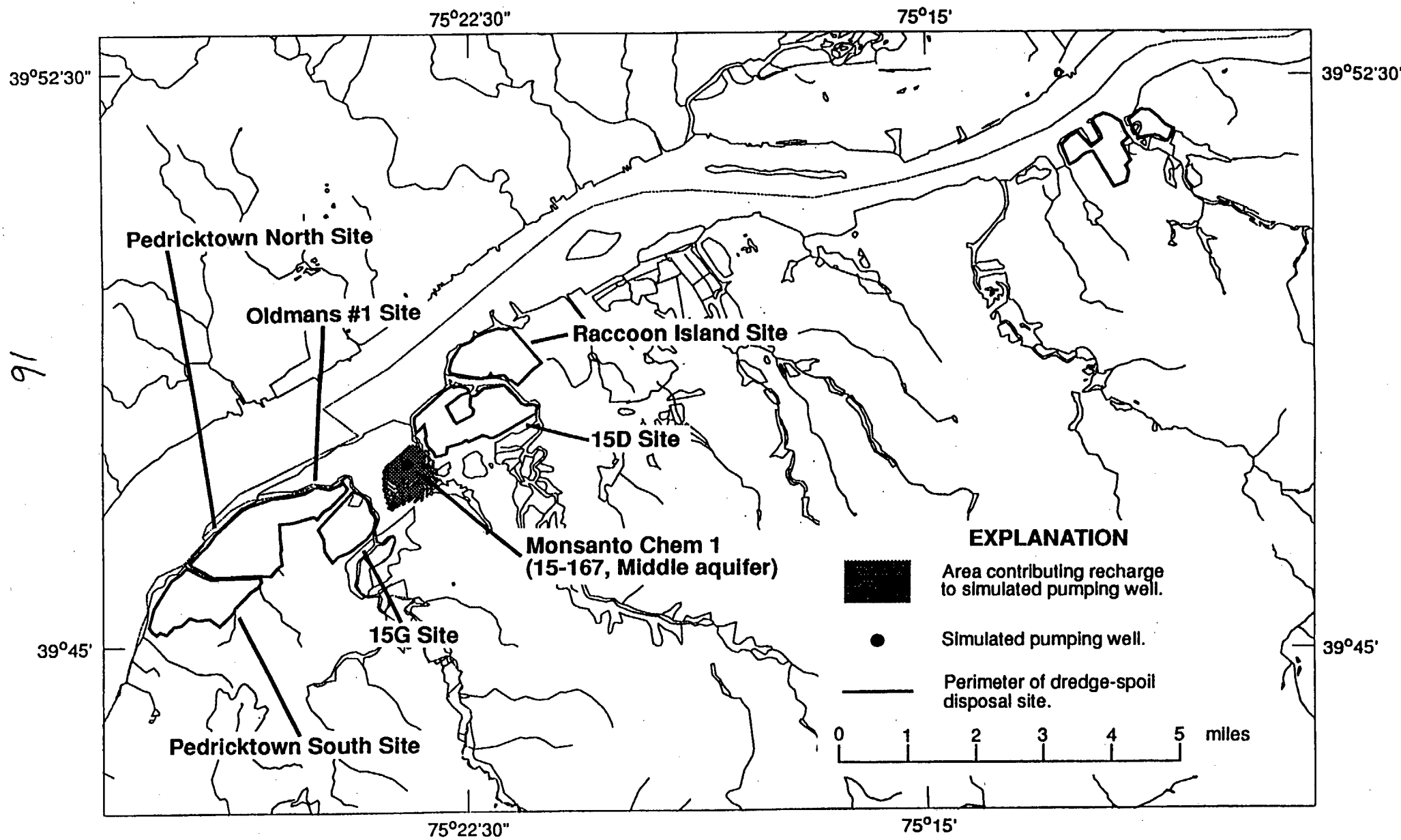

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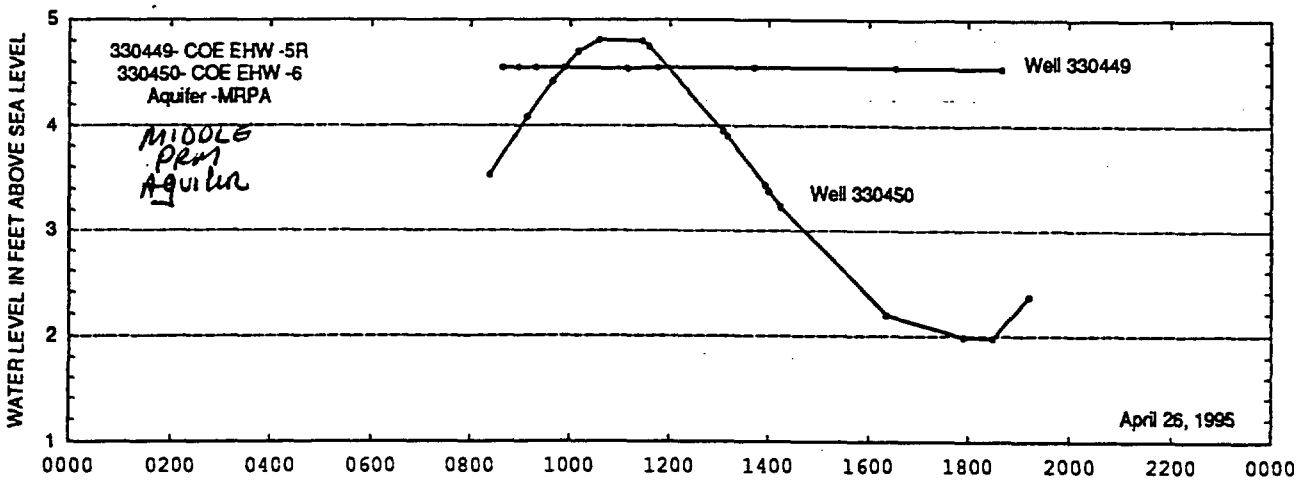
FIGURE 11

