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**HYDROGEOLOGIC ASSESSMENT OF THE  
COX CREEK DREDGED MATERIAL  
CONTAINMENT FACILITY**

by

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# CONTENTS

	<b>Page</b>
Key results .....	1
Introduction .....	2
Purpose and scope .....	2
Location of study area .....	2
Previous investigation .....	2
Hydrogeologic framework .....	3
Water-level fluctuations .....	4
Groundwater-flow system .....	5
Discussion of results .....	5
Acknowledgements .....	6
References .....	6
Appendixes:	
A. Lithologic logs of monitoring wells from well-completion reports.....	7
B. Geophysical logs run in the monitoring wells .....	11

**ILLUSTRATIONS**

<b>Figure</b>	<b>Page</b>
1.-2. Map showing:	
1. Location of study area .....	14
2. Monitoring wells at the Cox Creek Dredge Material Confinement Facility .....	15
3. Hydrogeologic cross section from Anne Arundel County Dorsey Road Well Field to Cox Creek Dredged Material Containment Facility.....	16
4. Relation between water-level fluctuations in monitoring wells and barometric pressure and precipitation rate in the area:	
a. AA Ae 49 .....	17
b. B-3 .....	17
c. AA Ae 50 .....	18
d. AA Ae 51.....	18
e. AA Ae 47 .....	19
f. AA Ae 48 .....	19
5.-6. Map showing the:	
5. Potentiometric surface of the Lower Patapsco aquifer system at the Cox Creek Dredged Material Containment Facility in the fall of 2014 .....	20
6. Regional potentiometric surface of the Lower Patapsco aquifer system in the fall of 2014 .....	21

**TABLES**

<b>Table</b>	<b>Page</b>
1. Construction data for the Cox Creek monitoring wells .....	22
2. Water-level data from the monitoring wells.....	23

# HYDROGEOLOGIC ASSESSMENT OF THE COX CREEK DREDGED MATERIAL CONTAINMENT FACILITY

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## **KEY RESULTS**

The Maryland Port Administration is examining the possibility of raising the dikes at the Cox Creek Dredged Material Containment Facility and expanding onto adjacent upland areas. The site, located in northern Anne Arundel County, Maryland, lies in the outcrop area of the Patapsco confining unit, which overlies the Lower Patapsco aquifer system, the Arundel Clay confining unit, and the Patuxent aquifer system. This study was conducted to evaluate and refine the hydrogeologic framework and groundwater flow regime previously developed by the U.S. Army Corps of Engineers as part of an assessment of the site expansion on local groundwater resources. Data collected during this study indicate that the shallowest aquifer at the site, the Lower Patapsco aquifer system, is effectively separated hydraulically from the surface by relatively thick, low permeability clay of the Patapsco confining unit as indicated by well water-level response to barometric pressure and precipitation events. Additionally, groundwater in the Lower Patapsco aquifer system at the site flows eastward toward the Patapsco River. Therefore, placement of additional dredged material is unlikely to affect the Lower Patapsco aquifer system.

## **INTRODUCTION**

The Port of Baltimore shipping channels require periodic maintenance dredging to maintain adequate depths. In order to increase storage capacity for dredged material, the Maryland Port Administration (MPA) is examining the possibility of raising the dikes at the existing Cox Creek Dredged Material Containment Facility (DMCF) and expanding the facility onto adjacent MPA-owned upland areas. Since the dredged material may be contaminated, it must be contained. At a DMCF, dredged material is placed behind dikes, dewatered, and allowed to settle. A previous subsurface geology and groundwater investigation of the existing facility was conducted by the U.S. Army Corps of Engineers, Baltimore District, in the mid 1990s as part of the Baltimore Harbor Anchorages and Channels, Maryland, Integrated Feasibility Report and Environmental Impact Statement (1997). Because water supply and usage in northern Anne Arundel County and southern Baltimore City and Baltimore County have changed since that time, the Maryland Geological Survey (MGS) obtained groundwater-level data and additional information on the subsurface geology from the proposed expanded area to determine whether the proposed activities would affect groundwater supplies in the area.

## **PURPOSE AND SCOPE**

The purpose of this report is to present data and information relevant to the groundwater flow system in the vicinity of the Cox Creek DMCF, and provide an interpretation as to whether the dredge material will affect the local groundwater system. This study was conducted to evaluate the conclusion of the U.S. Army Corps of Engineer's earlier investigation of the Cox Creek DMCF (U.S. Army Corps of Engineers, 1997) that additional placement of dredged material will not affect the local groundwater system (Lower Patapsco aquifer system). As part of this study, groundwater levels and geophysical logs were obtained from existing monitoring wells at the Cox Creek site. The geophysical logs were used, along with existing lithologic logs, to refine the hydrogeologic framework at the site and its relation to the regional aquifer framework. The groundwater-level measurements were used to determine the head gradient and direction of groundwater flow in the Lower Patapsco aquifer in the vicinity of the Cox Creek site and its relation to the regional potentiometric surface.

## **LOCATION OF STUDY AREA**

The study area is the Cox Creek DMCF in northern Anne Arundel County (figs. 1 and 2). Portions of southern Baltimore County, Baltimore City, and Anne Arundel County are also included in order to define the regional hydrogeologic framework and potentiometric surface. Monitoring wells used in the study are located near the intersection of Fort Smallwood Road and Kembo Road (AA Ae 47), south of Kembo Road along abandoned railroad tracks near Swan Creek (B-3 and AA Ae 49), near abandoned railroad tracks north of Kembo Road (AA Ae 48), and immediately adjacent and on the south side of Kembo Road near the Cox Creek DMCF (AA Ae 50 and AA Ae 51) (fig. 2).

## **PREVIOUS INVESTIGATION**

In the mid 1990s the U.S. Army Corps of Engineers, Baltimore District, conducted a subsurface geology and groundwater investigation to determine the acceptability of expanding the existing DCMF at the Cox Creek placement site. Groundwater levels were measured at several existing wells, while eleven new wells were drilled at the site to provide lithologic and groundwater-level data. The lithologic data, obtained from split spoon samples taken during drilling, indicated a clay layer (confining unit) at the site extending to approximately 150 ft below

land surface; at some of the well sites the clay interval contained sandy zones. Groundwater-level measurements in the monitoring wells showed water levels below sea level in the Lower Patapsco aquifer system near the Patapsco River; likely the result of drawdown from pumping across the river (to the east) at the Bethlehem Steel Sparrows Point Plant. Hydraulic conductivity and storage coefficient values were obtained through pumping tests in the monitoring wells, and a 3-dimensional, numerical groundwater-flow model was created to test the effects of the placement of dredged material. Multiple scenarios were tested, including a worst-case condition of a filled impoundment extending 39 feet above sea level during extreme drought with no recharge to the aquifer system. The modeling results indicated that even under the worst-case condition, placement of dredged material would not affect groundwater-flow direction in the water-table aquifer beyond the existing Cox Creek disposal area. Groundwater flow in the Lower Patapsco aquifer system would not be affected. Additionally, any movement of potential contaminants from the dredged material would be minimal because of the low hydraulic conductivity of the Patapsco confining unit, and would not affect the Lower Patapsco aquifer system. Five of the wells drilled for that study, as well as one existing well, were used for the current study (tab 1).

## **HYDROGEOLOGIC FRAMEWORK**

The Cox Creek DMCF study area is located in the Coastal Plain Physiographic Province in the outcrop area of the Patapsco confining unit. Maryland's Coastal Plain is a wedge of unconsolidated and poorly consolidated sediment generally dipping and thickening to the east and southeast and overlying pre-Cretaceous basement rock (Andreasen and others, 2013).

A previous investigation showed that Quaternary alluvium may overlie the Patapsco confining unit in the eastern part of the study area (U.S. Corps of Engineers, 1997). Additionally, recently dredged material overlies the Quaternary sediments and the Patapsco confining unit at the placement site. Underlying the Patapsco confining unit, from shallow to deep, are the Lower Patapsco aquifer system, the Arundel Clay confining unit, and the Patuxent aquifer system (Andreasen and others, 2013). The Arundel Clay confining unit and Patuxent aquifer system are too deep to be reached by the monitoring wells in this study. The shallowest hydrogeologic unit in the study area is an unconfined aquifer in the Quaternary sediments that overlie the Patapsco Formation. That aquifer is not present in the low-lying areas on the east side of the DMCF (Glaser, 1976).

The Patapsco confining unit separates the underlying Lower Patapsco aquifer system from the overlying Upper Patapsco aquifer system, which has been eroded away at the Cox Creek site (fig. 3). The confining unit consists of variegated clays of the Cretaceous Patapsco Formation, interpreted as being deposited in a backswamp environment on a deltaic plain. Lithologic logs show this unit consisting of red, gray, purple, brown and mottled clays (app. A). At the Cox Creek site, geophysical logs indicate that the thickness of the Patapsco confining unit is as much as 25 feet thick (fig. 3; app. B).

