

Summary of Area of Interest 11 (AOI 11)
Former Philadelphia Refining Complex
3144 Passyunk Avenue, Philadelphia, PA 19145

What is in this summary?

This document provides a plain language summary of Area of Interest 11 (AOI 11). Unlike the other AOIs, AOI 11 is not a surface portion of the former Refinery. AOI 11 was defined to represent a deeper groundwater unit, called the lower aquifer, that underlies most of the Refinery (**Figure 1**) and surrounding areas.

To date, two reports have been submitted for AOI 11 under Act 2. These were the 2011 Remedial Investigation Report (RIR) and the 2013 Final Report. These reports were not accepted by the PADEP due to the requirement for additional fate and transport modeling. Evergreen has completed additional investigation in AOI 11 since 2013. The results of the AOI 11 investigations completed since 2013 were included in the other AOI RIRs submitted after that time. The decision to discuss AOI 11 in the other AOI reports, was made to be able to describe the groundwater system (both shallow and deep groundwater) and pathways underlying each Refinery area more completely in each of the AOI RIRs. All reports were prepared as part of the Pennsylvania Department of Environmental Protection (PADEP) Act 2 cleanup program.

The Act 2 reports are technical reports which include descriptions of groundwater conditions, the chemicals present from past operations, and the next steps in the Act 2 process. The complete AOI 11 documents originally submitted in 2011 and 2013 can be downloaded at <https://phillyrefinerycleanup.info/act-2-documents/#aoi-11>.

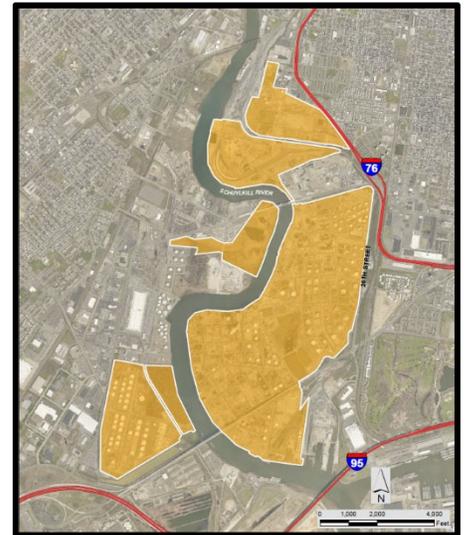


Figure 1. The Refinery Property

To assist in the review of this and the other AOI summaries, Evergreen has also prepared a companion summary document titled “Overview of Former Sunoco Philadelphia Refinery Environmental Investigations” that describes the Act 2 process and what to expect to find in Act 2 reports.

Commonly Used Terms

A few of the most common technical terms used in the reports are explained below:

Act 2 Statewide Health Standards – The PADEP has set Act 2 Statewide health standards for soil and groundwater that are protective of human health and the environment. Additional investigation is not required if a chemical is detected at a level at or below the Act 2 standard.

Delineation – When a chemical is detected in soil or groundwater at a level above the Act 2 standard, additional samples are collected nearby to map the extent of the levels above the Act 2 standard. Delineation shows the extent of the chemical concentrations that are above the Act 2 standard.

Fate and Transport – Once the characterization of contamination in soil and groundwater is complete, a “fate” (how the chemicals decrease in concentrations over time) and “transport” (how the chemicals move through the ground over time) analysis must be conducted. The fate and transport section of the RIRs presents a discussion of where and how the chemicals in soil or groundwater may move.

Geology – The soils and rock (referred to as bedrock) beneath the Site. The soils were deposited over long periods of time. Soils are described by geologic units (or groupings of soils), which represent similar soils. Soils placed by humans rather than natural processes are called “fill”. In many areas, fill was used to make the land higher in order to build the Site. Understanding the geology is important because it can influence how the chemicals in the ground will be found or move in the ground and in groundwater.

Groundwater – Groundwater is the water that is present in the spaces between grains of soil or rock. Groundwater is not an underground lake or stream, but it does flow from one area to another. Different groundwater units can be separated from one another if there are layers of soils that are packed very closely together, like a clay, between two groundwater units. Within the AOIs, there are two groundwater units, which are referred to as the shallow and the deep groundwater. AOI 11 is this deep groundwater unit. Similar to the geology, understanding groundwater is important because it can influence where the chemicals will be found or move over time. If chemicals are present in an area of groundwater, it is referred to as a groundwater plume.