the vicinity of the Oldmans #1, Pedricktown North, Pedricktown South, and 15G sites, especially with regard to wells south of the site in Salem County, a different approach was needed. A synoptic ground-water-level data-collection effort was undertaken to map the potentiometric surfaces of the relevant aquifers within three miles of the disposal sites. This technique does not have the precision that is associated with a ground-water flow model but is adequate to suit the purpose of this report, namely indicating the likely wells that could draw recharge from the disposal sites.

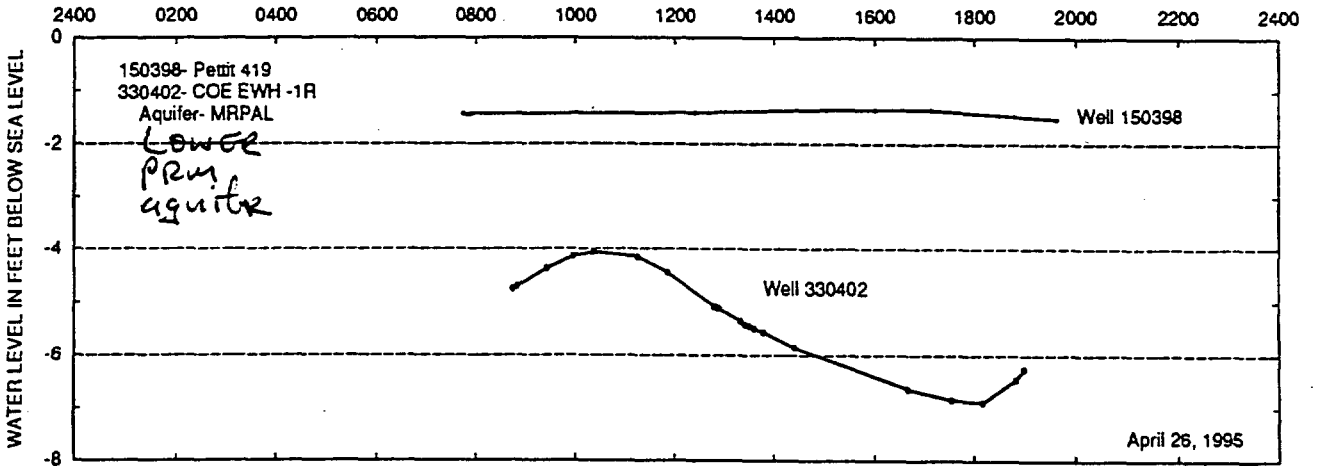
The basic water-level data collected are tabulated in table 7 (located, due to its length, at the back of the report). Because of the proximity of the tidal Delaware River to the sites, an adjustment of the water-level data to consistent tidal conditions was required for some wells. The water levels in four wells were observed during a tidal cycle in order to characterize the magnitude of tidal fluctuations of the confined aquifers. The wells measured were the U.S. Army Corps of Engineers wells EHW-5R (33-449) and EHW-6 (33-450), both screened in the middle Potomac-Raritan-Magothy aquifer, and the Petit well 419 (15-398) and U.S. Army Corps of Engineers well EWH-1R (33-402), both screened in the lower Potomac-Raritan-Magothy aquifer. For each aquifer, one of the wells was located adjacent to the Delaware River and the other well is located about one-half mile away from the river. Figure 12 shows the hydrographs of these wells indicating the tidal fluctuation in ground-water levels during a tidal sequence which changed from high tide to low tide. The maximum tidal fluctuation observed in both the middle and lower Potomac-Raritan-Magothy aquifer wells located adjacent to the river was about 2.8 ft. The tidal fluctuations are barely perceptible in the wells located about one-half mile away from the river. In order to compensate for these fluctuations, the water levels of all measured wells located within one-half mile of the river were adjusted to conform to an estimated mid-tide level. These adjustments are indicated in table 7.