The lower part of the Patapsco Formation consists of interbedded clays, sands and gravels deposited in a fluvio-deltaic environment (Andreasen and others, 2013). The sand and gravel bodies form the Lower Patapsco aquifer system. The proportion of sand to clay can vary greatly over relatively short distances. For example, lithologic logs indicate that borehole AA Ae 50 contains mostly clay above 85 ft below the land surface, while borehole AA Ae 47 contains more silt and sand within the same interval (app. A). The sands at the Cox Creek DMCF site are fine-to medium-grained, grayish-white, yellow, brown, and tan with traces of gravel in some areas (app. A). The clays are red, gray, white, yellow, purple, pink, brown, and mottled (app. A). The

Lower Patapsco aquifer system is estimated to be more than 100 ft thick at the site, although the wells are not deep enough to reach underlying units (fig. 3; app. B).

The Arundel Clay confining unit separates the Lower Patapsco aquifer system from the Patuxent Aquifer system. It consists of the Arundel Clay Formation, as well as clays from the Patapsco and Patuxent Formations where they are in contact with the clays of the Arundel Clay Formation. The confining unit was too deep to be reached by the monitoring wells at the Cox Creek site, but is described as consisting of tough, red and gray clays with some layers of sand (U.S. Army Corps of Engineers, 1997). It is estimated to be approximately 80 to 90 ft thick at the site (Andreasen and others, 2013).

The Patuxent Formation overlies pre-Cretaceous basement rock. It was deposited in a fluvial-deltaic environment similar to the Patapsco Formation and generally consists of medium- to coarse-grained sand and gravel with interbedded clay (Andreasen and others, 2013). Individual sand bodies may act as separate aquifers locally, but regionally connect to form the Patuxent aquifer system (Andreasen and others, 2013). The Patuxent Formation is too deep to be reached by the monitoring wells at the Cox Creek site.

### **WATER-LEVEL FLUCTUATIONS**

Synoptic water-level measurements were collected in all monitoring wells in October 2014 (tab. 2). Pressure transducers were then placed in pairs of wells to collect approximately one month of continuous water-level measurements. Wells AA Ae 49 and B-3 were measured from mid-December 2014 to late January 2015 (figs. 4a and 4b). Wells AA Ae 50 and AA Ae 51 were measured from late January 2015 to late February 2015 (figs. 4c and 4d). Wells AA Ae 47 and AA Ae 48 were measured from late February 2015 to late March 2015 (figs. 4e and 4f). The water levels were recorded by pressure transducers at 15-minute intervals.

Water levels in the Lower Patapsco wells (AA Ae 47, AA Ae 48, AA Ae 49, AA Ae 50, and AA Ae 51) show an inverse relation to the barometric pressure measured at the Riviera Beach weather station (Weather Underground) located approximately 3 miles southeast of the Cox Creek site (figs. 4a, 4c-4f). Water levels in AA Ae 48, AA Ae 49, AA Ae 50, and AA Ae 51 also show diurnal tidal affects. The water level in AA Ae 47 does not show these affects because the well is further from the shore. Water levels in these wells do not show a noticeable response to precipitation events. Water levels in the Lower Patapsco wells displayed a generally flat trend, and fluctuated by less than 2 feet over the approximate one month of continuous record. The strong response to barometric pressure and the lack of response to precipitation indicate that the Lower Patapsco aquifer system is a confined aquifer at the site.

The water level in B-3, screened in a silty zone of the Patapsco confining unit, was 0.85 ft below sea level in the fall 2014 (tab. 2). Water levels in B-3 fluctuated by approximately 3.4 feet (from about 0.85 to 4.2 ft above sea level) over the approximate one month of continuous record, and displayed a rising trend (fig. 4b). Water levels in well B-3 do not show a response to barometric pressure, but do respond to precipitation, rising rapidly before declining more gradually following extended precipitation events. Two precipitation events in mid-January (2015) caused little or no immediate increase in water levels; both events were of either of lesser magnitude or duration than two previous precipitation events (late December 2014 and early January 2015) that did result in immediate water-level responses. The direct response to precipitation events indicates unconfined aquifer conditions. The fluctuation in B-3 is enough such that the vertical-head gradient between B-3 and nearby AA Ae 49 is upward at the beginning

of the one month continuous record and downward at the end. The lack of response in either well to this gradient indicates the two are effectively separated by a confining unit.

## **GROUNDWATER-FLOW SYSTEM**

The water-table aquifer in the vicinity of the Cox Creek site consists of sandy and silty zones within the Patapsco Formation (Patapsco confining unit), and, in more low-lying areas (near wells AA Ae 49 and B-3), possibly Quaternary sediments (Glaser, 1976). The U.S. Corps of Engineers report (1997) indicates that the Quaternary sediments do not form the water-table aquifer in the vicinity of the disposal cells.

The Lower Patapsco aquifer system is a confined aquifer at the Cox Creek site. Water levels in the fall of 2014 range from approximately 4.5 ft above sea level in AA Ae 47 to approximately 2 ft above sea level in AA Ae 51 (fig. 5; tab. 2). These water levels are similar (within approximately 1 ft) to water levels measured in October 1996 (U.S. Army Corps of Engineers, 1997). The direction of groundwater flow at the site is from west to east toward the Patapsco River (fig. 5). Regionally, pumping from the Lower Patapsco aquifer system in northern Anne Arundel County (Glen Burnie area), approximately five miles southwest of the site, has not resulted in a cone of depression (fig. 6). Withdrawals at the Arnold well field approximately 11 miles south of the site have resulted in a cone of depression, with water levels as deep as 96 ft below sea level in September, 2014 (fig. 6). One withdrawal at an industrial site located just north of the Cox Creek DMCF (fig. 6) pumps a relatively small amount (less than 14,000 gallons per day in October, 2014), and has no effect on water levels or groundwater-flow directions in the Cox Creek area. In Anne Arundel County, groundwater flow in the Lower Patapsco aquifer system is generally from its outcrop area northwest of the Cox Creek site to the southeast (fig. 6) (Staley and others, 2014).

The Patuxent aquifer system is confined at the Cox Creek site by the Arundel Clay confining unit. Wells at the site are not deep enough to reach the Patuxent aquifer system. Withdrawals from the Patuxent aquifer system result in a deep cone of depression around Anne Arundel County's Dorsey Road well field near Glen Burnie with water levels in the fall of 2013 at approximately 109 ft below sea level (Staley and others, 2014). Other cones of depression in the Patuxent aquifer occur near the Arnold well field in Anne Arundel County and in the industrial area of southeast Baltimore County (Staley and others, 2014). The Cox Creek site is likely outside of the influence of these cones of depression, and groundwater flow in the Patuxent aquifer system at Cox Creek is likely toward the southeast.

## **DISCUSSION OF RESULTS**

Geophysical and lithologic logs show that the Lower Patapsco aquifer system is confined by the Patapsco confining unit at the Cox Creek DMCF site. The Patapsco confining unit is composed primarily of clay of relatively low hydraulic conductivity. The Patapsco Formation, which forms both the Patapsco confining unit and the underlying Lower Patapsco aquifer system, is a geometrically complex unit comprising multiple sand and clay layers. Several wells at the Cox Creek site contain high percentages of clay near the top of the Patapsco Formation, becoming sandier at depth. In other wells, the Patapsco Formation is dominated by more of a sandy facies. Overall there is a sufficient total thickness of clay (approximately 15-40 ft) overlying the Lower Patapsco aquifer system to effectively separate it hydraulically from the DMCF impoundments. The effectiveness of the clay layer as a confining unit is demonstrated in the response of groundwater levels to barometric fluctuations, to the lack of response to

precipitation events, and in the vertical-head gradient between the Lower Patapsco aquifer system and the water-table aquifer.

At the DMCF, groundwater in the Lower Patapsco aquifer system flows generally eastward toward the Patapsco River, and generally southeast regionally. Groundwater flow at the site is not affected by nearby or distant withdrawals. Water levels and direction of groundwater flow are similar to that measured in the mid 1990s (Mack and others, 1992; U.S. Army Corps of Engineers, 1997).

The presence of the Patapsco confining unit makes it unlikely that any potential contaminants from dredged material will affect the Lower Patapsco aquifer system; in addition, any contaminant that did reach the aquifer would flow toward the east (Patapsco River) and away from pumping centers. Since the Patuxent aquifer is deeper and further confined by the Arundel Clay confining unit, placement of dredged material at the Cox Creek site is unlikely to affect water levels.

### ACKNOWLEDGEMENTS

This study was funded through a joint agreement between the Maryland Environmental Service, the Maryland Department of Transportation, Port Administration, and the Maryland Department of Natural Resources. The authors would like to acknowledge the help of Stephen Curtin (US Geological Survey) and Jackson Forrest (Earth Data Inc.) for geophysical logging of the monitoring wells, Andrew Staley (Maryland Geological Survey) for assistance in figure preparation, David Bolton (MGS) for report review, and Stephen Van Ryswick and Heather Quinn (MGS) for assistance in surveying the monitoring wells. Access to the site was provided by the personnel of the Maryland Environmental Service. Jeff Halka (MGS, retired) was instrumental in planning the study.

