

Philadelphia Energy
Solutions (PES) Refining
and Marketing LLC
Complex

Remedial
Investigation
Reports Review



June 2020

Review Draft

Table of Contents

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| Table of Contents | i |
| Acronym List/Glossary | i |
| Document Overview and Purpose | 3 |
| Site Background..... | 4 |
| Sitewide Considerations for the RIRs | 8 |
| Sitewide Characterization | 12 |
| Cleanup Methods Used at Other Oil Refinery Sites | 22 |
| Discussion and Conclusions | 24 |
| References..... | 25 |
| Additional References..... | 26 |
| Appendix A: RIR Review – AOIs 1, 2, 3, 5, 6, 7, 8 and 10..... | 28 |

Acronym List/Glossary

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| AOI | Area of Interest; <i>subarea of the Site where individual environmental investigations have been completed.</i> |
| CAMU | Corrective Action Management Unit; <i>an area used for management of waste generated during remediation.</i> |
| COC | Contaminant of Concern; <i>chemical substances found in the environment that have harmful effects on people or the environment.</i> |
| EPA | United States Environmental Protection Agency; <i>a federal agency that oversees cleanup of contaminated sites, including this Site.</i> |
| IASHS | Indoor Air Statewide Health Standard; <i>PADEP indoor air standards.</i> |
| LNAPL | Light Non-Aqueous Phase Liquid; <i>a groundwater contaminant such as oil that floats on top of water and is present under the Site.</i> |
| MTBE | Methyl Tert Butyl Ether; <i>a volatile organic compound and contaminant found in groundwater under the Site.</i> |
| NIOSH | National Institute for Occupational Safety and Health; <i>a federal agency that works to prevent work-related injuries and illness.</i> |
| NIR | Notice of Intent to Remediate; <i>a notice submitted to PADEP that results in the facility entering into the Act 2 Program.</i> |
| OSHA | Occupational Safety and Health Administration; <i>a federal agency that sets and enforces standards and provides education to ensure safe and healthy working conditions.</i> |
| PADEP | Pennsylvania Department of Environmental Quality; <i>a state agency that is overseeing the remedial investigation and cleanup of the Site.</i> |

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|------|--|
| PES | Philadelphia Energy Solutions; <i>the most recent operator at the Site.</i> |
| RIR | Remedial Investigation Report; <i>a report that describes all the data collected at a site to demonstrate that the environmental conditions at the property are known.</i> |
| SWMU | Solid Waste Management Unit; <i>a place where solid wastes have been placed or an area where solid wastes have been routinely released.</i> |
| VOC | Volatile Organic Compound; <i>compounds that easily become vapors or gases and represent a group of contaminants of concern (COCs) at the Site.</i> |
| SVOC | Semi-Volatile Organic Compound; <i>a subgroup of volatile organic compounds (VOCs) that are a group of COCs at the Site.</i> |

Document Overview and Purpose

The former Sunoco Philadelphia Refinery, now known as the Philadelphia Energy Solutions Refining Marketing (PES) LLC Complex (Site) is located along the Schuylkill River in Philadelphia. EPA Region 3, the Pennsylvania Department of Environmental Protection (PADEP), and the city of Philadelphia have been working with Sunoco and Evergreen Resources Group, LLC (Evergreen) on remedial investigations of the areas of interest (AOIs) at the Site.

Sunoco has led groundwater cleanup at several areas of the Site since the 1990s. Evergreen has looked at soil and groundwater contamination on and next to the Site. Findings from these studies are in several remedial investigation reports (RIRs). Sunoco has also prepared two risk assessment reports. PADEP has approved completed RIRs for eight AOIs, including AOIs 1, 2, 3, 5, 6, 7, 8 and 10.