The results of the measurements were compiled into the potentiometric-surface maps of the upper, middle, and lower Potomac-Raritan-Magothy aquifers shown on figures 13 to 15, respectively. Several cones of depression in the potentiometric can be readily seen in the vicinity of the Raccoon Island, 15D, Oldmans #1, Pedricktown North, Pedricktown South, and 15G sites. Of particular interest are the cones of depression in the middle Potomac-Raritan-Magothy aquifer (fig. 14) because they are the closest to the disposal sites. The observed cone of depression, located northeast of Oldmans Creek, in between Oldmans #1 and 15D correspond to the simulated wells and contributing area depicted on figures 10 and 11. As indicated in table 6, those wells draw recharge from the adjacent sites, but the proportion of flow from the sites is low and the travel times are generally more than 50 years. The other significant cone of depression in the middle aquifer is just to the south of the cluster of the Oldmans #1, Pedricktown North, Pedricktown South, and 15G sites. The pumpage associated with the cone of depression is from the B.F. Goodrich Co. wells 4, 6, 9, 10 (33-86,33-85, 33-83, 33-997). The withdrawals for these wells, listed in table 4, total 427 mgal/y. This withdrawal rate is similar to those of Monsanto wells 1 and 35D (15-167, 15-601) shown on figures 14 and 15. The contributing areas for these wells will be similar in size. It is likely that recharge from the sites will occur to the Goodrich Co. wells because of the proximity to the cluster of sites, especially Pedricktown North and 15G.

There were no distinct cones of depression in the lower Potomac-Raritan-Magothy aquifer near the cluster of the Oldmans #1, Pedricktown North, Pedricktown South, and 15G sites. However, as a result of withdrawals on a regional level, water levels in the lower aquifer are lower



HYDROGRAPH OF TIDAL FLUCTUATIONS IN WELL 330449 AND WELL 330450



HYDROGRAPH OF TIDAL FLUCTUATIONS IN WELL 150398 AND WELL 330402

FIGURE 12

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FIGURE _: Water-levels in the Upper aquifer of the Potomac-Raritan-Magothy aquifer system surrounding the Pedricktown area site.

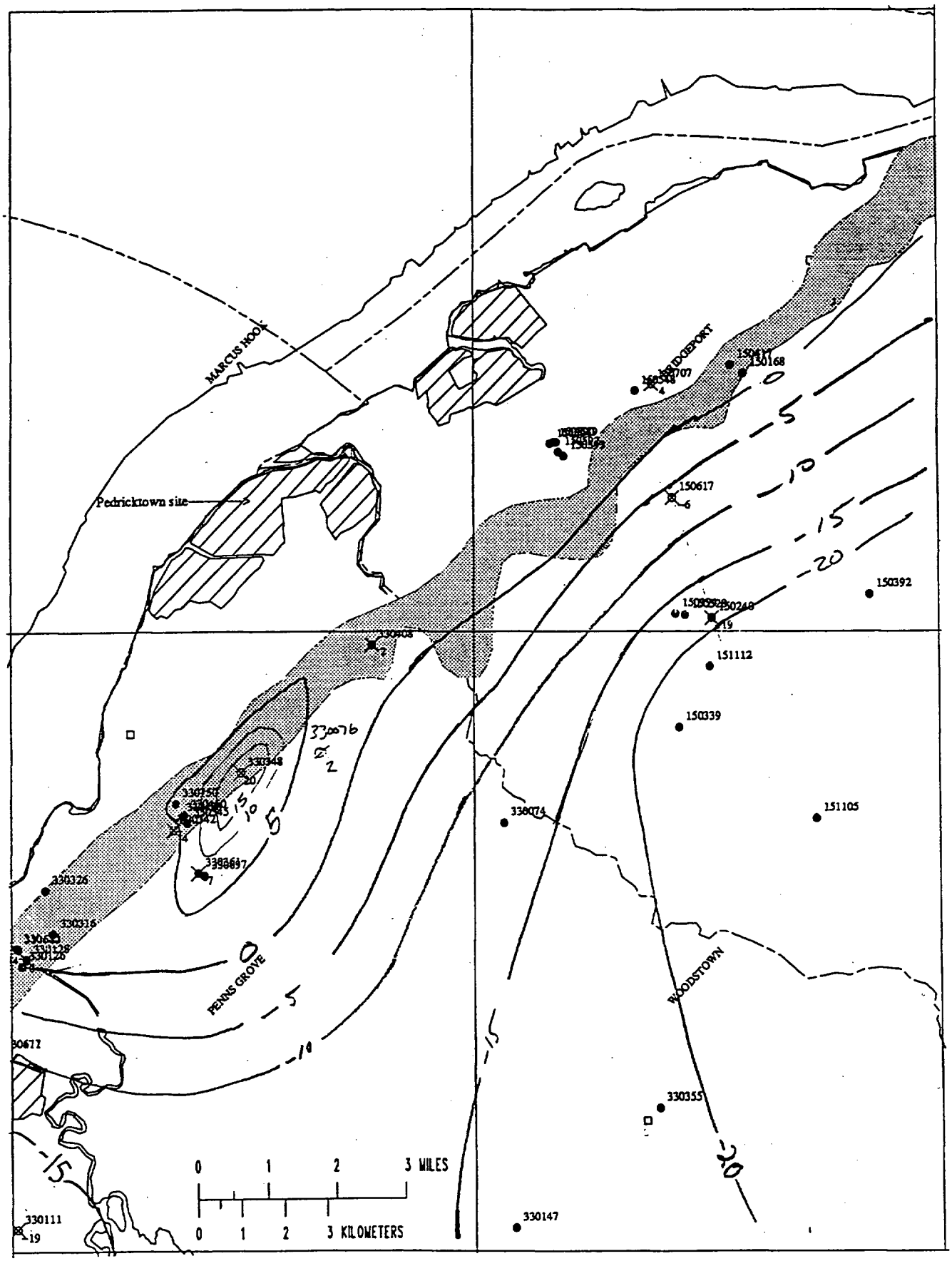

FIGURE 13 - Potentiometric Surface Map of upper PRM aquifer

FIGURE 2: Water-levels in the Middle and Undifferentiated part of the Potomac–Raritan–Magothy aquifer system surrounding the Pedricktown area site.