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**Appendix A. Lithologic logs of monitoring wells from well-completion reports.**

**Monitoring well  
AA Ae 47**

<b>Sample interval (feet below land surface)</b>	<b>Primary lithology</b>	<b>Detailed description</b>
0-1.5	Silty clay	Dark brown silty clay
2.5-9.0	Clay	Light gray clay
10-11.5	Silty sandy clay	Gray silty sandy clay
12.5-14	Silty sand	Gray and orange silty sand (water-bearing)
15-16.5	Clayey sand	Purple-gray clayey sand (water-bearing)
17.5-26.5	Silty clay with silt	Dark gray silty clay with light gray silt
27.5-29	Silty clay	Dark gray silt and light brown silty clay
30-31.5	Clayey sand	Lavender gray clayey sand with lignite
32.5-34	Clayey silt	Dark gray clayey silt
35-46.45	Clayey silt	Dark gray clayey silt with fine brown mica flakes
50-50.7	Silty sand	Yellow-white silty sand
55-65.8	Sand	Very light tan-white sand, fine grained, clayey in areas
70-70.9	Silty sand	Tan-orange/orange brown silty sand, areas of white silt
75-75.45	Sand	Yellow-white fine grained sand
80-80.5	Sandy silt	Grayish-white sandy silt
85-85.5	Silty sand	Orange/light gray/yellow-white silty sand
90-95.8	Clay	Burgundy red/ light gray clay
100-105.45	Silty sand	Grayish-white silty sand
110-120.45	Sand	Grayish-white fine gr. sand
125-125.48	Sand	Yellow fine gr. sand
130-135.7	Sand	Tan/yellowwith orange fine to med. grained sand
140-145.3	Sand	Light brownish-gray fine to med. grained sand
150-150.33	Sand	Light brownish-tan fine to med. grained sand

**Appendix A. Continued.**

**Monitoring well  
AA Ae 48**

<b>Sample interval (feet below land surface)</b>	<b>Primary lithology</b>	<b>Detailed description</b>
0-0.7	Sandy silt	Dark brown sandy silt
0.7-1.05	Clayey sand	Reddish-brown clayey sand
1.05-1.5	Sand	Yellowish-brown medium sand
5-5.7	Silty sand	Grayish-brown fine to medium silty sand (water-bearing)
5.7-6.5	Silty sand	Yellowish-brown fine to medium silty sand (water-bearing)
10-11	Silty sand	Gray medium to coarse silty sand (water-bearing)
11-31.5	Clayey silt	Reddish-brown, grayish-white, and olive-yellow clayey silt
35-36.5	Clay	Red and yellow-green and very light grayish-white mottled clay
37.5-38.5	Clay	Gray-purple clay with light gray clay
38.5-38.9	Clay	Light gray clay with red and yellow-green clay
40-41.5	Clay	Light gray and red clay with veins of yellow-orange clay
45-66.5	Clay	Dark burgundy and light gray clay; different parts of interval are more burgundy or more light gray
70-76.25	Clay	Lavender and light gray clay with veins of burgundy clay
80-81.5	Clay	Dark brick red, light gray, lavender, and yellow-green clay
85-85.9	Clay	Lavender and light gray clay with areas of burgundy and specks of yellow clay
95-95.4	Silty sand	Light silver gray silty sand
95.4-96.3	Clay	Green-brown and burgundy clay
100-106.5	Silty clay, silty sand, and clay	Reddish brown silty clay, silver gray silty sand, and some lavender clay
110-110.9	Clayey silty sand	Light brown to brownish-white clayey, silty sand
115-115.3	Silty sand	Reddish-brown and light brown silty sand
120-130.3	Silty sand	Light grayish-white silty sand

**Appendix A. Continued.**

**Monitoring well  
AA Ae 49**

<b>Sample interval (feet below land surface)</b>	<b>Primary lithology</b>	<b>Detailed description</b>
0-1	Sand	Moist brownish orange, light brown medium sand
1-20	Silty clay	Moist mottled reddish brown, grayish white, pink silty clay
20-20.2	Clayey sand	Wet grayish white, yellowish brown, clayey fine sand
20.2-80	Silty clay	Moist mottled reddish brown, grayish white, pink silty clay
80-80.7	Sandy clay	Moist grayish white sandy clay
80.7-81.2	Silty clayey sand	Wet grayish white silty clayey with fine sand (water bearing)
81.2-90	Silty clay	Moist grayish white clay, silty clay
90-95.3	Sand, some clay	Wet grayish white medium sand, some clay (water bearing)
95.3-120	Silty clay	Moist mottled reddish brown, grayish white, pink silty clay
120-135.1	Silty clay	Moist light to dark gray silty clay
135.1-140.9	Sand	Wet grayish white fine sand (water bearing)
140.9-155	Silty clay	Moist grayish white silty clay
155-165	Sand	Moist to wet grayish white medium sand (water bearing)

**Monitoring well  
AA Ae 50**

<b>Sample interval (feet below land surface)</b>	<b>Primary lithology</b>	<b>Detailed description</b>
0-5	Clay	Clay, yellowish brown, moist
5-5.9	Silty clay	Silty clay, mottled yellowish brown, gray, moist
5.9-6.2	Silt, trace sand	Silt, trace medium sand, dark gray, moist
6.2-7	Clay, some sand	Clay, with some medium sand, mottled reddish brown, gray, moist
7-75	Silty clay	Silty clay, moist, mottled reddish brown, grayish white, pink
75-85	Clay	Clay, grayish white with some fine sand
85-90	Sand	Sand, grayish white, fine, wet (water bearing)
90-90.8	Clay	Clay, grayish white, with some fine sand
90.8-120	Silty clay	Silty clay, moist, mottled reddish brown, grayish white, purple, dark gray
120-145	Sand	Sand, pale yellow, pale yellow brown, light grayish white, medium, wet (water bearing)
145-149	Clayey sand	Clayey sand, light grayish white, medium, moist to wet (water bearing)

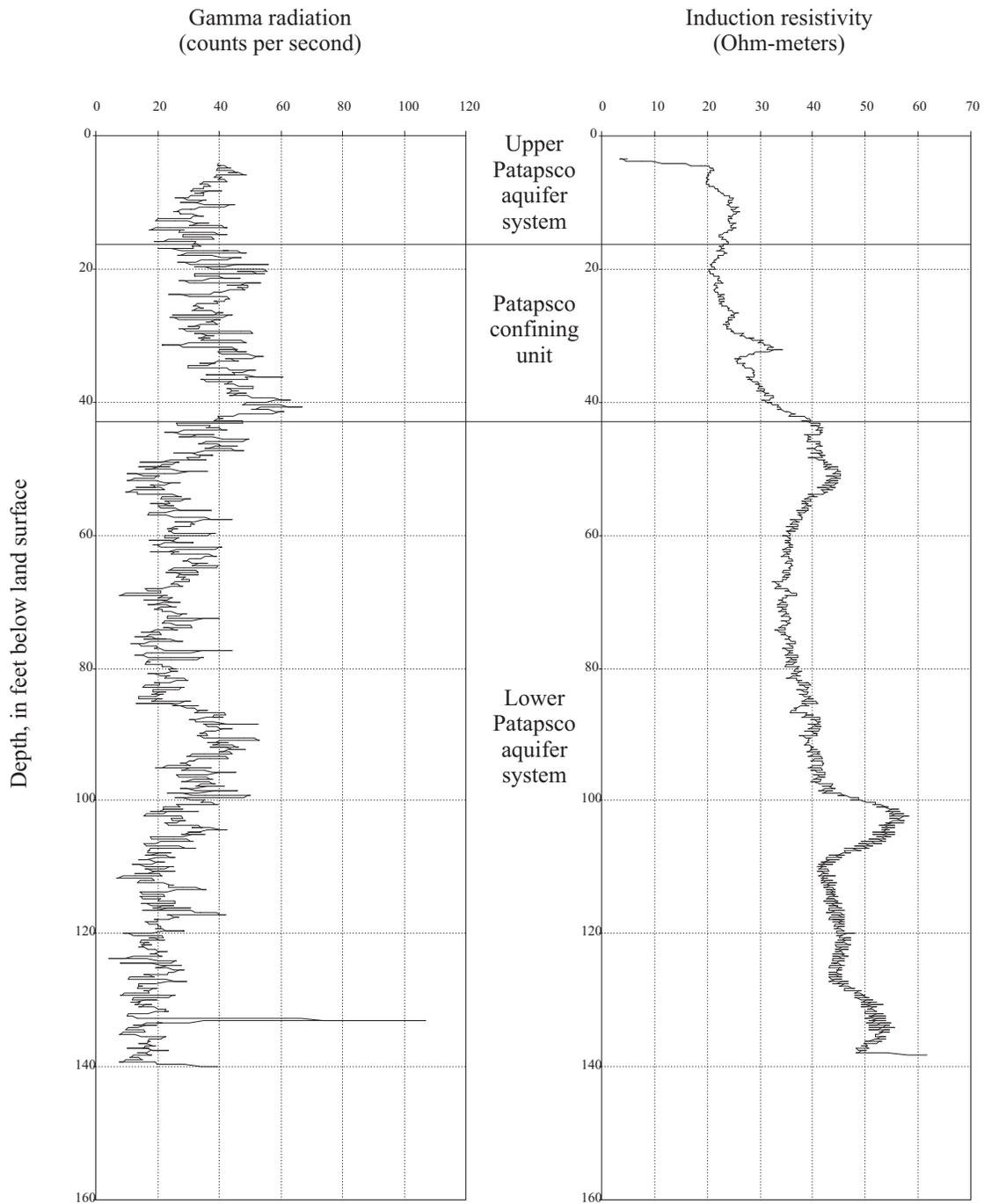
**Appendix A. Continued.**

**Monitoring well  
AA Ae 51**

<b>Sample interval (feet below land surface)</b>	<b>Primary lithology</b>	<b>Detailed description</b>
0-115	No samples	
115-120	Clayey silt	Moist dark gray clayey silt
120-125	Clayey silt	Moist mottled reddish brown, pink, purple clayey silt
125-147	Sand	Saturated yellow, yellowish orange, white medium grain sand