This report provides information on the Site and the RIR process. It covers contaminants of concern, future land use scenarios, and PADEP non-residential standards for soil and groundwater. It also shares key findings from the eight RIRs for AOIs 1, 2, 3, 5, 6, 7, 8 and 10. It also discusses common cleanup methods at refinery sites. The report's goal is to help nearby residents, businesses and organizations better understand contamination at the Site, how it could affect them, and what to expect for future site investigations and cleanup.¹

¹ EPA's Technical Assistance Services for Communities (TASC) program provided this report under contract #EP-W-13-015 with contractor Skeo. EPA's TASC program funded the report. Its contents do not necessarily reflect the policies, actions or positions of EPA.

Site Background

Location and Current Status

The 1,400-acre Site is located along the east and west banks of the Schuylkill River in Philadelphia. Residential, commercial and other industrial properties surround the Site. The refinery made fuel and petrochemicals for the chemical industry. Its operations resulted in soil and groundwater contamination. In June 2019, after a production unit explosion, PES stopped operations and filed for bankruptcy.

During the refinery's operations, it was the largest single source of air pollution in Philadelphia, emitting 9% of the city's fine particle emissions, 20% of the city's greenhouse gas emissions and 470,000 pounds of air toxics each year. Since the refinery has stopped operating, the area's air quality is expected to improve significantly. It is possible that these air quality improvements will be long lasting. Recent news reports indicate that the developer expected to purchase the property has no plans to restart the refinery. Instead, Hilco Development Partners plans to redevelop it as a light industrial park reliant on its highway, rail, sea and pipeline connections. Site studies and cleanup preparations are ongoing.

Operational and Regulatory History

The Atlantic Refining Company started operating an oil distribution center on the property in the 1860s. The facility processed, transported and stored petroleum. In the 1900s, crude oil processing began. Full-scale gasoline production started during World War II. In addition to refining crude oil, the facility produced various chemicals such as acids and ammonia.

Sunoco purchased the facility in 1988. Environmental investigations took place at the Site during the 1980s and 1990s. In 2003, to better manage site investigations, the Site was divided into 11 AOIs. AOI 11 includes deep groundwater under the Site and surrounding areas. Figure 1 shows AOIs 1 through 10; AOI 11 is located under the Site.

Several remediation systems are in place throughout the Site to protect human health and the environment. These include recovery systems, which pump contaminated material and water out of the ground, barriers under the ground that get rid of vapors at the surface, systems that inject air into the ground to clean up groundwater, and venting systems that capture vapor and treat it. There are currently 10 remediation systems operating at the Site. Current remediation systems are detailed in Appendix A.