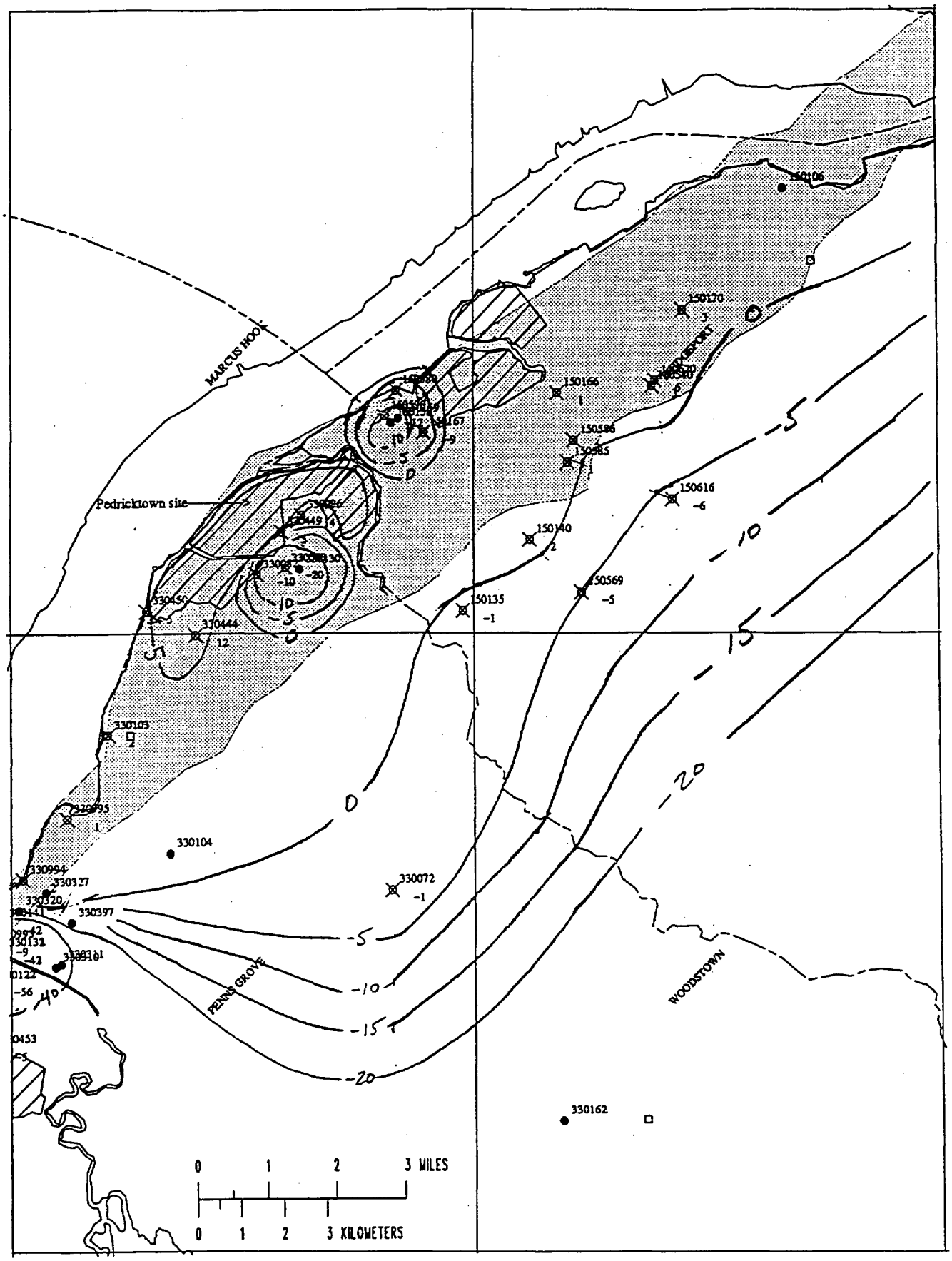

Figure 14. -- Potentiometric Surface map of middle PRM aquifer

FIGURE _: Water-levels in the Lower aquifer of the Potomac-Raritan-Magothy aquifer system surrounding the Pedricktown area site.