Commonly Used Terms Continued

Potential Exposure Pathways – A potential exposure pathway is the way a receptor (for example a worker) may become exposed to a chemical in soil, groundwater, or indoor air. A complete exposure pathway is when there is chemical present that can come into contact with a receptor and no barriers exist to prevent contact. A complete exposure pathway, for example, could be present if a worker could touch soils that have unacceptable levels of a chemical.

Remediation – Remediation is the cleanup up of contamination in soil or groundwater. An example of remediation is pumping LNAPL and groundwater out of wells to a treatment plant. An example of soil remediation is excavation, removal, and disposal of soil in a permitted landfill. All current remediation is called “interim” since an Act 2 Cleanup Plan has not been submitted. Other, permanent, remedial actions can include construction of surface caps as a barrier to chemicals in soil and groundwater, installation of vapor mitigation systems in buildings, and land use restrictions to prevent exposures.

General Description of Area of Interest 11

Within the AOIs, there are two groundwater units, which are referred to as the shallow and the deep groundwater. AOI 11 represents the deep groundwater unit which is also referred to as the lower aquifer and is present under most of the former Refinery and surrounding areas. The location of the facility in South Philadelphia is shown on **Figure 1**. Some key features of the lower aquifer are:

- The deep groundwater consists of mostly sand and gravel deposits with some clay layers.
- The deep groundwater exists beneath the former Refinery because there is a significant clay layer present that separates it from shallow groundwater, called the water table aquifer, in most places. There are some areas where the clay layer (called an aquitard) is missing and the deep groundwater connects to the shallow groundwater (see **Figure 2** for a vertical slice or cross section showing underground how the deep groundwater [light blue] relates to the shallow groundwater [dark blue] and aquitard, or clay layer [dark gray]).
- Bedrock underlies the deep groundwater and defines its bottom (gray hatched area at the bottom of **Figure 2**). Bedrock is generally 70 to 90 feet below ground surface at the former Refinery but may be shallower in some areas.
- Deep groundwater generally flows from the north to south beneath the former Refinery (see black arrows on **Figure 3**). The deep groundwater also flows into and beneath portions of the Schuylkill River.

Figure 2. Vertical Slice Showing the Refinery Aquifers

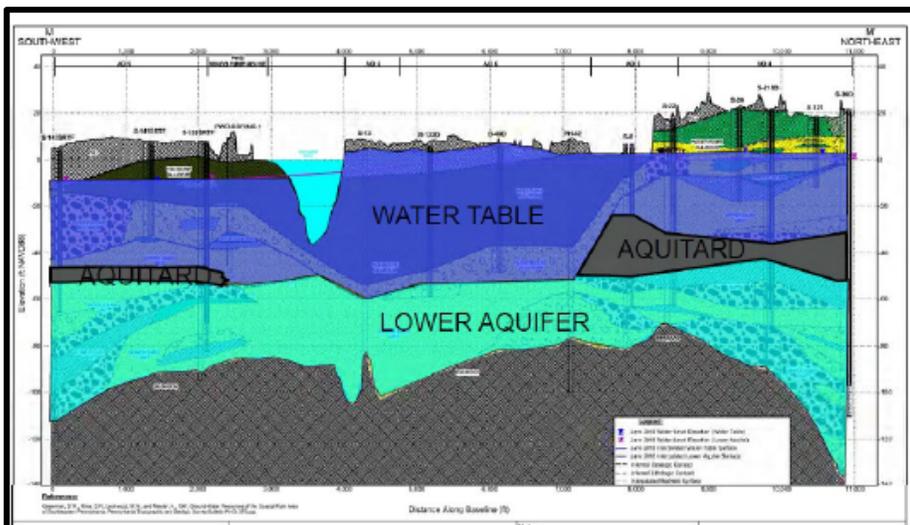
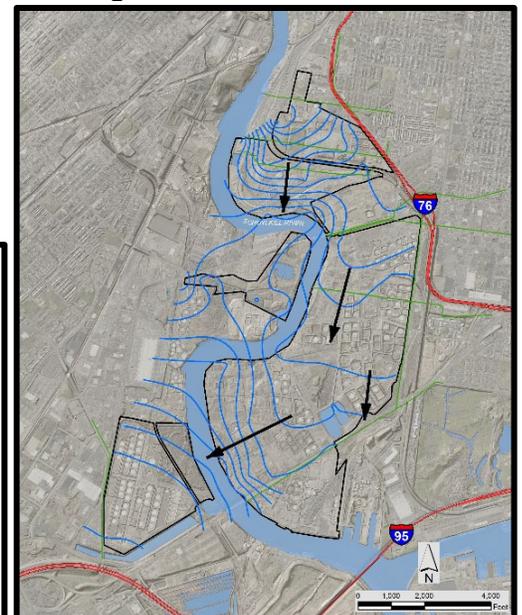