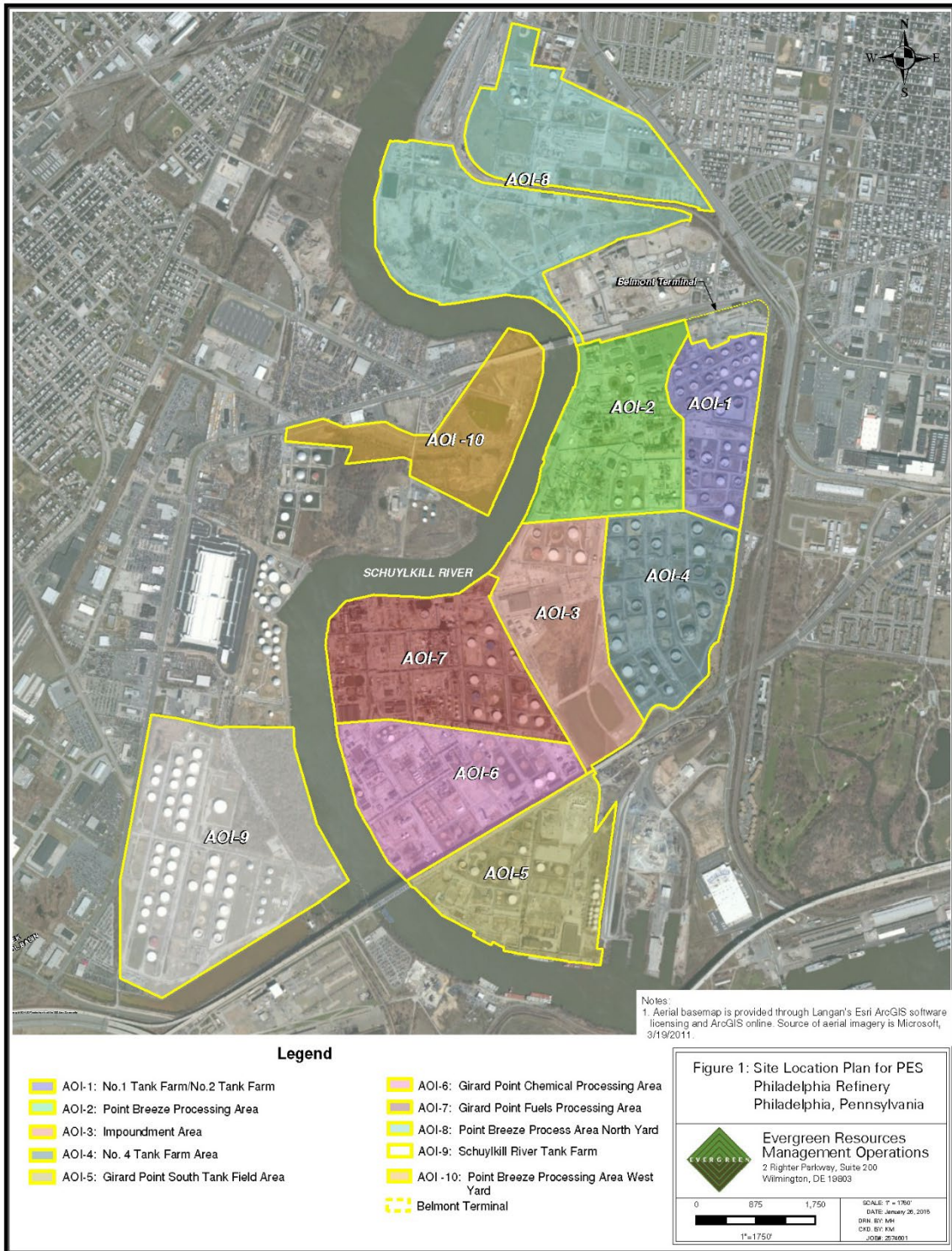


Figure 1. PES site map (Source: Evergreen)

Environmental investigations for each AOI took place through the PADEP Act 2 cleanup program. The Act 2 process starts with a Notice of Intent to Remediate (NIR). Sunoco submitted the NIR in 2006. In 2013, remediation liability transferred to Evergreen. Evergreen prepares the RIRs. This is the current stage of the Act 2 process at the Site. RIRs have been completed for AOIs 1, 2, 3, 5, 6, 7, 8 and 10.