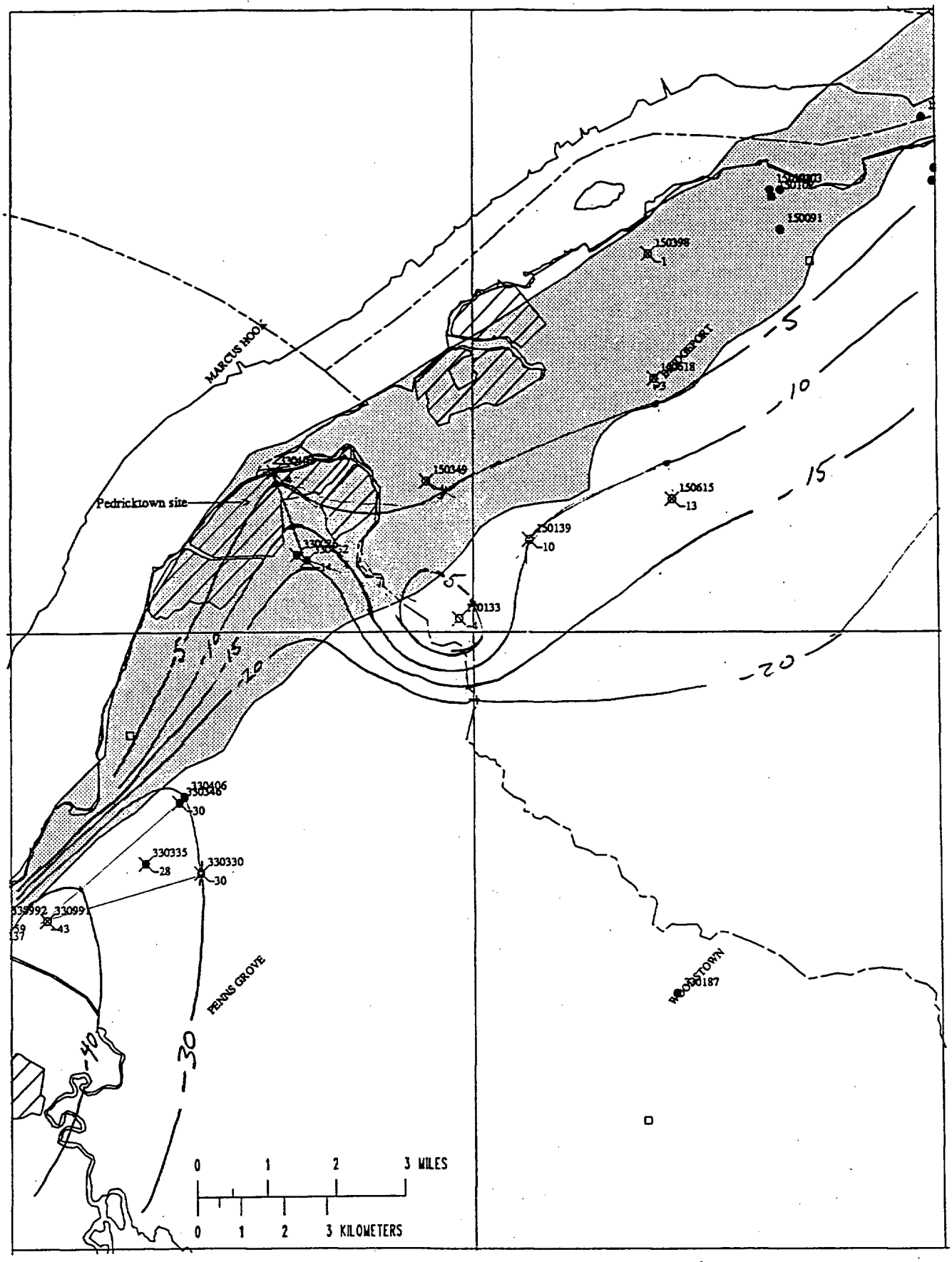

Figure 15. -- Potentiometric Surface Map of lower PRM aquifer.

than in the middle aquifer, especially to the south of the sites. It is possible, therefore, that some recharge from the sites could make its way into the lower aquifer. The water levels in the upper aquifer are generally higher than the middle aquifer, so it would be unlikely that any recharge water from the sites would flow to the upper aquifer.

Evaluation of Penns Neck and Killcohook Sites

--Potentiometric-surface maps (figures 16,17,18) in vicinity of Penns Neck/Penns Grove.

-- Discuss gw flow direction.

-- No pumpage in the vicinity of the Killcohook site, therefore no wells to impact.

Evaluation of Artificial Island Site

-- Pumpage in the vicinity of the Artificial Island site is from PRM or Mt.Laurel-Wenonah; those aquifers are too deep for any significant impact from the surface.

CONCLUSIONS

1.) Wells east of the National Park and 17G sites draw recharge from the sites, but the proportion is at most one-quarter and the mean travel times from sites to wells are more than 25 years.

2.)Minimal amount of recharge and long travel time from 15D, Oldmans #1, and 15G sites to Monsanto wells.

3.)Possible recharge to Goodrich wells from the cluster of the Oldmans #1, Pedricktown North, Pedricktown South, and 15G sites

4.) (*conclusions on Penns Neck site go here*)

5.) There is not any significant pumpage in the vicinity of the Killcohook site, therefore no wells to impact.

6.)The water-supply pumpage in the vicinity of the Artificial Island site is from PRM or Mt.Laurel-Wenonah aquifer. These aquifers are too deep for any significant impact to occur from the surface.

