US Army Corps
of Engineers
Philadelphia District

GROUNDWATER MONITORING PLAN

Pearce Creek Confined Disposal Facility

January 2017

1. INTRODUCTION

This Groundwater Monitoring Plan has been developed to support the design, installation, and operations and maintenance by the USACE Philadelphia District of a liner system at the Pearce Creek Confined Disposal Facility (CDF), located in Earleville, Cecil County, Maryland.

1.1 Objective

The objective of this Groundwater Monitoring Plan is to monitor potential changes in groundwater quality resulting from the installation of an impermeable liner which is designed to mitigate the effects of future and past dredge disposal at the Pearce Creek CDF.

1.2 Previous Similar Applications

The USACE Philadelphia District has conducted monitoring projects of this type previously. As an example, the currently ongoing New Jersey CDF Monitoring Program was initiated in 2002 in cooperation with the New Jersey Department of Environmental Protection (NJDEP). The monitoring program was initiated by the USACE Philadelphia District and is being conducted voluntarily as a proactive means of monitoring groundwater conditions at several New Jersey CDFs on a continuing basis.

1.3 Assumptions

In designing the Pearce Creek Groundwater Monitoring Plan, several assumptions were made, including:

1. Program includes Magothy, Upper Patapsco Shallow, and Upper Patapsco Deep aquifers
2. Data collected will include groundwater characterization (groundwater analytical samples) and groundwater levels
3. No monitor wells inside the CDF will be included as they will be abandoned in accordance with Maryland Department of the Environment (MDE) requirements
4. Monitor wells and piezometers included in the study are located on government property, in road rights-of-way, and on private properties
5. Study area consists of Pearce Creek CDF and up to approximately 0.5 mile outside CDF perimeter
6. No residential drinking water samples will be tested
7. No river/creek/surface water samples will be tested
8. Total duration of monitoring program is indefinite at this time. Monitoring is expected to occur in all years of and intermediate years during placement of dredge material, and a period of time thereafter
9. Site performance standards are Federal MCL/SMCL and MDE drinking water values

2. SITE DESCRIPTION AND HYDROGEOLOGY

This section provides a brief physical description of the Pearce Creek CDF. The site hydrogeology is summarized, especially as it relates to, and influences, the well installation and well sampling activities.

2.1 Site Description

The Pearce Creek CDF is located in Cecil County, Maryland, immediately south of Pearce Creek and the eastern shore of the Elk River, a major tributary of the Chesapeake Bay. The CDF encompasses 260 acres, and is defined by a dike that encircles the facility and has a perimeter length of approximately 2.5 miles. The CDF is bounded by residential properties to the west, by residential, agricultural, and undeveloped properties to the south and east, and by Pearce Creek and the Elk River to the north. The interior of the CDF is generally covered with phragmites and other hydrophilic plants (Kleinfelder, 2013). The United States Geological Survey Scientific Investigations Report 2012-5263 concluded the Pearce Creek CDF degraded local groundwater quality and negatively impacted domestic wells in the area. As a consequence, all properties in the communities of Bay View Estates, West View Shores and Sunset Pointe are in the process of connecting to public water.

2.2 Site Hydrogeology

The Pearce Creek CDF is located in the Atlantic Coastal Plain physiographic province, which consists of a largely unconsolidated, thick wedge of continental, coastal, and marine sediments of Cretaceous to Recent age. The sediments in the Atlantic Coastal Plain are underlain unconformably by Precambrian and lower Paleozoic crystalline rock. The coastal plain sediments in the vicinity of Pearce Creek are estimated to be approximately 900 feet thick (USGS, 2012).

The United States Geological Survey (USGS) (2012) has interpreted an alternating series of aquifers and confining units underlying the site. In stratigraphic order from the ground surface downward, the youngest units in general consist of anthropogenic (fill and dredged material) material that intermix with the surficial Matawan Formation (composed of clay and silty clay) to form a surficial confining unit that is approximately 20 to 40 feet thick. Because the new well locations are located outside of the CDF, it is unlikely that the fill and dredged materials will be encountered.

The Magothy Aquifer underlies the Matawan Formation, is predominantly composed of coarse sand and gravel, and is the shallowest water-bearing unit beneath the site. The Magothy Aquifer generally ranges in thickness from 40 to 50 feet, except west of the CDF where it thins to less than 20 feet in the vicinity of the Elk River.

A confining unit underlies the Magothy Aquifer. The confining unit between the Magothy Aquifer and Upper Patapsco Shallow Aquifer is absent over a portion of the site. It is generally present within the project area and is composed of clays and silty clays, and ranges in thickness from about 10 to 50 feet.

The Upper Patapsco Shallow Aquifer underlies the confining unit, and is the principle water-bearing zone for the majority of the residential wells in the area. This aquifer unit is encountered at a subsurface depth of approximately 40 feet beneath the ground surface, and is approximately 60 feet in thickness. The Upper Patapsco Shallow Aquifer is composed

predominantly of fine sands and thin beds of gravel, although clay and silt stringers ranging from 5 to 10 feet in thickness are common.

Another confining unit underlies the shallow aquifer and separates the Upper Patapsco Shallow Aquifer from the Upper Patapsco Deep Aquifer. The confining unit is approximately 80 feet thick beneath the West View Shores residential community, and consists predominantly of clay and silty clay.

The Upper Patapsco Deep Aquifer is the deepest hydrogeologic unit beneath the project area under study. Based on the USGS (2012) interpretation, the Upper Patapsco Deep Aquifer in this area should be encountered between the depths of approximately 190 to 235 feet.

The USGS (2012) report contains a description and data regarding historical groundwater flows and contours.

3. PLAN DESCRIPTION

3.1 Components

The Pearce Creek Groundwater Monitoring Program will include collection of groundwater samples and groundwater level data. Both data types will be collected over the course of the program, both prior to reuse of the lined CDF for placement of dredge material and afterwards.

Groundwater samples will be collected for chemical analysis using standard USEPA low-flow sampling procedures, and submitted for analysis of the following parameters:

1. Total Metals: Aluminum, Arsenic, Beryllium, Cadmium, Calcium, Iron, Lead, Magnesium, Manganese, Nickel, Potassium, Sodium, and Zinc
2. General Chemistry Parameters: Alkalinity, Total Dissolved Solids, Total Suspended Solids, Fluoride, Chloride, Bromide, Sulfate, Nitrogen (nitrite and nitrate), Nitrogen (nitrate), and Nitrogen (nitrite)
3. Radiologic Parameters: Radium 226, Radium 228, Gross Alpha, and Gross Beta

Groundwater samples will be analyzed using approved USEPA methods of analysis, and will be performed by a laboratory having related certifications by MDE. All groundwater sampling and related field work will be performed by MDE certified sampling personnel.

In addition to the above laboratory analyses, field water quality parameters (pH, specific conductance, temperature, oxidation-reduction potential, turbidity, and dissolved oxygen) will be recorded and reported. Periodically the USACE may also collect samples for dissolved metals using a 0.45 micron filter, thereby allowing a comparison of total and dissolved metals in an effort to evaluate what metals may be migrating from the site in groundwater.

Groundwater level data will be collected four times per year (January, April, July, and October) in order to develop groundwater contour maps over the study area and take into account seasonal variations. These contour maps will be used to determine groundwater flow direction and assess the effects on the groundwater table resulting from the liner construction.

3.2 Monitor Wells and Piezometers in Study

The monitoring program will include existing monitor wells and require installation of several new monitor wells and piezometers. Both the existing and new monitor wells and piezometers will be screened in the Magothy, Upper Patapsco Shallow, and Upper Patapsco Deep aquifers that underlie the site.

Table 5-1 contains a list of the existing and proposed monitor wells and piezometers to be included in the monitoring plan (a total of 37 monitor wells and piezometers). These wells and piezometers are located on government property as well as on private properties. USACE anticipates that the proposed new monitor wells will be installed after liner construction and prior to initiation of placement of new dredge material into the CDF. This is projected to occur in winter or early spring of 2017.

A comparison of well locations and modeling results was performed. The groundwater model documented in the Final Groundwater Model Report, Pearce Creek Dredge Material Containment Area, Cecil County, MD, May 2013, was updated to include the effects of the impermeable liner within the CDF during operating conditions. The changes are documented in the Addendum to the Final Groundwater Model Report dated February 2015.

Figures 5-1a and 5-1b, 5-2a and 5-2b, and 5-3a and 5-3b show groundwater elevation contours and particle tracks for water particles released beneath the CDF for the Magothy, Upper Patapsco Shallow and Upper Patapsco Deep aquifers, respectively. The a and b suffix in the figure names indicates the direction of the cross section located on the bottom half of the figure. The 43 randomly-selected particle starting locations are the same horizontal locations as those shown in the May 2013 report. The black points in the figures show the starting locations and the yellow points show how the particles move from the starting location over 25 years in the direction indicated by the groundwater elevation contours. Also shown in the figures are the existing and proposed monitoring wells and piezometers to be included in the monitoring plan.