Figure 3. Groundwater Flow



What was found during the Act 2 investigations for AOI 11?

Groundwater samples were collected from the deep groundwater as part of the remedial investigations in AOIs 1 through 10. The results of the sampling were:

- Over 85 monitoring wells had nearly 3,500 groundwater measurements to determine the direction of groundwater flow.
- About 1,000 groundwater samples have been collected from monitoring wells within AOI 11 and from offsite monitoring wells located adjacent to the former Refinery (some of the offsite wells are associated with other Act 2 Sites). Some groundwater impacts were identified in AOI 11, but the concentrations of the chemicals, however, were found at much lower levels and at less locations than shallower groundwater. The chemicals that have been detected above the Act 2 Statewide standards in the deep groundwater are:
 - benzene, 1,2-dichloroethane, 1,2-dibromoethane, methyl tertiary butyl ether (MTBE), 1,2,4-trimethylbenzene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, bis 2-ethylhexyl phthalate, dibenz(a,h)anthracene, naphthalene, arsenic, cobalt, chromium, iron, lead, and manganese
- **Figure 4** shows the locations of the groundwater samples collected from monitoring wells in AOI 11. The results of the deep groundwater collected at these locations are colored coded in relation to the Act 2 Statewide standards (green dots mean no chemicals were present at concentrations above the Act 2 standard, orange dots mean one or more chemicals were present at concentrations above the Act 2 standard). Many of the chemicals detected over the Act 2 Statewide standards in the deep groundwater are common to oil refineries and are consistent with past operations. However, some of the metals, such as iron and manganese, are naturally occurring in the subsurface and are consistent with deep groundwater concentrations in this area of Pennsylvania. For comparison, **Figure 5** shows the benzene concentrations in deep groundwater. As noted above, green dots mean no benzene concentrations above the Act 2 standard were found, and orange dots are wells with an exceedance of the benzene standard.
- Many of the compounds detected above the Act 2 Statewide standards are found in just a few wells. One of the primary chemicals in the deep groundwater that is generated from past operations is benzene. The figure below illustrates that few wells exceed the standard for benzene.

Figure 4. Groundwater Samples

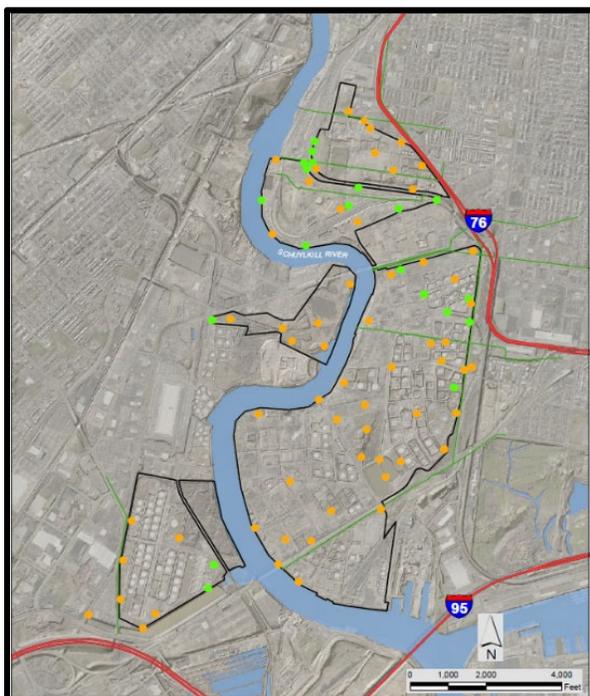
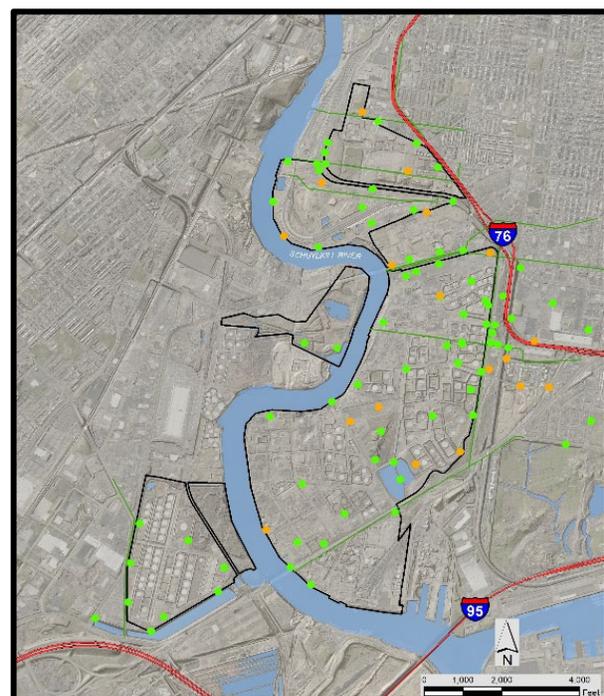