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Table 4.--Ground-water withdrawals from the Potomac-Raritan-Magothy aquifer system in the vicinity of dredge-spoil disposal sites

[Withdrawal is the greatest daily amount of ground-water withdrawal per year between the years 1988-1993; MRPAU- upper Potomac-Raritan-Magothy aquifer; MRPAM- middle Potomac-Raritan-Magothy aquifer; MRPAL- lower Potomac-Raritan-Magothy aquifer; *- minimal use, backup well]

USGS Well Number	State of New Jersey Permit Number	Owner	Local Identifier	Latitude	Longitude	Township	Aquifer	Screen Interval (ft)	With-drawal (Mgal/y)
150137	30-01371	Pureland Water Co	Pure 2(3-1973)	394535	752054	Logan	MRPAM	158 - 208	116
150144	30-01370	Pureland Water Co	1-1973	394613	752129	Logan	MRPAM	81 - 136	86
150158	30-00873	Monsanto Chemical	Bridgeport W2	394733	752351	Logan	MRPAM	57 - 82	227
150159	30-00872	Monsanto Chemical	Bridgeport E1	394736	752344	Logan	MRPAM	56 - 81	122
150166	30-00410	Penns Grove WSC	Bridgeport 2	394755	752108	Logan	MRPAM	65 - 85	44
150167	30-01170	Monsanto Chemical	1	394726	752319	Logan	MRPAM	64 - 94	146
150569	30-02405	Pureland Water Co	3	394529	752045	Logan	MRPAM	161 - 201	92
150601	-	Monsanto Chemical	35D			Logan	MRPAM	-	-
330070	30-00229	NJ Turnpike Authrity	1N-2	394141	752343	Oldmans	MRPAM	-	29
330083	30-01139	B F Goodrich Co	9 (PW-1)	394547	752535	Oldmans	MRPAM	93 - 133	134
330085	30-01141	B F Goodrich Co	6 (PW-2)	394556	752530	Oldmans	MRPAM	109 - 129	186
330086	30-01139	B F Goodrich Co	4 (PW-3)	394557	752523	Oldmans	MRPAL	169 - 189	107
330109	30-01322	Ganes Chemical	1973-1	393734	753149	Pennsville	MRPAU	116 - 131	7
330112	30-01033	Pennsville T WD	PTWD 4	393754	753147	Pennsville	MRPAU	117 - 137	74
330118	50-00041	Pennsville T WD	PTWD 1	393958	753045	Pennsville	MRPAM	213 - 238	51
330119	30-00018	Pennsville T WD	PTWD 2	394009	753043	Pennsville	MRPAM	210 - 230	84
330122	30-01234	Atlantic City Electric	Deepwater 3R	394045	753027	Pennsville	MRPAM	154 - 234	20
330125	30-00151	Atlantic City Electric	Deepwater 5	394051	753030	Pennsville	MRPAM	149 - 219	46
330126	30-01080	E I duPont	Ranney 7	394057	752950	Pennsville	MRPAU	52 - 140	.2
330135	30-00987	E I duPont	Ranney 5	394110	752955	Pennsville	MRPAU	47 - 116	175
330137	50-00003	E I duPont	E07-W01F	394112	753028	Pennsville	MRPAL	317 - 347	.5
330316	30-02322	E I duPont	R09-R02C	394121	752921	Carneys Point	MRPAU	-	203
330319	30-01272	E I duPont	Q13-R01CD	394139	752925	Carneys Point	MRPAM	-	.3
330320	--	E I duPont	Layne 3	394140	752953	Carneys Point	MRPAM	-	2
330321	30-01271	E I duPont	103	394143	752940	Carneys Point	MRPAM	-	228
330322	50-00004	E I duPont	Carney Pt 2	394149	752916	Carneys Point	MRPAM	169 - 219	17
330326	30-00423	E I duPont	Carney Pt 4	394153	752928	Carneys Point	MRPAU	-	.001
330328	30-01109	E I duPont	Carney Pt 1	394157	752918	Carneys Point	MRPAM	175 - 195	21

Table 4.--Ground-water withdrawals from the Potomac-Raritan-Magothy aquifer system in the vicinity of dredge-spoil disposal sites -- continued

USGS Well Number	State of New Jersey Permit Number	Owner	Local Identifier	Latitude	Longitude	Township	Aquifer	Screen Interval (ft)	With-drawal (Mgal/y)
330331	30-01099	Penns Grove WSC	Schultes Well	394205	752657	Carneys Point	MRPAM	47 - 62	97
330335	30-01133	E I duPont	Carney Pt 7	394212	752751	Carneys Point	MRPAL	411 - 417	17
330345	50-00102	Penns Grove WSC	PGWSC 2B/RF1A	394241	752711	Carneys Point	MRPAU	45 - 58	72
330346	30-00563	Penns Grove WSC	Ranney 7	394256	752718	Carneys Point	MRPAL	317 - 357	243
330360	28-10466	Pennsville T WD	PTWD 5	393750	753131	Pennsville	MRPAU	101 - 117	117
330361	30-01815	Penns Grove WSC	Layton 4	394205	752700	Carneys Point	MRPAU	44 - 54	77
330364	34-01031	Public Service E-G	PW 5	392743	753158	Lower Alloways Cr	MRPAM	765 - 840	143
330385	--	Public Service E-G	3-74	392754	753215	Lower Alloways Cr	MRPAM	--	13
330452	34-01074	Public Service E-G	Hope Creek	392751	753207	Lower Alloways Cr	MRPAM	746 - 817	61
330453	30-03013	Pennsville T WD	PTWD 6	393957	753017	Pennsville	MRPAM	99 - 114	73
330460	30-03310	Penns Grove WSC	PGWSC 1A/RF2A	394247	752714	Carneys Point	MRPAU	41 - 61	82
330671	30-05148	Pennsville T WD	PTWD 3A	393954	753013	Pennsville	MRPAU	87 - 102	10
330997	30-06023	B F Goodrich Co	10	394547	752535	--	MRPAM	76 - 105	*