No monitor wells inside the CDF are included in the Monitoring Plan as these interior wells were abandoned prior to initiating the liner construction work because they could have represented a potential for leakage into aquifers beneath the CDF. These interior monitor wells were abandoned in accordance with MDE requirements. Well abandonment details were provided in a separate Well Abandonment submittal, and Water Well Abandonment – Sealing Report Forms were submitted to MDE and the Cecil County Health Department.

No residential drinking water wells will be included in the Monitoring Plan. There are several reasons why the USACE cannot effectively monitor these wells. The USACE cannot be sure of construction details of these wells; USACE does not know which residents may abandon their home supply wells in favor of piped in municipal water; and, Cecil County Health Department is responsible for sampling residential home supply wells should there be health-related issues. However, USACE has installed monitor wells to the west of the Pearce Creek CDF, as well as in other nearby locations, and several of these monitor wells are included in the Monitoring Plan.

During the USGS investigation in 2010, additional Magothy wells were planned along the western border of the site at the locations where Upper Patapsco Shallow wells CSW-9 and 18B are located. These locations are in between proposed new Magothy wells CSW-29 and PZ-1. However, during drilling at the 18B location (CE Dd 156), the Magothy was encountered at the surface and only extended to about 8.5' bgs. In addition, according to the USGS boring log, only about 4' of sand capable of transmitting water was encountered at this location. Below 8.5', a silty clay unit was present to a depth of 60'.

Also at location CSW-9, a well 9A (CE Dd 144) was installed by the USGS and initially classified by them as a Magothy well. However, after groundwater sampling and evaluating water level data, the USGS reclassified this well as perched water based on water quality and hydrologic conditions, despite having referred to this material as Magothy in the boring log in the USGS report.

The reasons discussed above are why the USGS did not install additional Magothy monitoring wells along the western border of the site, and why the USACE has not proposed additional Magothy drilling in this area.

It should be noted that monitor wells CSW-8 and 22 were not included in the plan since each of these wells are located near other wells that are included in the monitoring plan and are screened in the same aquifer.

CSW-8 is located on private property and is approximately 100 feet east of Well 8A, which is in the monitoring plan. Both of these wells are placed in the Upper Patapsco Shallow aquifer and are each located on different private properties.

Well 22 is located on private property on Pond Neck Rd and is approximately 700 feet southeast and upgradient of Well 21S, which is in the monitoring plan. Both of these wells are placed in the Magothy aquifer and are screened at very similar elevations. Well 22 is screened at elevation -34.72 to -44.72 feet, while 21S is screened at -35.40 to -45.40 feet.

Figure 5-4 shows the Magothy formation monitor wells and piezometers to be used in the monitoring plan. Figure 5-5 shows the Upper Patapsco Shallow formation monitor wells to be used in the monitoring plan. Figure 5-6 shows the Upper Patapsco Deep formation monitor wells to be used in the monitoring plan.

Descriptions of placement and installation of the proposed monitor wells and piezometers are below:

3.2.1 Magothy Aquifer

1. Piezometers PZ-1 through PZ-3 are located along the eastern perimeter of the CDF, while PZ-4 and PZ-5 continue along the southeast edge of the CDF.
2. Monitor wells CSW-30 and CSW-32 are located along the eastern perimeter of the CDF. CSW-30 is located midway between monitor well 11C and piezometer PZ-2. CSW-32 is located midway between PZ-2 and PZ-3.
3. Monitor well CSW-27 is located approximately midway along the southwest edge of the CDF, which is aligned parallel with Pond Neck Rd. It is approximately midway between monitor wells 16A and 12R.
4. Monitor well CSW-29 is located along the west edge of the CDF approximately 600 feet to the northeast of monitor well 16A.

3.2.2 Upper Patapsco Shallow Aquifer

1. Monitor wells CSW-31 and CSW-33 are paired up with CSW-30 and CSW-32 respectively, along the east edge of the CDF.
2. Monitor well CSW-28 is located approximately midway along the southwest edge of the CDF, which is aligned parallel with Pond Neck Rd. It is approximately midway between monitor wells CSW-10 and 14R.
3. Monitor well CSW-37 is located to the north of the CDF near PZ-1.

3.2.3 Upper Patapsco Deep Aquifer

1. Monitor well CSW-34 is located approximately midway along the southwest edge of the CDF, which is aligned parallel with Pond Neck Rd.
2. Monitor well CSW-35 is located near the front entrance to the CDF.
3. Monitor well CSW-36 is located near the southeast corner of the CDF.
4. Monitor well CSW-38 is located approximately midway along the eastern perimeter of the CDF.
5. Monitor well CSW-39 is located on the northwestern edge of the site.

4. METHODOLOGY

4.1 Monitor Well/Piezometer Installation

A Maryland-licensed driller will install the proposed monitor wells and piezometers in accordance with USACE, MDE, and Cecil County Health Department regulations and guidance. The monitor wells and piezometers will be constructed of 4-inch and 2-inch diameter PVC, respectively. Due to the required depths and local geology, they will likely be installed using either mud-rotary or sonic drilling equipment. A 5-foot or 10-foot long well screen will be installed, whichever is appropriate. All proposed new monitor wells and piezometers are located on Government property and will be stickup wells. Table 5-2 contains a summary of the proposed monitor wells to be installed. For comparison purposes, Table 5-3 contains a summary of the existing monitor wells included in the Groundwater Monitoring Plan.

Prior to installing any wells, the driller will place one pilot borehole at each proposed single well location or location of multiple wells. The purpose of the pilot boreholes is to establish the stratigraphy and locate the desired aquifer and screening interval. The pilot borehole will be drilled and sampled from the surface level for each well, and be utilized for the well installation.

Continuous sonic soil cores or split-spoon soil sampling will be performed using standard methods while drilling the pilot borings. The soil borings will be logged by a qualified geologist. While drilling the pilot borehole, one 2-foot split spoon sample will be collected every 5 feet until a depth is reached approximately 10 feet above the top of the expected screening range of the monitor well to be installed. At this point continuous split-spoon sampling will be done to confirm the well screening and well bottom depths.

Several of the wells will be installed as pairs or 3-well groupings consisting of a shallower well and one or two deeper wells. These well pairs or groupings will be drilled and installed within approximately 10 horizontal feet of each other. The pilot boring for the deeper monitor well in the pair or grouping will be drilled, sampled, and logged first. The pilot boring depth will be equal to the depth of the deep well in the associated well pair. The data obtained from logging this boring will be used to select the depth and screen interval of the shallower well. The borehole for the shallower well will be blind drilled to within approximately 10 feet of the appropriate depth selected for this well, based on logging of the pilot borehole. At this point, continuous split spoon sampling may be done to confirm the well screening and well bottom depths. At all new monitor well locations, when the target depth range is reached, the boring will be terminated once a sufficient length of screenable material is encountered (i.e., five-foot or ten-foot length of screenable sand).

In addition, the USACE may also consider using a downhole gamma log or other borehole geophysical methods to aid in characterizing the hydrogeology at a given location.

4.2 Groundwater Sampling

After construction of the liner system and prior to placement of new dredge material, a groundwater sampling event will be performed to establish baseline conditions. Samples will be collected from all of the monitor wells and piezometers in the monitoring program (see Table 5-1). A total of 37 monitoring wells and piezometers will be sampled in the monitoring program. A complete synoptic round of groundwater level readings for all of these monitor wells and piezometers will also be recorded during the sampling event. A second synoptic round of pre-construction groundwater levels will also be collected at a later time.

After construction of the liner system, two analytical groundwater sampling events will be conducted each year (spring and fall) for the duration of the monitoring program. This sampling will begin in 2017. It should be noted that there may be certain years when dredge material is not placed in the CDF. During these times the USACE may request from MDE that sampling be performed less frequently. Synoptic rounds of groundwater level readings will be obtained four times per year for the duration of the monitoring program. After five years, synoptic rounds of groundwater level readings will be limited to wells in the Magothy aquifer and the Upper Patapsco Shallow aquifer.

Transducers will be installed in four monitor wells located around the perimeter of the CDF and set in the Magothy aquifer. The transducers will be used to collect groundwater elevation data for a period of one month prior to the beginning of a dredging cycle, during the dredging cycle, and for one month after the completion of the dredging cycle. The transducers will be programmed to collect measurements every hour. Local precipitation data will be used to adjust and correct water level changes during the data collection period. These data will allow evaluation and comparison of groundwater flow patterns before, during, and after dredging operations. This task using transducers will be only done once, for the initial dredging cycle.

4.2.1 Method of Analytical Sampling

Sampling will follow standard USEPA low flow operating procedures. The following field parameters will be real-time monitored as per the low flow procedure using a groundwater quality meter to determine when the purged groundwater has stabilized prior to sampling:

- specific conductance
- pH
- temperature
- oxidation-reduction potential
- turbidity
- dissolved oxygen

These data will be reported along with laboratory analytical results for the groundwater samples. Depth to water shall also be monitored to track drawdown rates during purging. A Grundfos 2-inch adjustable speed submersible pump/controller, or approved similar equipment, will be used for all groundwater sample collection in combination with a continuous flow-through cell suitable for taking water quality measurements using the groundwater quality meter. The groundwater quality meter must be calibrated for all measured parameters on a daily basis, and must be documented in the field notebook. Daily instrument calibration will be performed in

accordance with the standard low flow sampling procedures, MDE certification requirements, and instrument manufacturer recommendations.