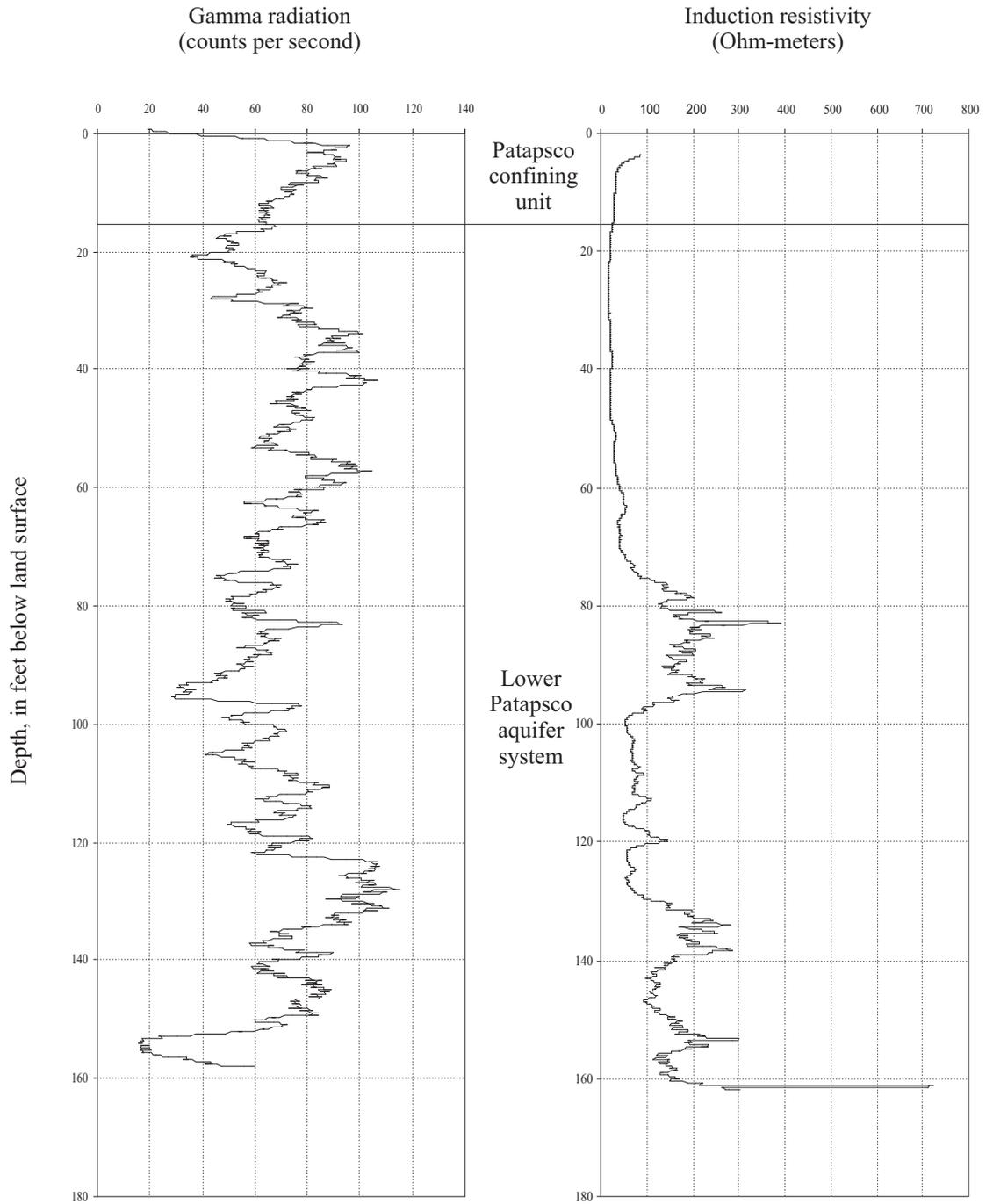
## Appendix B. Geophysical logs run in the monitoring wells.

### Monitoring well AA Ae 47



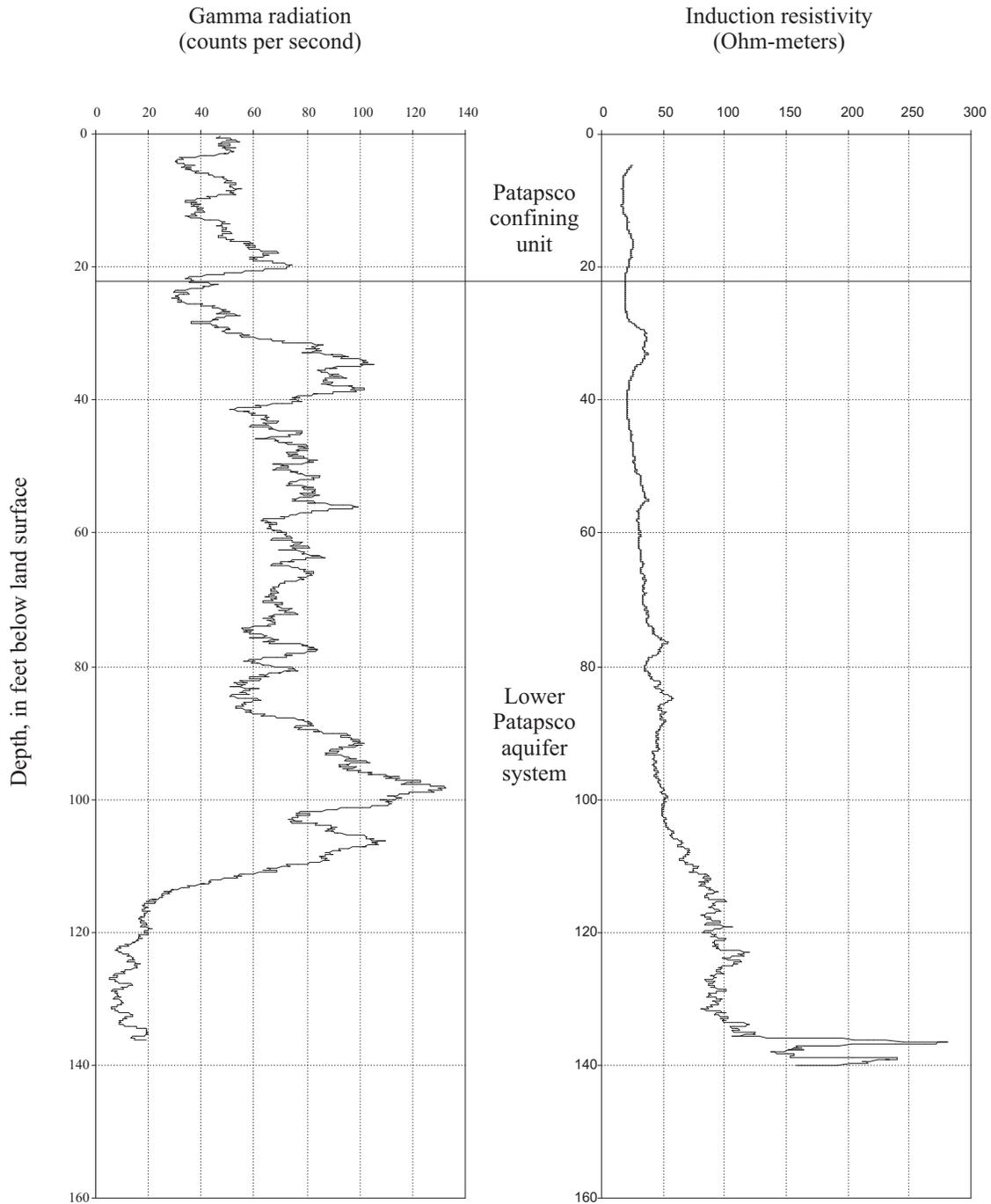
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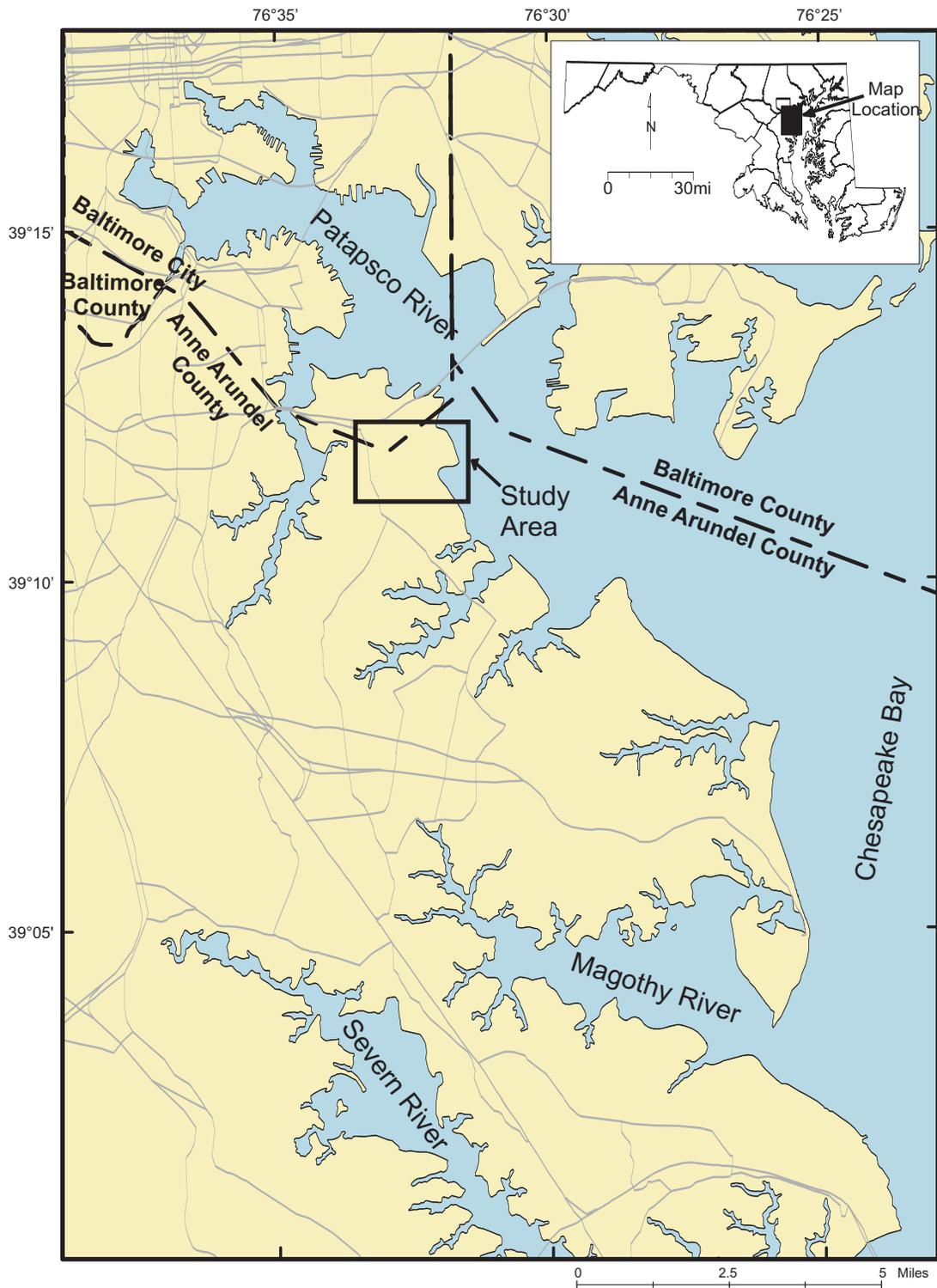
**Monitoring well  
AA Ae 49**