Table 7.-- Water levels measured in wells in the vicinity of the Raccoon Island, 15D, Oldmans #1, Pedricktown North, Pedricktown South, 15G sites, Penns Neck, and Killcohook Sites

[Water altitude adusted to estimated mid-tide level, as necessary; * - water-level data was reported by owner]

USGS Well Number	State of New Jersey Permit Number	Owner	Local Identifier	Latitude	Longitude	Land Surface Altitude (ft)	Screened Interval (ft)	Date / Time Measured		Water Altitude (ft)	Tide-adjusted Water Altitude (ft)
Upper aquifer of the Potomac-Raritan-Magathy aquifer system.											
150240	30-00973	Del Monte Corp	9	394510	751838	32	190 - 231	3/28/95	1625	-19	
150617		USGS	Shiveler upper	394637	751916	31	60 - 70	3/23/95	1338	-6	
150707	50-00077	USGS	Gaventa W TAB	394800	751936	7	6 - 7	3/23/95	1154	4	
330076	30-00661	Gaehring	Gaehring 1	394328	752446	27	118 - 123	4/17/95	1247	2	
330109	30-01322	Ganes Chemical	1973-1	393734	753149	5	116 - 131	4/17/95	1451	4	
330111	30-01253	Pennsville T WD	Hook RD OBS	393746	752955	10	190 - 235	4/04/95	1140	-20	
330128		E I duPont	N04-M1D	394102	752946	12	108 - 113	4/05/95	1342	0	
330342		State of NJ	Penns Grove 24	394236	752724	18	46 - 51	4/04/95	1536	4	
330348		State of NJ	Penns Grove 14 OBS	394317	752619	25	-	4/07/95	1000	20	
330360	28-10466	Pennsville T WD	PTWD 5	393750	753131	10	101 - 117	4/04/95	1100	-2	
330361	30-01815	Penns Grove WSC	Layton 4	394205	752700	13	44 - 54	4/06/95	1245	7	
330408	30-00815	Pedricktown Swim	Swim 1	394450	752410	15	26 - 36	4/11/95	1132	2	
*330671	30-05148	Pennsville T WD	PTWD 3A	393954	753013	7	87 - 102	3/22/95	--	-2	
330686	30-08335	Pennsville TWP	PTWD 4A RPL	393749	753149	10	110 - 130	4/04/95	1045	0	
330745	30-04948-2	Atlantic City Elec Co	Deepwater MW3	394054	753028	9	3 - 18	4/06/95	1750	3	
Middle aquifer and Undifferentiated part of the Potomac-Raritan-Magathy aquifer system.											
150135	30-01314	Shell Oil Co	Obs Well 8A	394516	752241	7	130 - 180	3/28/95	1455	-1	
150140	30-01248	Pureland Water Co	Test Well 4	394608	752135	6	132 - 184	3/28/95	1415	2	

Table 7.-- Water levels measured in wells in the vicinity of the Raccoon Island, 15D, Oldmans #1, Pedricktown North, Pedricktown South, 15G sites, Penns Neck, and Killcohook Sites -- continued

USGS Well Number	State of New Jersey Permit Number	Owner	Local Identifier	Latitude	Longitude	Land Surface Altitude (ft)	Screened Interval (ft)	Date / Time Measured		Water Altitude (ft)	Tide-adjusted Water Altitude (ft)
150166	30-00410	Penns Grove WSC	Bridgeport 2	394755	752108	5	65 - 85	4/06/95	1045	1	
150167	30-01170	Monsanto Chem	Monsanto 1	394726	752319	10	64 - 94	3/27/95	1541	-9	
150170	30-01220	Vine Concrete Co	Repaupo 1	394854	751906	11	85 - 106	3/23/95	1013	3	
150380		Monsanto Chem	Obs 2	394757	752346	18	71 - 76	3/27/95	1444	-7	-6
150540	30-02621	US EPA	EPA 108	394800	751936	7	87 - 97	3/23/95	1149	3	
150569	30-02405	Pureland Water Co	PWC 3	394529	752045	32	161 - 201	3/28/95	1035	-5	
150585	30-02522	Rollins Env Services	DP5	394704	752058	8	79 - 89	3/27/95	1021	1	
150586	30-02539	Rollins Env Services	DP4	394720	752052	12	95 - 125	3/27/95	1013	2	
150598		Monsanto Chem	1S	394738	752357	13	4 - 14	3/27/95	1504	-12	-12
150616		USGS	Shiveler middle	394637	751916	31	230 - 240	3/23/95	1333	-6	
150620	30-03677	USGS	Gaventa middle 1	394804	751933	7	131 - 141	3/23/95	1117	6	
330072	30-00206	NJ Turnpike Auth	1S-1	394154	752351	35	342 - 368	4/03/95	1100	-1	
330082	30-00660	Bridge, Bruce H	Bridge	394542	752603	6	-	3/23/95	1320	-10	
330083	30-01139	B F Goodrich CO	10	394547	752535	10	93 - 133	3/27/95	1321	-20	
330103	30-00467	Penns Grove S A	1	394346	752828	8	50 - 60	3/27/95	1151	2	2
330106		Linski Alex	1	393514	752917	5	359 - 365	4/11/95	1406	-30	
*330118	50-00041	Pennsville T WD	PTWD 1	393958	753045	8	213 - 238	2/21/95	--	-22	-21
330119	30-00018	Pennsville T WD	PTWD 2	394009	753043	7	210 - 230	4/04/95	1355	-4	-4
330122	30-01234	Atlantic City Elec Co	Deepwater 3R	394045	753018	10	165 - 235	4/06/95	1810	-56	-56
330131	30-01054	E I duPont	H05-M01E	394109	753009	8	237 - 247	4/05/95	1225	-42	-40
330132	30-01055	E I duPont	H05-M02E	394109	753009	9	192 - 200	4/05/95	1226	-43	-41
330141	30-01052	E I duPont	H11-M01E	394131	753009	9	197 - 207	4/05/95	1237	-42	-40
330334	30-00621	E I duPont	Carney Pt 6	394211	752901	5	157 - 182	4/05/95	1311	-43	