The same sampling method will be used for all sample locations in the monitoring program. Bailers and other sampling methods will not be used in this sampling program unless specifically approved by the USACE and MDE. If insufficient groundwater is available to use the low flow sampling technique, no groundwater sample will be collected. If the water level in the well approaches the low flow drawdown limit and/or the well turbidity exceeds 20 NTUs, the USACE will make a determination as to whether a groundwater sample will be collected. The cause of turbidity (i.e. well not developed properly, improper well construction, iron, etc.) will be investigated if no sample is collected, and a plan will be developed and implemented to address the elevated turbidity.

All sampling equipment, including pumps and cells, etc. shall be decontaminated prior to each sample location. Pumps shall be subjected to daily and between-well decontamination procedures, as discussed in the procedure.

Preservation, sample bottles, and holding times for samples collected for chemical and radiological analysis shall be in accordance with the associated methods. The sampling crew will ship the samples the same day of sample collection via laboratory courier or overnight delivery service for either same day or next day delivery to the laboratory. Field quality control (QC) samples, including blind field duplicates, rinsate blanks, laboratory duplicates, and matrix spike/matrix spike duplicate samples will be collected at frequencies consistent with regulatory protocols.

5. DATA ANALYSIS AND REPORTING

Soil boring logs and well construction logs from new monitor well installation will be developed for each of the three underlying aquifers and added to the site database to further clarify the Pearce Creek site conceptual model. Water level data will be used to generate groundwater flow contours. This will be done on a continuing basis to identify whether any changes in groundwater flow take place over time. When sufficient groundwater level data has been collected the USACE will evaluate differences in groundwater levels relative to pre-construction data. Noticeable differences may provide an indication as to whether groundwater levels in one area are substantially different compared to those in other areas. Transducer data will be used to generate graphs of groundwater elevation vs. time. This will allow evaluation and comparison of groundwater levels in the Magothy aquifer before, during, and after a dredging operation.

Laboratory results will be reported in a legally defensible USEPA Contract Laboratory Program (CLP)-type data package, including raw data that can be validated by an external third party. Data shall be maintained in an electronic format that can be imported to an Access database to permit rapid selection and mathematical manipulation of data. Electronic Data Deliverables (EDDs) compliant with the USACE's Automated Data Review (ADR) specification will also be obtained from the laboratory. These deliverables will allow the project data review chemist to complete an automated review of the laboratory data through the ADR process, and apply data validation qualifiers for QC outliers based on results for selected laboratory and field QC samples. The ADR output files with the reviewed and qualified results will then be uploaded into the Environmental Data Management System (EDMS) database file for the project. These validated results will be utilized in the generation of project reports, and will incorporate a comparison with the Federal MCLs and SMCLs and MDE drinking water criteria.

The USACE will develop a database for the project, and generate trend plots of various groundwater analytical parameters at each well location. This will allow evaluation of groundwater chemistry changes over time.

6. SUBMITTALS

The USACE will provide MDE with a project summary report on an annual basis over the duration of the site monitoring activities. Site monitoring activities are intended to occur while site is active and for a period of time thereafter. This report will describe all work performed during the past year. It will include boring logs, well construction details, laboratory analytical results from groundwater samples, water level readings, groundwater contour maps, site figures showing monitor well and piezometer locations, and other data or figures that are appropriate for the work completed during the year. The reports will include recommendations for future actions, if appropriate, including recommended modifications to the monitoring plan as more groundwater data is collected. With the exception of the initial report in 2017, annual reports will be submitted to MDE by February 1 of each year in accordance with Water Quality Certification requirements.

The USACE will submit the initial report in March 2017. This report will include a summary of previous sampling results from historical data collected before the USGS investigation, the USGS data, and analytical results from a subset of the wells sampled by the USACE in 2012. The March 2017 report will also include sampling results (2014 and 2016) from the 4 Upper Patapsco Deep wells installed on private properties in West View Shores and Bay View Estates (note that these wells will be abandoned when the public water supply is available to property owners so they are not a part of the long-term groundwater monitoring plan), and results from the existing wells sampled by the USACE in the fall 2016 (note that only a subset of the existing wells were sampled due to private property access agreements and access issues due to the ongoing liner construction). The USACE will develop a database of this historical data and prepare trend plots of the wells showing various parameters in groundwater over time.

The second annual report will be submitted in February 2018 and include data from the 18 new wells (scheduled for installation in the spring of 2017) and 19 existing wells that will be regularly sampled (twice/year in the spring and fall) as part of this Groundwater Monitoring Program. Updated groundwater trend plots, groundwater contour maps, and other pertinent information will be included in this and subsequent annual reports.

7. REFERENCES

1. U.S. Geological Survey, 2012. Hydrologic Framework, Hydrology, and Water Quality in the Pearce Creek Dredge Material Containment Area and Vicinity, Cecil County, Maryland, 2010-11.

2. Kleinfelder, 2013. Subsurface Exploration Report, Pearce Creek Confined Disposal Facility, Earleveille, Cecil County, MD

3. U.S. Army Corps of Engineers, 2013. Final Groundwater Model Report, Pearce Creek Dredge Material Containment Area, Cecil County, MD

8. TABLES AND FIGURES

Table 5-1: Monitoring Wells Included in Monitoring Plan

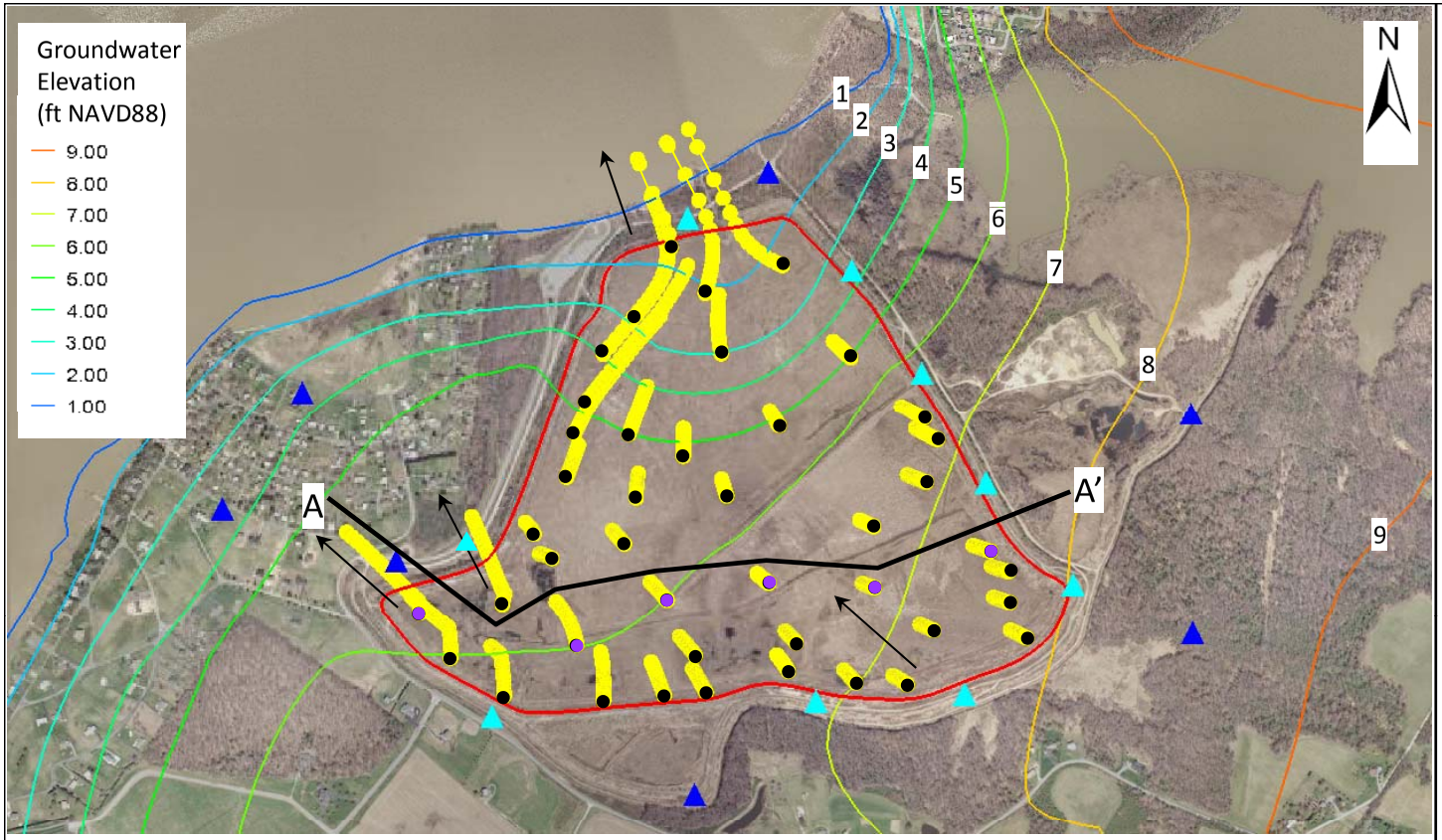
Existing/Proposed	Designation	Monitor Well/ Piezometer	Aquifer	Government/ Private Property
Existing	CSW-5	Monitor Well	Magothy	Private
	CSW-7		Up Pat Shallow	Private
	CSW-9		Up Pat Shallow	Government
	CSW-10		Up Pat Shallow	Government
	CSW-13		Magothy	Government
	7A		Magothy	Private
	7B		Up Pat Deep	Private
	8A		Up Pat Shallow	Private
	8B		Magothy	Private
	11A		Up Pat Deep	Government
	11C		Magothy	Government
	11R		Up Pat Shallow	Government
	12R		Magothy	Government
	13A		Up Pat Shallow	Government
	14R		Up Pat Shallow	Government
	16A		Magothy	Government
	18B		Up Pat Shallow	Government
	21S		Magothy	Government
	21D		Up Pat Shallow	Government
Proposed	CSW-27		Magothy	Government
	CSW-28		Up Pat Shallow	Government
	CSW-29		Magothy	Government
	CSW-30		Magothy	Government
	CSW-31		Up Pat Shallow	Government
	CSW-32		Magothy	Government
	CSW-33		Up Pat Shallow	Government
	CSW-34		Up Pat Deep	Government
	CSW-35		Up Pat Deep	Government
	CSW-36		Up Pat Deep	Government
	CSW-37		Up Pat Shallow	Government
	CSW-38		Up Pat Deep	Government
	CSW-39		Up Pat Deep	Government
	PZ-1	Piezometer	Magothy	Government
	PZ-2		Magothy	Government
	PZ-3		Magothy	Government
	PZ-4		Magothy	Government
	PZ-5		Magothy	Government
	Total = 37			