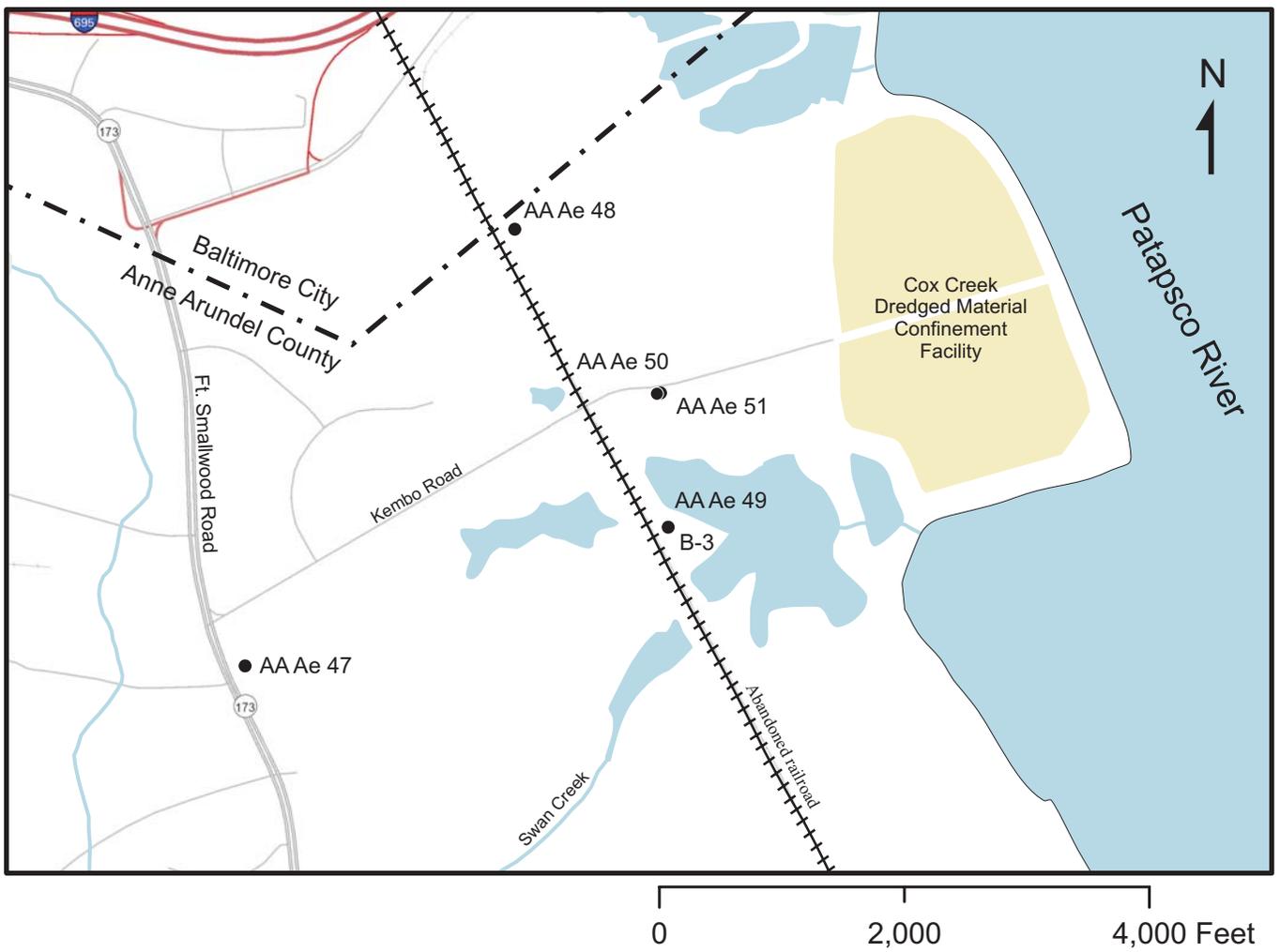
**Appendix B. Continued.**

**Monitoring well  
AA Ae 50**





**Figure 1. Location of study area.**



**Figure 2. Monitoring wells at the Cox Creek Dredged Material Confinement Facility.**

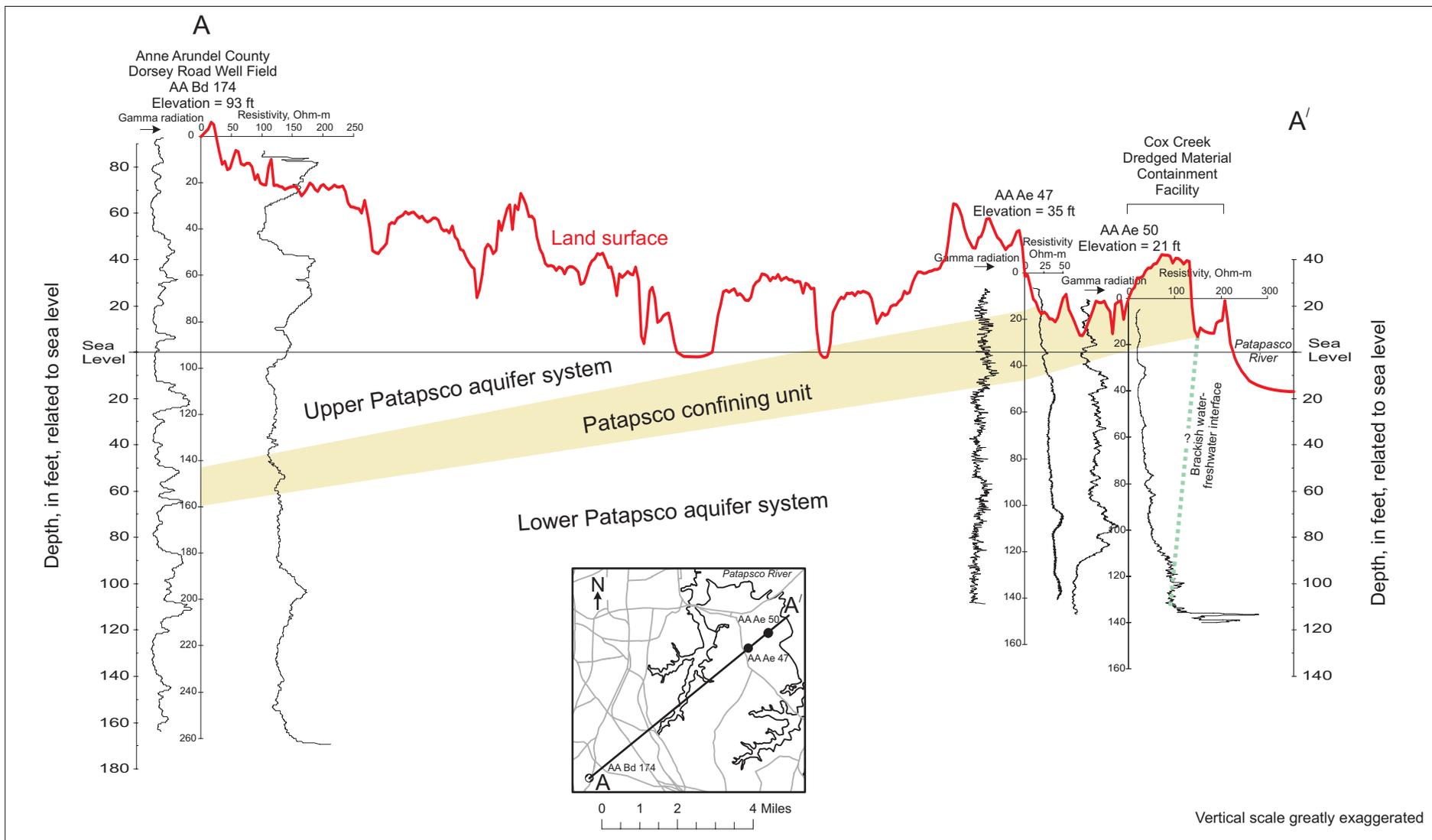