Table 7.-- Water levels measured in wells in the vicinity of the Raccoon Island, 15D, Oldmans #1, Pedricktown North, Pedricktown South, 15G sites, Penns Neck, and Killcohook Sites -- continued

USGS Well Number	State of New Jersey Permit Number	Owner	Local Identifier	Latitude	Longitude	Land Surface Altitude (ft)	Screened Interval (ft)	Date / Time Measured		Water Altitude (ft)	Tide-adjusted Water Altitude (ft)
330431	30-01659	Pennsville T WD	TW 1	393753	753140	10	102 - 117	4/11/95	1330	0	
330444		Corps of Engineers	DGB 100	394459	752702	23	83 - 88	4/11/95	0907	12	
330449	30-02228	Corps of Engineers	EHW-5	394614	752539	10	32 - 37	4/11/95	0958	5	
330450	30-02238	Corps of Engineers	EHW-6	394516	752750	10	28 - 33	4/11/95	0907	5	5
330453	30-03013	Pennsville T WD	PTWD 6	393957	753017	10	99 - 114	4/04/95	1205	-5	
330993	30-03545-7	E I duPont	F07-M01D	394115	753019	10	88 - 93	4/11/95	1233	-9	-7
330994	30-05614-4	E I duPont	L19-M0ID1	394202	752949	12	121 - 126	4/05/95	1258	2	4
330995	30-05495-8	E I duPont	T29-M01C	394245	752907	6	71 - 76	4/05/95	1330	1	3
330996	30-08967	Corps of Engineers	EHW-8	394626	752519	20	-51	4/11/95	1010	4	
330997	30-06023	B F Goodrich Co	10	394547	752535	10	76 - 105	3/27/95	1321	-20	
		Lower aquifer of the Potomac-Raritan-Magathy aquifer system.									
150133	30-01222	Pureland Water Co	Test Well 1	394510	752244	20	317 - 367	3/28/95	1510	-4	
150139	30-01223	Pureland Water Co	Test Well 3	394608	752135	7	301 - 345	3/28/95	1355	-10	
150349		Pureland Water Co	Landtect 2	394650	752316	6	170 - 220	3/28/95	1235	-4	
150398	30-02016	Pettit, Louis	419	394935	751938	1	50 - 60	3/23/95	0918	-1	
150615		USGS	Shiveler lower	394637	751916	29	378 - 388	3/23/95	1342	-13	
150618		USGS	Gaventa deep	394804	751933	7	230 - 240	3/23/95	1105	-3	
330086	30-01139	B F Goodrich Co	4 (PW-3)	394557	752523	13	169 - 189	3/27/95	1344	-14	
330137	50-00003	E I duPont	E07-W01F	394112	753028	10	317 - 347	4/05/95	1230	-62	-59
330330	50-00098	Penns Grove WSC	Layton 11	394205	752657	16	--	4/06/95	1230	-30	
330335	30-01133	E I duPont	Carney PT 7	394212	752751	15	411 - 417	4/05/95	1351	-28	
330346	30-00563	Penns Grove WSC	Ranney 7	394256	752718	19	317 - 357	4/05/95	1145	-30	

Table 7.-- Water levels measured in wells in the vicinity of the Raccoon Island, 15D, Oldmans #1, Pedricktown North, Pedricktown South, 15G sites, Penns Neck, and Killcohook Sites -- continued

USGS Well Number	State of New Jersey Permit Number	Owner	Local Identifier	Latitude	Longitude	Land Surface Altitude (ft)	Screened Interval (ft)	Date / Time Measured		Water Altitude (ft)	Tide-adjusted Water Altitude (ft)
330402		Corps of Engineers	EHW-1 TEST	394657	752546	6	109 - 114	4/11/95	1025	-4	-4
330432	30-01141	B F Goodrich CO	3	394553	752513	10	180 - 195	3/27/95	--	-14	
330991	30-01913-3	E I duPont	P11-M01F	394131	752926	15	429 - 434	4/05/95	1250	-43	
330992	30-01049-7	E I duPont	H11-W01F	394131	753007	11	307 - 455	4/05/95	1240	-59	-57