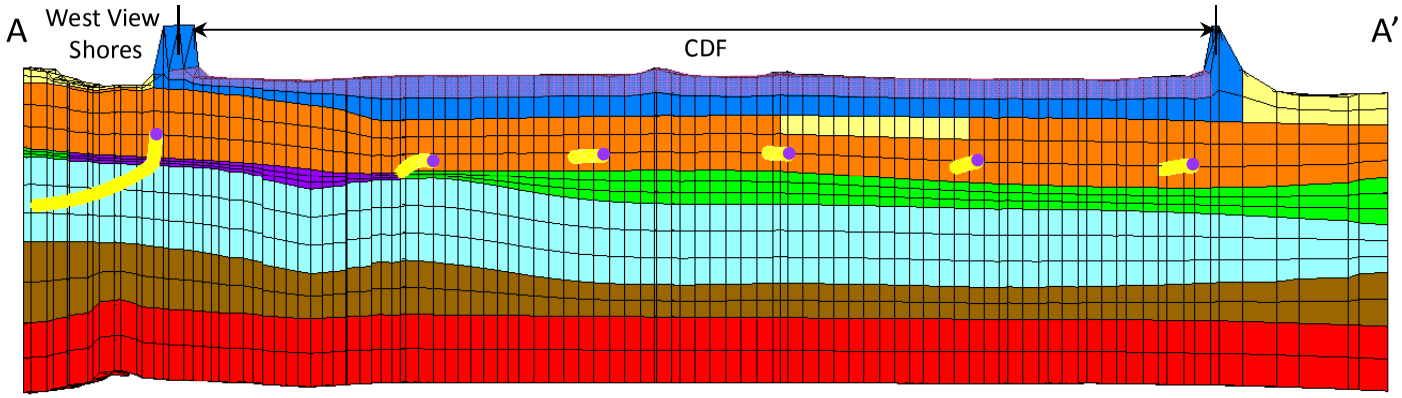
Table 5-2: Proposed New Monitor Wells at Pearce Creek CDF

No.	Well Desig	Desciption/Location	Diameter (inches)	Latitude/Longitude		Approx Depth Range (ft bgs)*	Aquifer
1	CSW-27	SW perimeter of CDF adjacent to Pond Neck Rd	4	39°25'25"	75°59'21"	35 to 65	Magothy
2	CSW-28	SW perimeter of CDF adjacent to Pond Neck Rd	4	39°25'25"	75°59'21"	40 to 120	Up Pat Shallow
3	CSW-29	W perimeter of CDF adjacent to Stemmers Run	4	39°25'41"	75°59'20"	30 to 50	Magothy
4	CSW-30	East perimeter of CDF	4	39°25'56"	75°58'48"	20 to 40	Magothy
5	CSW-31	East perimeter of CDF	4	39°25'56"	75°58'48"	100 to 150	Up Pat Shallow
6	CSW-32	East perimeter of CDF	4	39°25'41"	75°58'37"	50 to 80	Magothy
7	CSW-33	East perimeter of CDF	4	39°25'41"	75°58'37"	65 to 150	Up Pat Shallow
8	CSW-34	SW perimeter of CDF adjacent to Pond Neck Rd	4	39°25'25"	75°59'21"	200 to 220	Up Pat Deep
9	CSW-35	W perimeter of CDF by front gate	4	39°25'36"	75°59'28"	200 to 270	Up Pat Deep
10	CSW-36	SE perimeter of CDF	4	39°25'27"	75°58'37"	200 to 220	Up Pat Deep
11	CSW-37	North perimeter of CDF adjacent to Elk River	4	39°26'00"	75°59'3"	180 to 220	Up Pat Shallow
12	CSW-38	East perimeter of CDF	4	39°25'49"	75°58'42"	170 to 230	Up Pat Deep
13	CSW-39	Northwest perimeter of CDF	4	39°25'52"	75°59'16"	160 to 200	Up Pat Deep
14	PZ-1	North perimeter of CDF adjacent to Elk River	2	39°26'00"	75°59'3"	20 to 40	Magothy
15	PZ-2	East perimeter of CDF	2	39°25'49"	75°58'42"	55 to 80	Magothy
16	PZ-3	East perimeter of CDF	2	39°25'34"	75°58'29"	70 to 95	Magothy
17	PZ-4	South perimeter of CDF	2	39°25'27"	75°58'39"	35 to 85	Magothy
18	PZ-5	South perimeter of CDF	2	39°25'26"	75°58'52"	50 to 90	Magothy

Table 5-3: Existing Monitor Wells at Pearce Creek CDF

No.	Well Desig	Diameter (inches)	Screen Length (ft)	Well Screen Depth (ft bgs)	Aquifer
1	CSW-5	4	10	80 to 90	Magothy
2	CSW-7	4	10	81 to 91	Up Pat Shallow
3	CSW-9	4	10	115 to 125	Up Pat Shallow
4	CSW-10	2	15	100 to 115	Up Pat Shallow
5	CSW-13	4	5	48 to 53	Magothy
6	7A	4	5	11 to 16	Magothy
7	7B	4	5	217 to 222	Up Pat Deep
8	8A	4	10	79 to 89	Up Pat SHallow
9	8B	4	5	39 to 44	Magothy
10	11A	4	10	188 to 198	Up Pat Deep
11	11C	4	10	20 to 30	Magothy
12	11R	4	10	118.5 to 128.5	Up Pat Shallow
13	12R	4	5	35 to 40	Magothy
14	13A	4	10	135 to 145	Up Pat Shallow
15	14R	4	10	108 to 118	Up Pat Shallow
16	16A	4	10	30 to 40	Magothy
17	18B	4	10	77 to 87	Up Pat Shallow
18	21S	4	10	57 to 67	Magothy
19	21D	4	10	145 to 150	Up Pat Shallow





Cross Section Legend:

- Surficial Deposits
- Magothy Aquifer
- Upper Confining Unit
- Upper Patapsco Shallow Aquifer
- Lower Confining Unit
- Upper Patapsco Deep Aquifer
- Upper Confining Unit thin or not present
- Impermeable Liner
- Dredge Material above Liner

Plan View Legend:

- Particle release point
- Particle track (each pt = 1 yr)
- Selected particle track release points
- Pearce Creek CDF outline
- Existing Monitoring Well
- New Monitoring Well

Notes:

Particles released from the Magothy below the CDF. Particles were placed on the bottom element of the aquifer.

Total track time = 25 yrs

Section A-A' is along several selected particle tracks. Most particles stay within the Magothy Aquifer. Where the confining unit is thin in the southwest, the particles pass into the Upper Patapsco Shallow Aquifer.