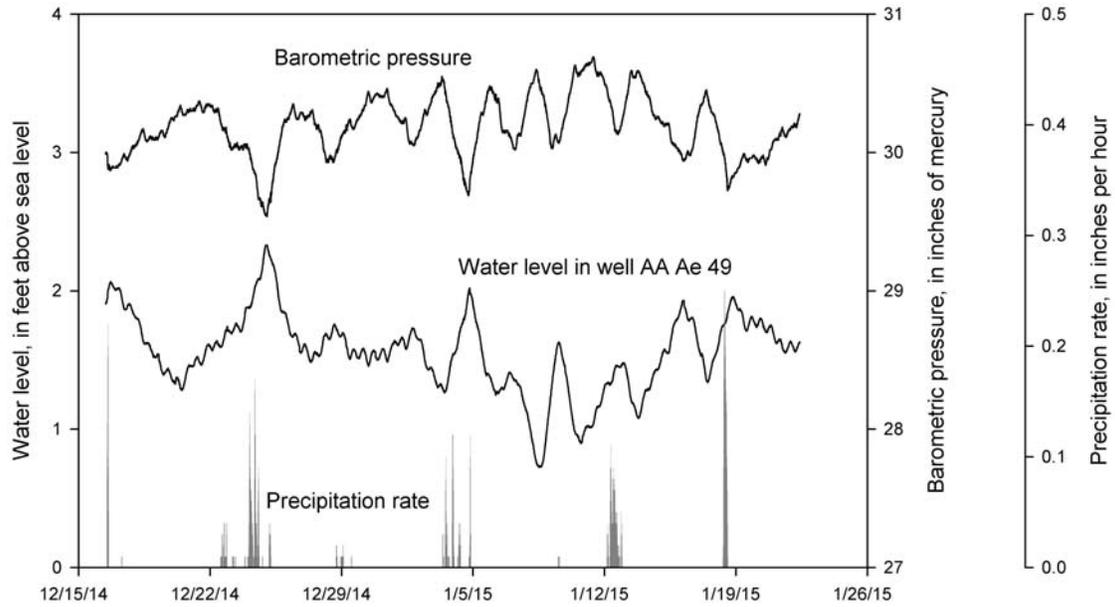
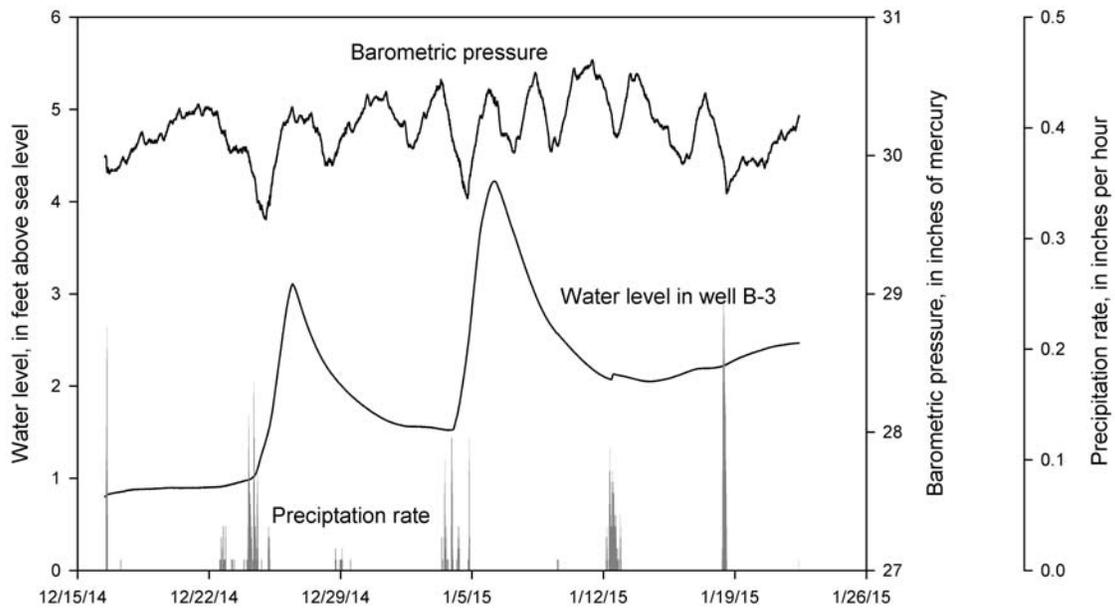


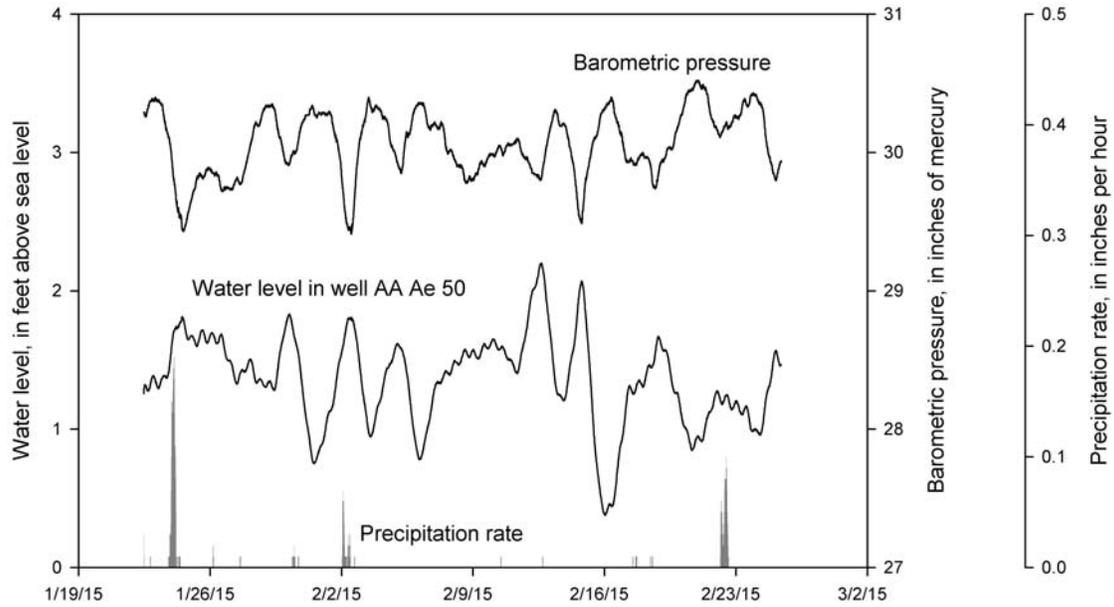
Figure 3. Hydrogeologic cross section from Anne Arundel County Dorsey Road Well Field to Cox Creek Dredged Material Containment Facility.