Figure 5. Benzene in Groundwater



The full reports have large-scale figures that illustrate the information collected for deep groundwater that are easier to read, as well as the complete data tables that have all laboratory results compared to the Act 2 standards. The RIRs also summarize how much of the chemicals are present, including the locations of associated monitoring wells.

Discussion of Potential Exposure Pathways

Chemicals detected in the lower aquifer generally include those commonly associated with refinery operations. Potential risks from AOI 11 are from the migration of groundwater containing chemicals that may ultimately reach a receptor. The fate and transport analysis will evaluate how water from deep groundwater discharges to the Schuylkill River to predict the concentrations in the surface water. Similarly, the fate and transport analysis will evaluate how deep groundwater moves off-site and how far the chemicals in the groundwater will persist in deep groundwater as it moves toward New Jersey. Based on the analysis completed to date, it is not expected that the chemicals in deep groundwater will result in unacceptable surface water concentration in the Schuylkill River or could travel to New Jersey, where groundwater is used as a drinking water resource. As stated above, groundwater in deep groundwater will be further evaluated in future Act 2 submittals including a Fate and Transport RIR and Risk Assessment, and any potential risks (including groundwater discharges to the Schuylkill River and off-site toward New Jersey) will be addressed by the final remedial actions.

Conclusion

Based on the completed activities, deep groundwater has been investigated consistent with the requirements set forth in Act 2. A combination of statewide health standards and site-specific standards are under consideration for the deep groundwater unit.

The PADEP and EPA reviewed the 2011 AOI 11 RIR and the 2013 Final Report and requested additional fate and transport modeling. Therefore, it is more appropriate to include the data for AOI 11 collected since 2013 into the RIRs for other Areas of Interest, and to include the deep groundwater in the site-wide Fate and Transport RIR that will use a computer model to predict chemical movement in groundwater and how concentrations are expected to behave over time. After the Fate and Transport RIR is submitted and approved, Evergreen will be able to submit Risk Assessment(s) and Cleanup Plan(s) for the Site.

Note: This document has been prepared to provide a plain-language description of the information that describes the lower aquifer included in previous reports. These reports, which include the 2011 Site Characterization/Remedial Investigation Report for Area of Interest (AOI) 11, 2013 Final Report for AOI 11, and several RIRs for Facility AOIs 1 through 9 were prepared for the Philadelphia Energy Solutions Refining and Marketing LLC (PES) Philadelphia Refining Complex (Complex) and include information provided in and collected up to the time of the report submittal. The reports were prepared for Evergreen Resources Group, LLC (Evergreen) and its predecessor, Sunoco. Evergreen is responsible for managing the investigation and cleanup of the legacy (pre-PES ownership) environmental impacts at the former Sunoco South Philadelphia Refinery, which is now known as the PES Complex. Per Section 901 of the Pennsylvania Land Recycling and Environmental Remediation Standards Act, this document was prepared to enhance the opportunity for public involvement through establishment of a basic understanding of the remedial investigation process. This summary document does not constitute a Remedial Investigation Report or other Act 2 report, nor does it contain all the information provided in the referenced reports. The full Act 2 reports can be accessed at www.phillyrefinerycleanup.info.