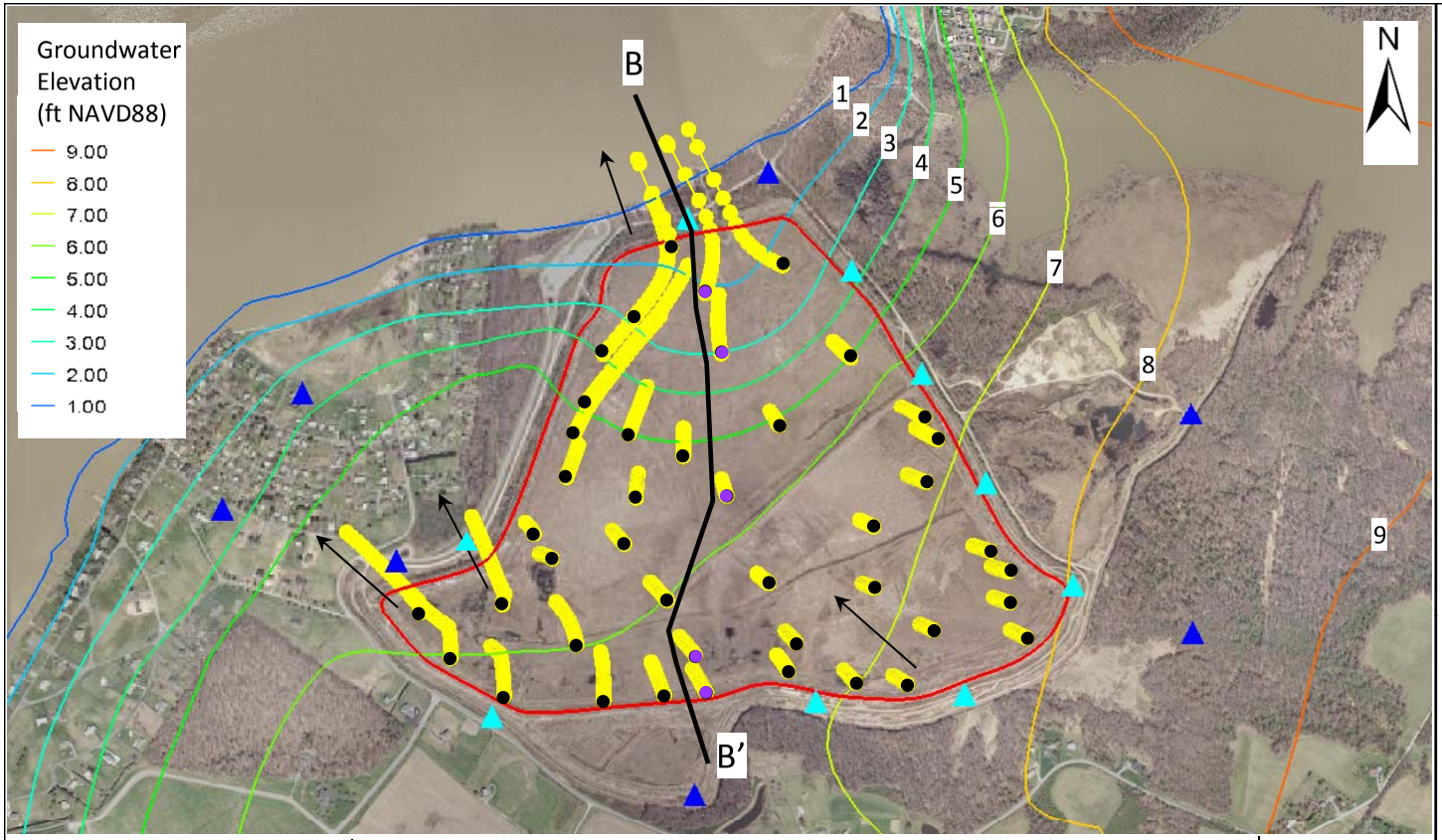
This figure is comparable to Figure 6.14 in the Groundwater Modeling Report that shows Operating Conditions without the liner.

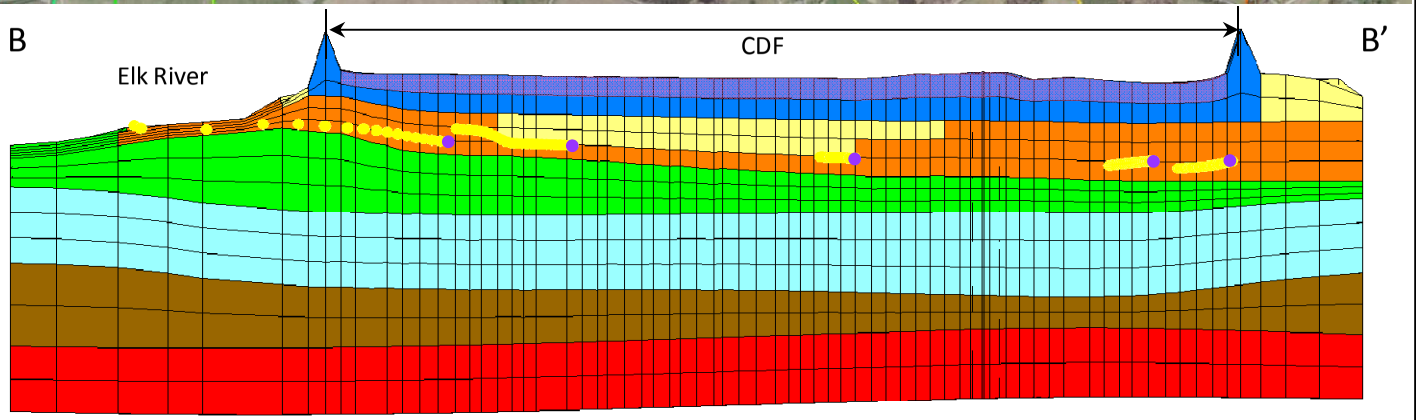
Particle Forward Tracks from Magothy Aquifer: Full Liner Conditions

Addendum to Final Groundwater Modeling Report

Figure 5-1a

February 2015





Cross Section Legend:

- Surficial Deposits
- Magothy Aquifer
- Upper Confining Unit
- Upper Patapsco Shallow Aquifer
- Lower Confining Unit
- Upper Patapsco Deep Aquifer
- Upper Confining Unit thin or not present
- Impermeable Liner
- Dredge Material above Liner

Plan View Legend:

- Particle release point
- Particle track (each pt = 1 yr)
- Selected particle track release points
- Pearce Creek CDF outline
- Existing Monitoring Well
- New Monitoring Well

Notes:

Particles released from the Magothy below the CDF. Particles were placed on the bottom element of the aquifer.

Total track time = 25 yrs

Section B-B' is along several selected particle tracks. Most particles stay within the Magothy Aquifer. Where the confining unit is thin in the southwest, the particles pass into the Upper Patapsco Shallow Aquifer.

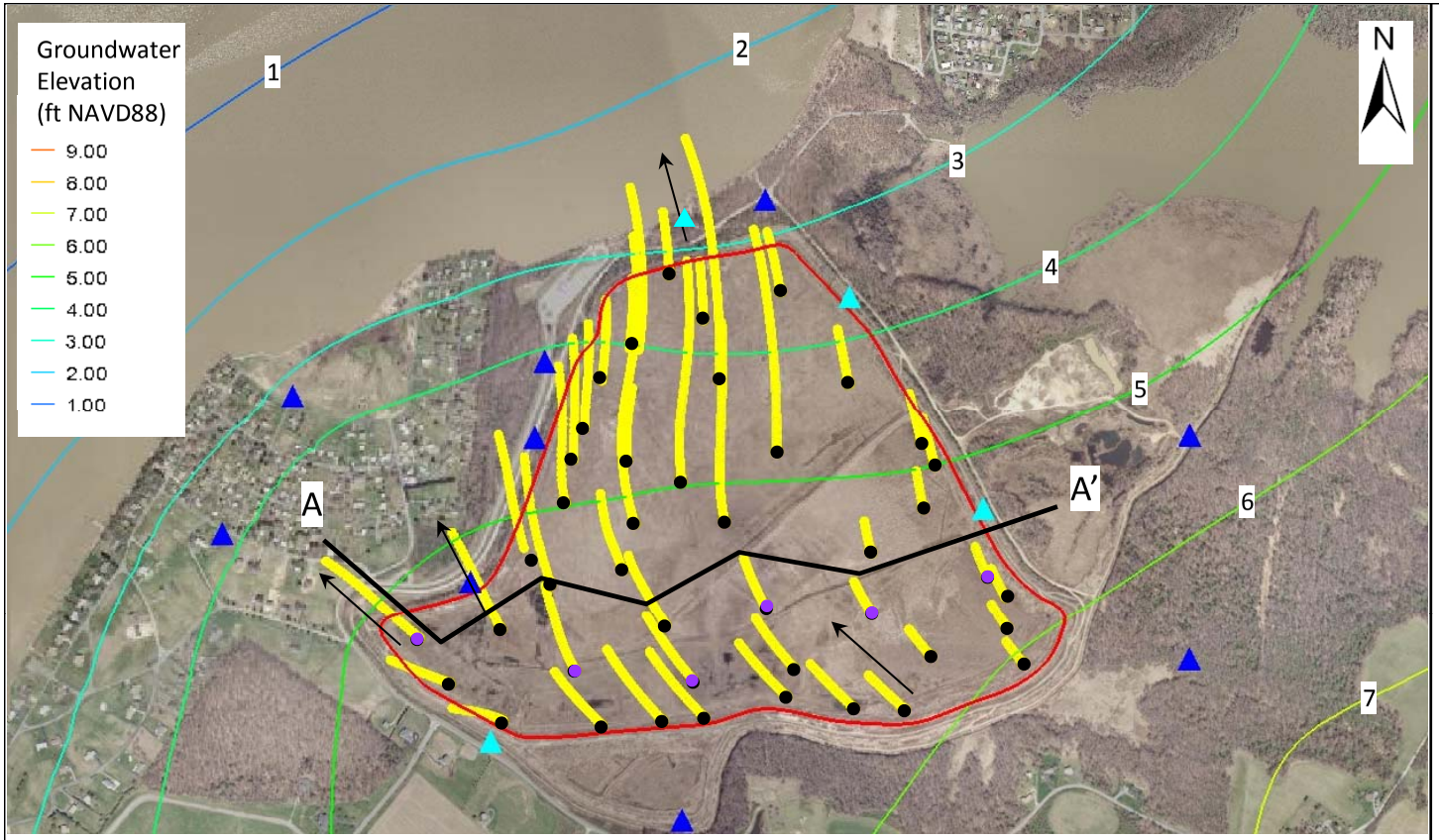
This figure is comparable to Figure 6.14 in the Groundwater Modeling Report that shows Operating Conditions without the liner.