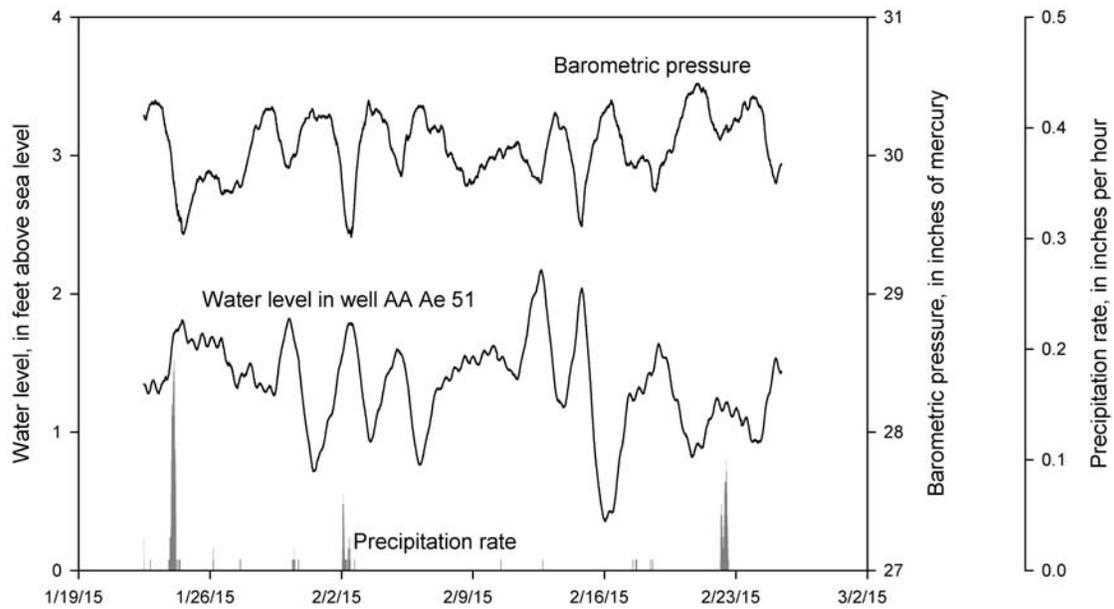
**Figure 4a. Relation between water-level fluctuations in monitoring well AA Ae 49 and barometric pressure and precipitation rate in the area.**



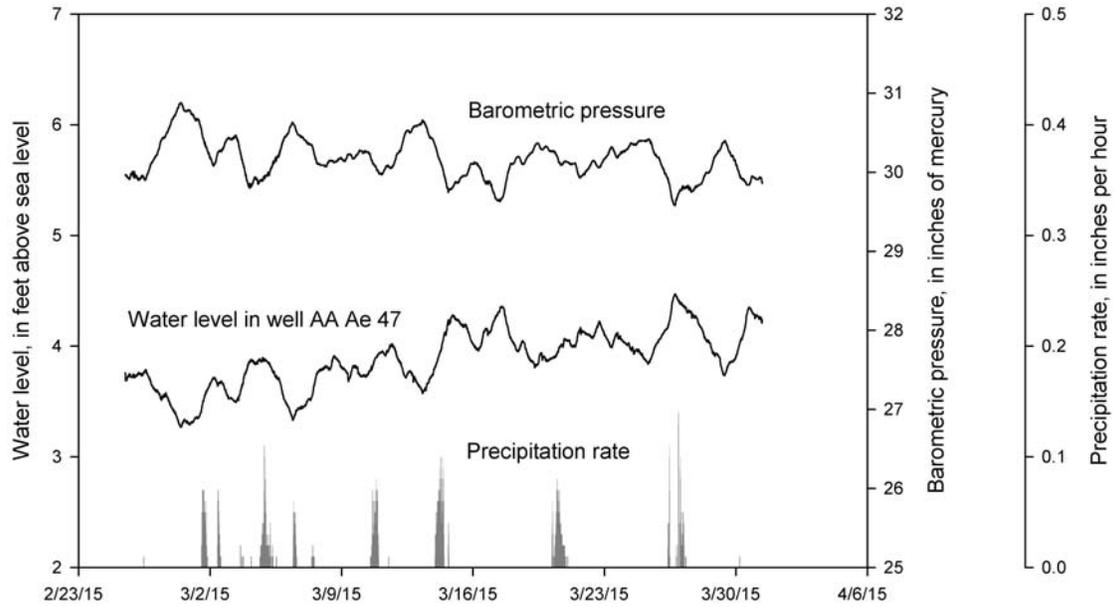
**Figure 4b. Relation between water-level fluctuations in monitoring well B-3 and barometric pressure and precipitation rate in the area.**



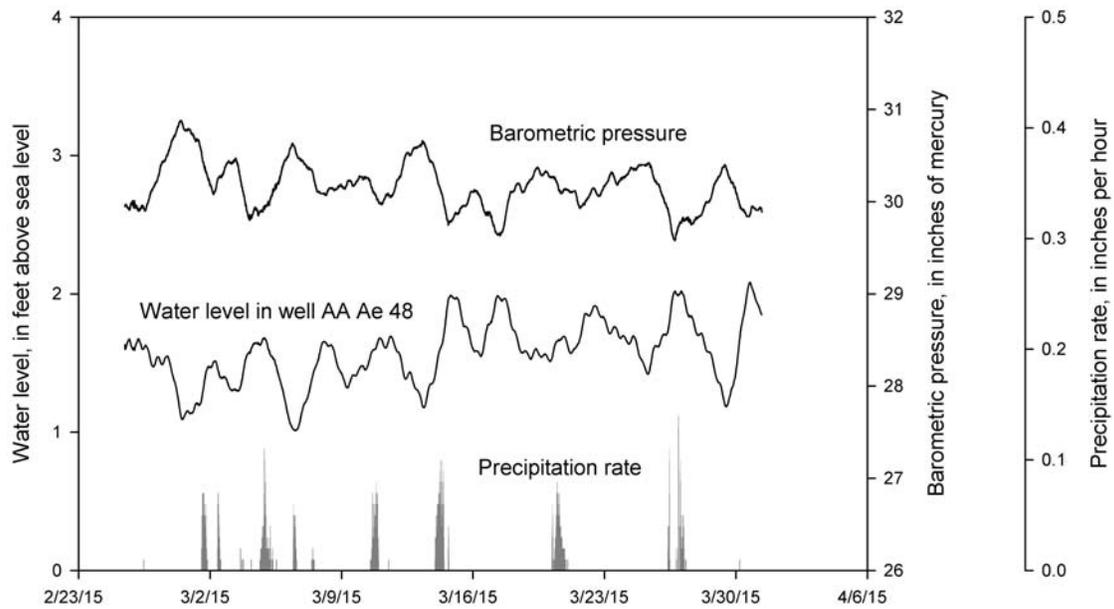
**Figure 4c. Relation between water-level fluctuations in monitoring well AA Ae 50 and barometric pressure and precipitation rate in the area.**



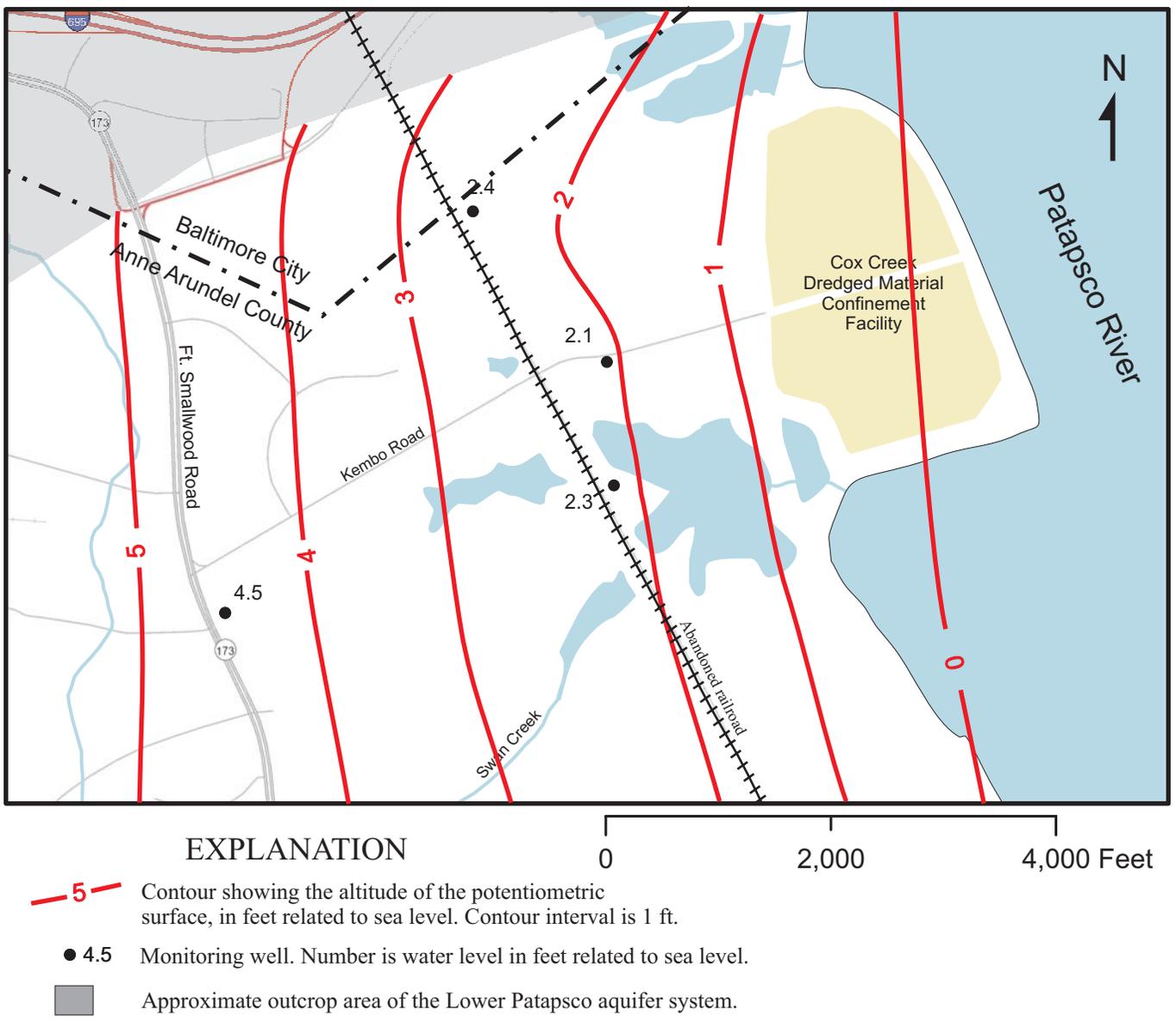
**Figure 4d. Relation between water-level fluctuations in monitoring well AA Ae 51 and barometric pressure and precipitation rate in the area.**