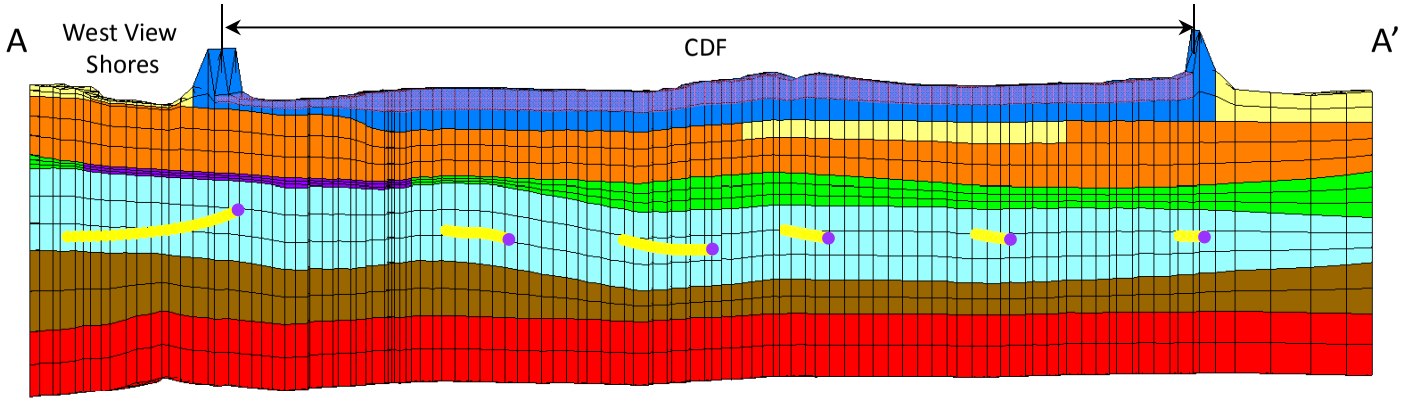
Particle Forward Tracks from Magothy Aquifer: Full Liner Conditions

Addendum to Final Groundwater Modeling Report

Figure 5-1b

February 2015





Cross Section Legend:

- Surficial Deposits
- Magothy Aquifer
- Upper Confining Unit
- Upper Patapsco Shallow Aquifer
- Lower Confining Unit
- Upper Patapsco Deep Aquifer
- Upper Confining Unit thin or not present
- Impermeable Liner
- Dredge Material above Liner

Plan View Legend:

- Particle release point
- Particle track (each pt = 1 yr)
- Selected particle track release points
- Pearce Creek CDF outline
- Existing Monitoring Well
- New Monitoring Well

Notes:

Particles released from the Upper Patapsco Shallow Aquifer below the CDF. Particles were placed on the middle element of the aquifer.

Total track time = 25 yrs

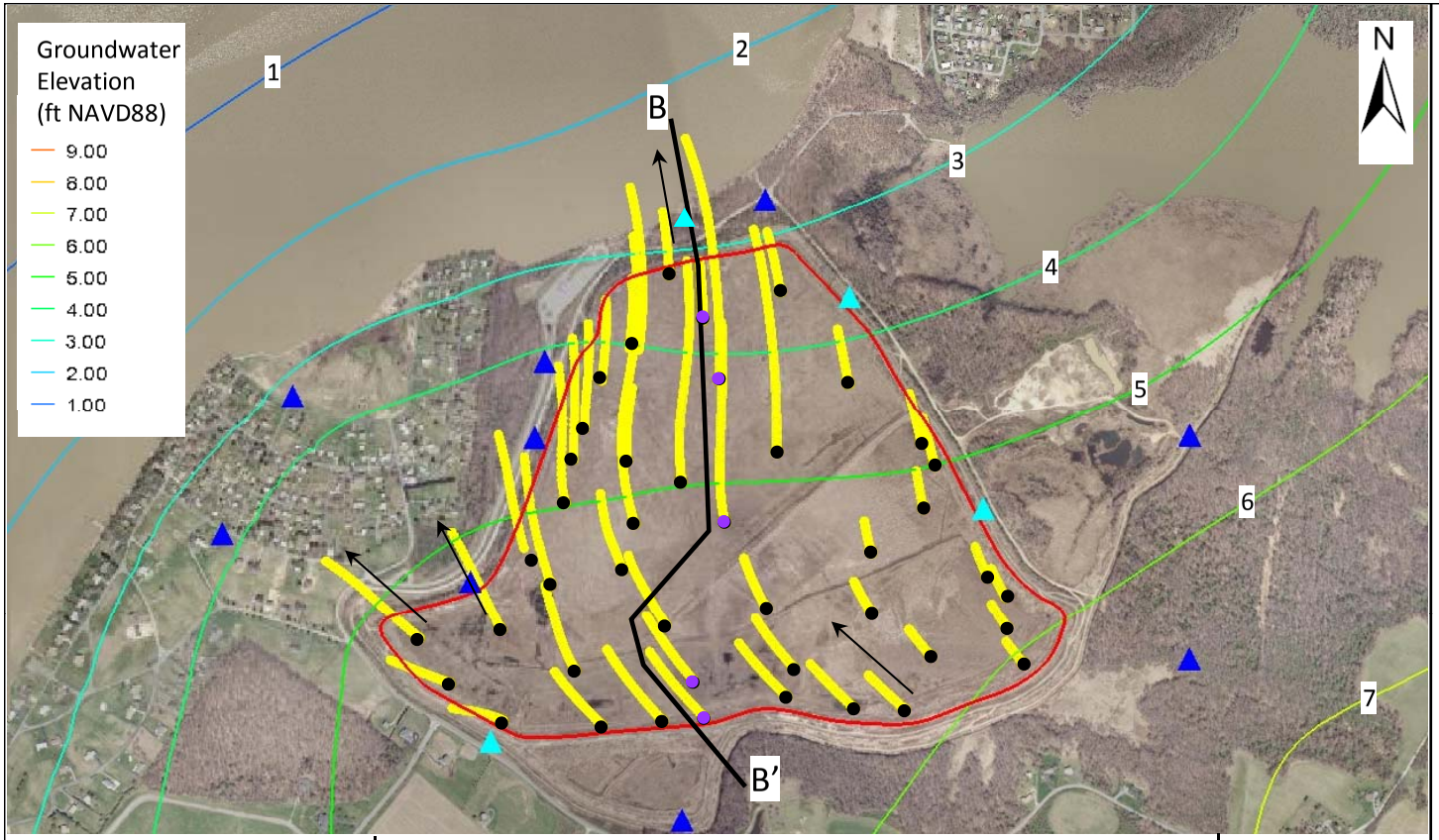
Section A-A' is along several selected particle tracks. The particles stay within the Upper Patapsco Shallow Aquifer. Particles that move the furthest are closest to the location where the Upper Confining Unit is thin or not present.

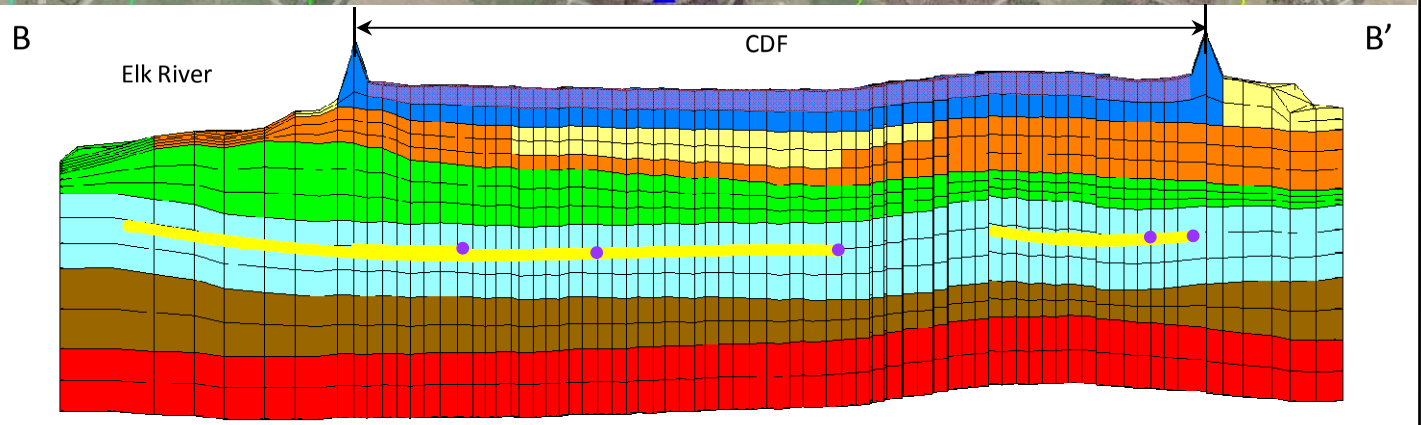
Particle Forward Tracks from Upper Patapsco Shallow Aquifer: Full Liner Conditions

Addendum to Final Groundwater Modeling Report

Figure 5-2a

February 2015





Cross Section Legend:

- Surficial Deposits
- Magothy Aquifer
- Upper Confining Unit
- Upper Patapsco Shallow Aquifer
- Lower Confining Unit
- Upper Patapsco Deep Aquifer
- Upper Confining Unit thin or not present
- Impermeable Liner
- Dredge Material above Liner

Plan View Legend:

- Particle release point
- Particle track (each pt = 1 yr)
- Selected particle track release points
- Pearce Creek CDF outline
- Existing Monitoring Well
- New Monitoring Well

Notes:

Particles released from the Upper Patapsco Shallow Aquifer below the CDF. Particles were placed on the middle element of the aquifer.

Total track time = 25 yrs

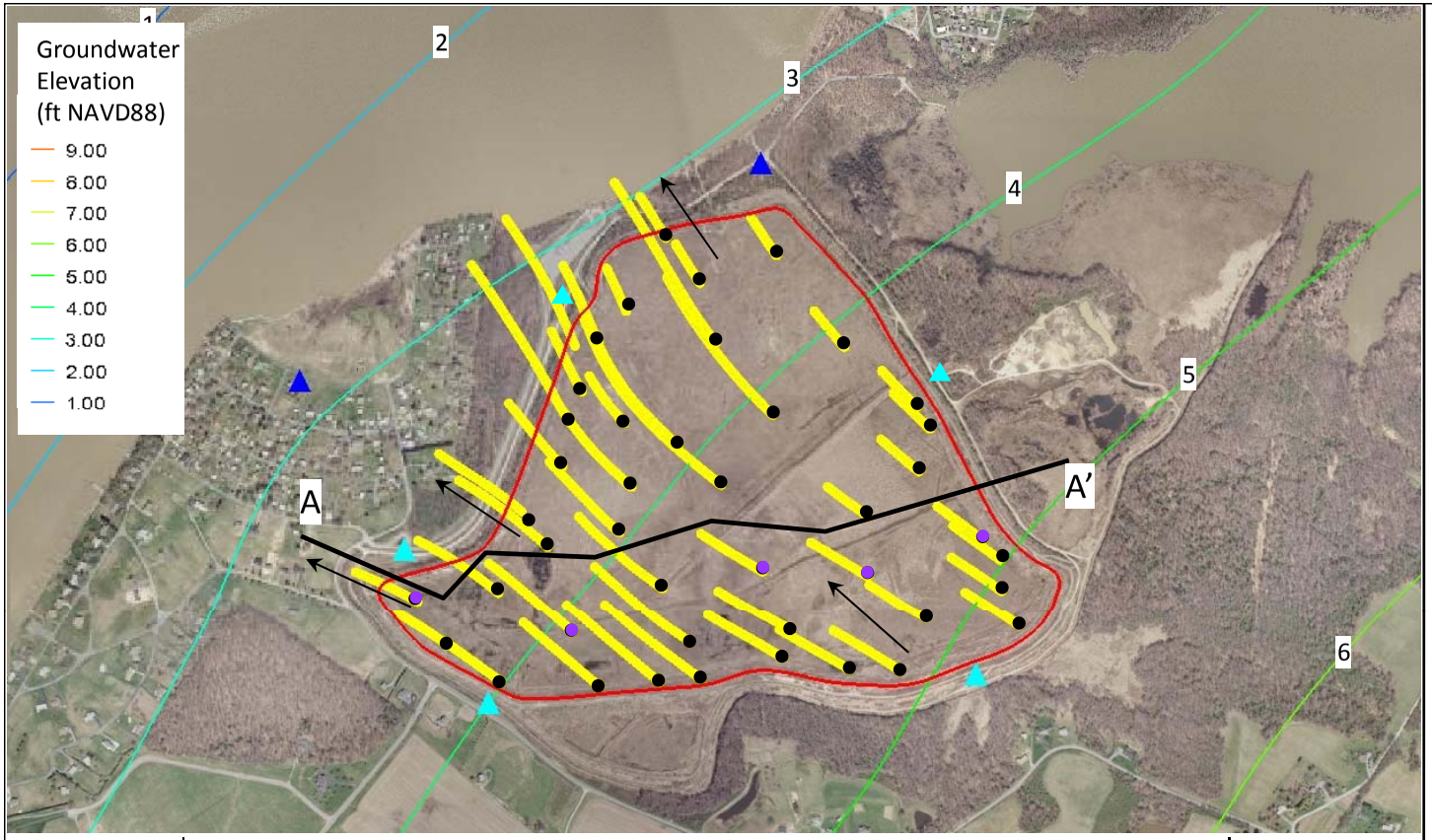
Section B-B' is along several selected particle tracks. The particles stay within the Upper Patapsco Shallow Aquifer.

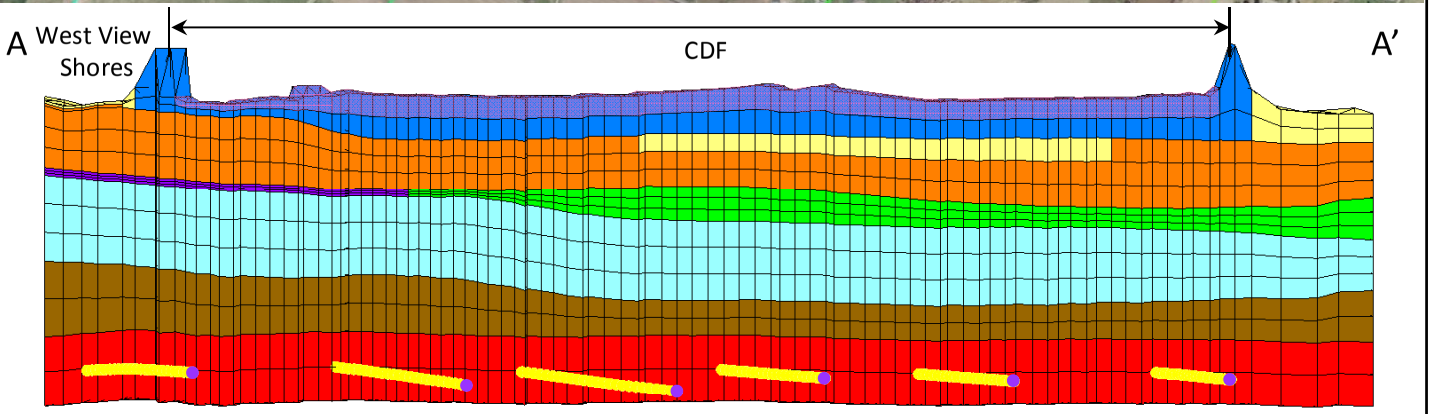
Particle Forward Tracks from Upper Patapsco Shallow Aquifer: Full Liner Conditions

Addendum to Final Groundwater Modeling Report

Figure 5-2b

February 2015





Cross Section Legend:

- Surficial Deposits
- Magothy Aquifer
- Upper Confining Unit
- Upper Patapsco Shallow Aquifer
- Lower Confining Unit
- Upper Patapsco Deep Aquifer
- Upper Confining Unit thin or not present
- Impermeable Liner
- Dredge Material above Liner

Plan View Legend:

- Particle release point
- Particle track (each pt = 1 yr)
- Selected particle track release points
- Pearce Creek CDF outline
- Existing Monitoring Well
- New Monitoring Well

Notes:

Particles released from the Upper Patapsco Deep Aquifer below the CDF. Particles were placed on the bottom element of the aquifer.