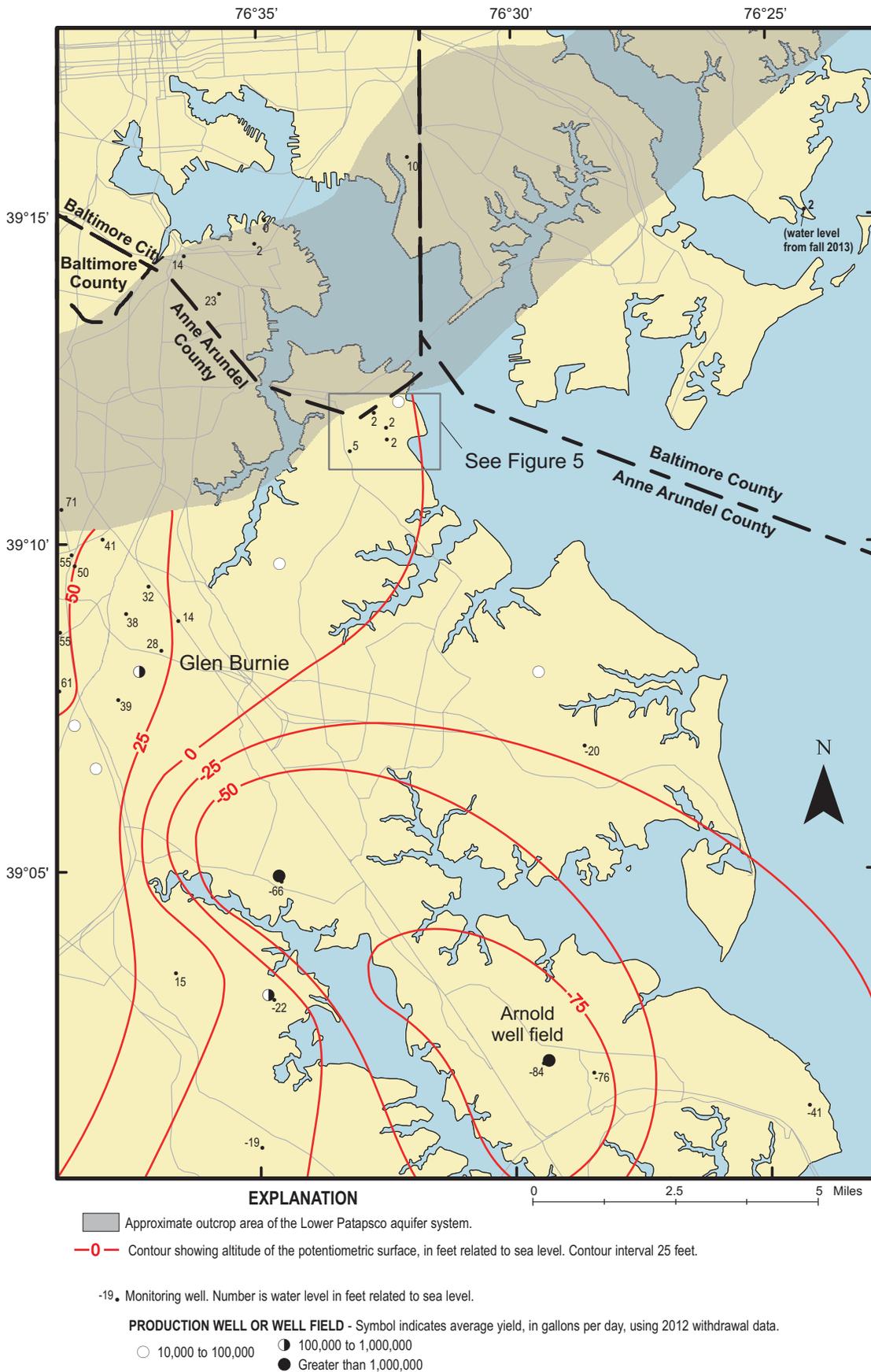
**Figure 4e. Relation between water-level fluctuations in monitoring well AA Ae 47 and barometric pressure and precipitation rate in the area.**



**Figure 4f. Relation between water-level fluctuations in monitoring well AA Ae 48 and barometric pressure and precipitation rate in the area.**



**Figure 5. Potentiometric surface of the Lower Patapsco aquifer system at the Cox Creek Dredged Material Containment Facility in the fall of 2014.**



**Figure 6. Regional potentiometric surface of the Lower Patapsco aquifer system in the fall of 2014**

**Table 1. Construction data for the Cox Creek monitoring wells.**

[USGS, U.S. Geological Survey; USACE, U.S. Army Corps of Engineers; NAD, North American Datum; D-M-S, degrees-minutes-seconds; ft., feet below land surface; in., inches; -, unknown]

<b>USGS well number</b>	<b>USACE well number</b>	<b>Permit number</b>	<b>Latitude NAD 83 D-M-S</b>	<b>Longitude NAD 83 D-M-S</b>	<b>Drilling method</b>	<b>Depth drilled, ft.</b>	<b>Bottom of well, ft.</b>	<b>Screen top, ft.</b>	<b>Screen bottom, ft.</b>	<b>Casing and screen diameter, in.</b>	<b>Top of gravel pack, ft.</b>	<b>Grout material</b>
AA Ae 47	C-1	AA-94-0592	39-11-24.2	76-33-11.3	Mud rotary	150	140	130	140	4	125	cement
AA Ae 48	D-2	AA-94-0586	39-11-59.3	76-32-43.1	Mud rotary	130	130	120	130	4	111.8	cement
AA Ae 49	E-1	AA-94-0447	39-11-35.2	76-32-27.3	Mud rotary	167	165	155	165	4	141	cement
AA Ae 50	F-1	AA-94-0446	39-11-46.0	76-32-28.1	Mud rotary	149	147	127	147	4	119	cement
AA Ae 51	F-2	AA-94-0587	39-11-46.0	76-32-28.5	Mud rotary	147	145	125	145	6	115	cement
none	B-3	-	39-11-34.9	76-32-27.4	-	-	32 <sup>1</sup>	-	-	-	-	-

<sup>1</sup> Sounded using graduated measuring tape

**Table 2. Water-level data from the Cox Creek monitoring wells.**

[MP, measuring point; ft., feet]

Well		AA Ae 47	AA Ae 48	AA Ae 49	AA Ae 50	AA Ae 51	B-3
MP elevation, ft.		37.85	38.29	15.09	23.98	25.08	16.91
MP height above land surface, ft.		2.4	1.9	2.45	2.7	2.6	3.2
Water Level, ft below measuring point (Water level, ft. related to sea level)	4/2/2014	34.01 (3.84)	36.46 (1.83)		22.36 (1.62)	23.37 (1.71)	
	10/16/2014	33.39 (4.46)	35.92 (2.37)	12.78 (2.31)		22.94 (2.14)	17.76 (-0.85)
	12/16/2014			13.18 (1.91)			16.13 (0.78)
	1/22/2015			13.6 (1.49)	22.74 (1.24)	23.74 (1.34)	14.45 (2.46)
	2/25/2015	34.08 (3.77)	36.67 (1.62)		22.72 (1.26)	23.72 (1.36)	
	3/31/2015	33.63 (4.22)	36.45 (1.84)				



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A message to Maryland's citizens

The Maryland Department of Natural Resources (DNR) seeks to balance the preservation and enhancement of the living and physical resources of the state with prudent extraction and utilization policies that benefit the citizens of Maryland. This publication provides information that will increase your understanding of how DNR strives to reach that goal through the earth science assessments conducted by the Maryland Geological Survey.

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