Total track time = 25 yrs

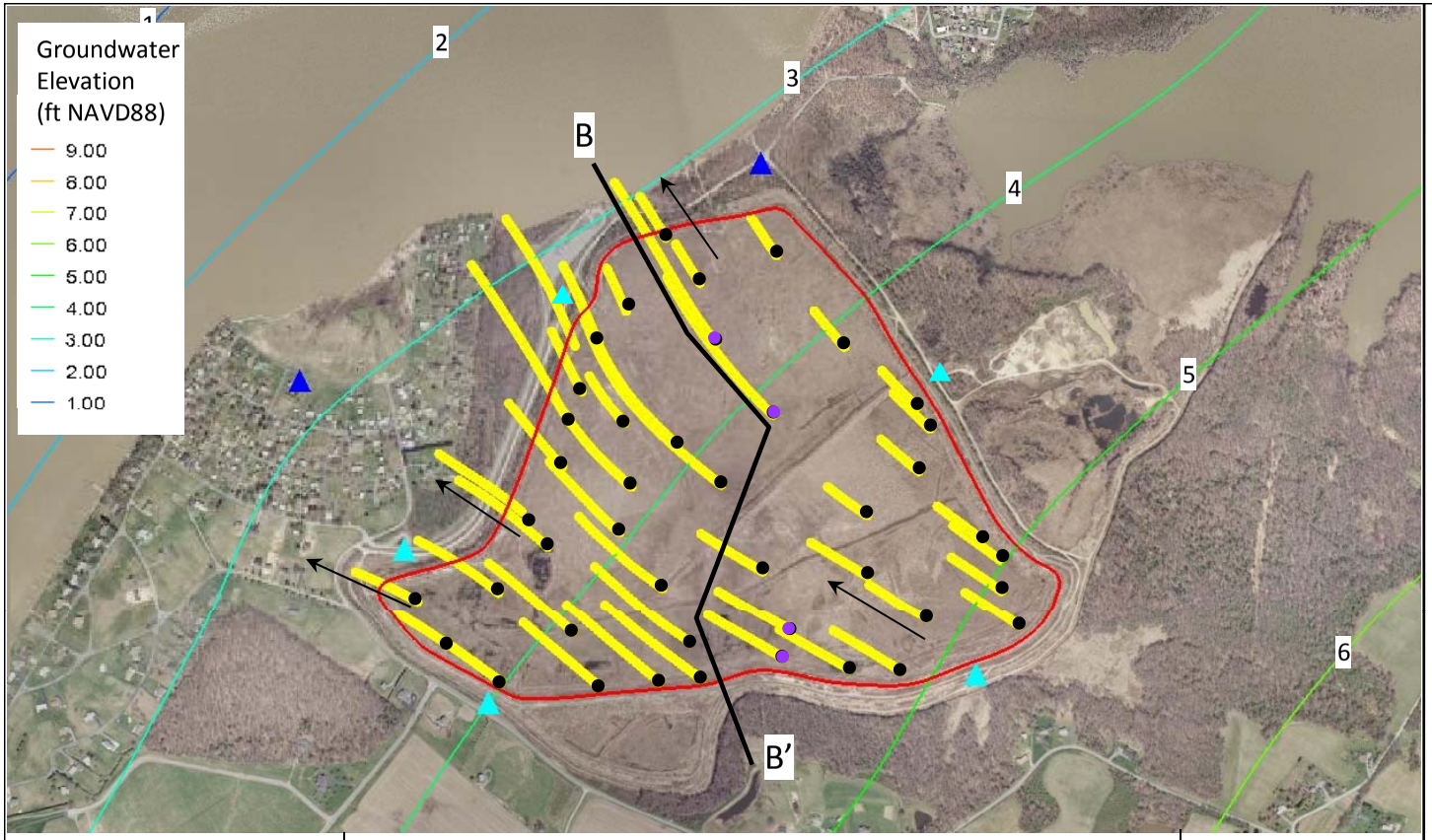
Section A-A' is along several selected particle tracks. The particles stay within the Upper Patapsco Deep Aquifer.

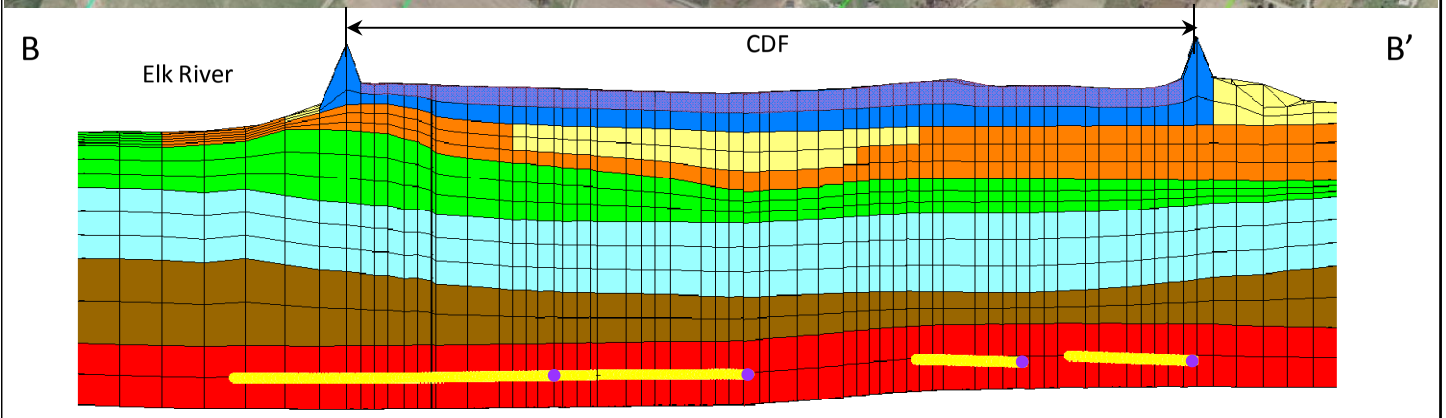
Particle Forward Tracks from Upper Patapsco Deep Aquifer: Full Liner Conditions

Addendum to Final Groundwater Modeling Report

Figure 5-3a

February 2015





Cross Section Legend:

- Surficial Deposits
- Magothy Aquifer
- Upper Confining Unit
- Upper Patapsco Shallow Aquifer
- Lower Confining Unit
- Upper Patapsco Deep Aquifer
- Upper Confining Unit thin or not present
- Impermeable Liner
- Dredge Material above Liner

Plan View Legend:

- Particle release point
- Particle track (each pt = 1 yr)
- Selected particle track release points
- Pearce Creek CDF outline
- Existing Monitoring Well
- New Monitoring Well

Notes:

Particles released from the Upper Patapsco Deep Aquifer below the CDF. Particles were placed on the bottom element of the aquifer.

Total track time = 25 yrs

Section B-B' is along several selected particle tracks. The particles stay within the Upper Patapsco Deep Aquifer.

Particle Forward Tracks from Upper Patapsco Deep Aquifer: Full Liner Conditions

Addendum to Final Groundwater Modeling Report

Figure 5-3b

February 2015

US Army Corps of Engineers
Philadelphia District

DESIGNED BY
DRAWN BY
CHECKED BY
QUALITY CONTROL BY
SUBMITTED BY
APPROVED BY
DATE
CONTRACT NUMBER
FILE NAME
DESCRIPTION

U.S. ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT
PHILADELPHIA, PA 19107-3390
www.nap.usace.army.mil

DELAWARE RIVER TO CHESAPEAKE BAY
DELAWARE AND MARYLAND
PEARCE CREEK CONFINED DISPOSAL FACILITY
MODIFICATIONS
PLAN - MAGOTHY MONITORING

SHEET NUMBER
5-4

US Army Corps of Engineers
Philadelphia District

DELAWARE RIVER TO CHESAPEAKE BAY
DELAWARE AND MARYLAND
PEARCE CREEK CONFINED DISPOSAL FACILITY
MODIFICATIONS
PLAN - UPPER PATAPSCO SHALLOW MONITORING

SHEET NUMBER
5-5

1 PLAN - UPPER PATAPSCO DEEP MONITORING
SCALE = 1" = 200'

NOTES:

1. TOPO SHOWN WAS DEVELOPED USING LIDAR DATA FROM 2014.

US Army Corps of Engineers Philadelphia District

U.S. ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT
PHILADELPHIA, PA 19107-3390
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DWN BY: SJP	DESIGNED BY: MFM	ISSUE/RELEASE DATE: 100% 27 JAN 15
CKD BY: .	REVIEWED BY: .	PROJ. NUMBER: .
		SOLICITATION NUMBER: RFP W912BU-1X-XXXX
DWG SCALE: 1"=200'		CONTRACT NUMBER: .
DWG. SIZE: 30"x42" Arch E1	FILE NAME: 5-6 PLAN - UPPER PATAPSCO DEEP MONITORING.dwg	

DELAWARE RIVER TO CHESAPEAKE BAY
DELAWARE AND MARYLAND
PEARCE CREEK CONFINED DISPOSAL FACILITY
MODIFICATIONS
PLAN - UPPER PATAPSCO DEEP MONITORING

SHEET NUMBER
5-6