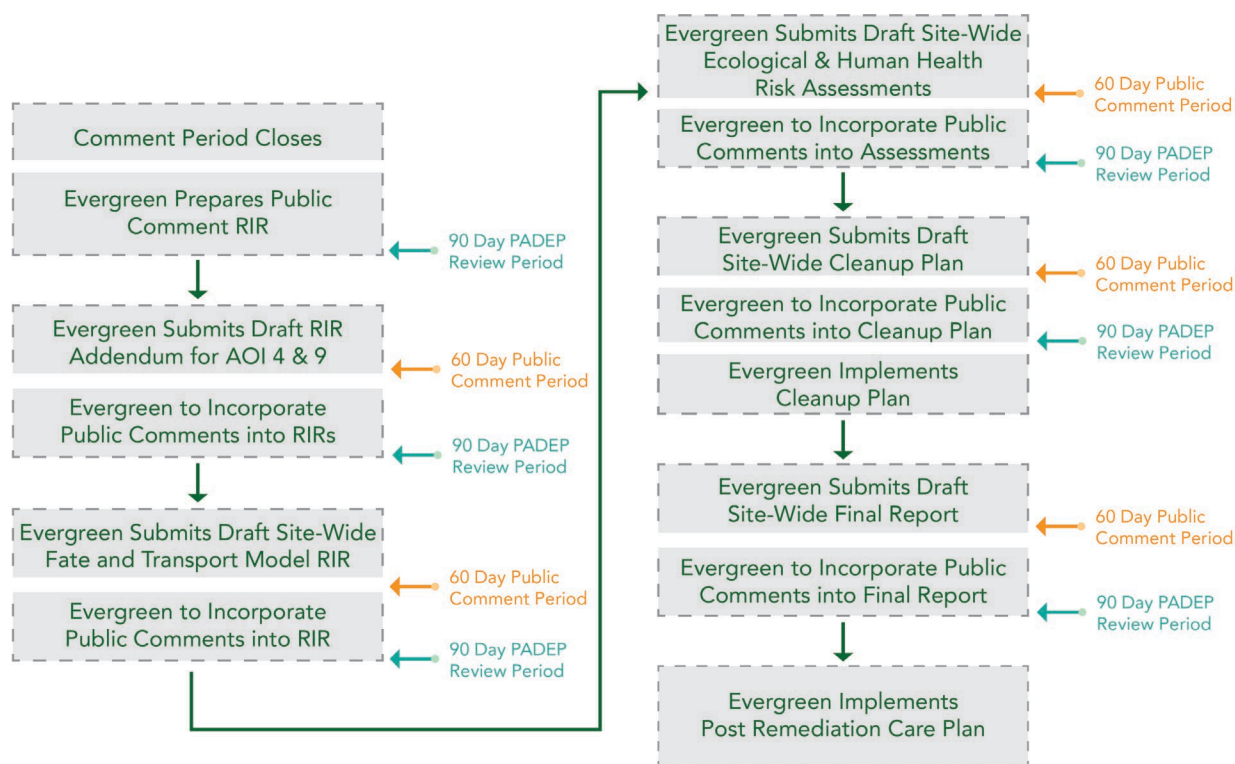


Figure 2. Act 2 Process at the Site

After completion of the remaining RIRs for AOIs 4 and 9, Evergreen will submit a draft study for the entire Site including AOI 11 (i.e., sitewide) that describes how chemicals move through the environment at the Site and what happens to the chemicals as they move. This is referred to as a fate and transport model. Some RIRs also included fate and transport modeling, and these results will be incorporated into the sitewide model. Evergreen will also submit a sitewide study to EPA and PADEP that describes the possible risks that chemicals found at the Site may have on human health and the environment. This is referred to as an ecological and human health risk assessment (Figure 2).

Potential Pathways and Active Threats

Researchers have found that people living near refineries face increased rates of respiratory illness. At the Site, while the area’s air quality is expected to improve rapidly due to the refinery’s

shutdown, the contamination left behind in the soil and groundwater will require long-term cleanup. Cleanup should protect future users of the site property and keep the contamination from moving into groundwater. The refinery's pollution may affect an area of underground water (i.e., an aquifer) used by the state of New Jersey for drinking water.

Cleanup activities can sometimes have negative effects on nearby residents. These effects may include truck traffic, noise and dust. *Community members may want to ask EPA and PADEP how the cleanup will minimize these effects.* For example, use of the refinery's seaport and rail connections for transporting equipment used for cleanup and to remove contaminated soil from the Site could provide a way to minimize truck traffic through the community. Assuming the refinery remains shut down permanently, the structures will need to be dismantled safely. Cleanup will need to include properly handling and disposing of building materials that contain asbestos. Monitoring of components will be needed to make sure flammable materials posing a risk to workers or surrounding communities through fire, explosion or off-gassing are not present.

RIR Process

An RIR is a report. It describes all information collected for an AOI documenting environmental conditions in the area. This process is called "characterization." Act 2 program requirements guide the remedial investigation process. After submittal, EPA and PADEP review each RIR. PADEP then responds with an approval or rejection letter. The letter specifies if the RIR meets Act 2 program requirements.

Fate, Transport and Conceptual Site Model

Fate: how chemicals break down in the environment.

Transport: how chemicals travel through the environment.

Conceptual Site Model: a model that provides an overall picture of what and where contamination is located, fate and transport, and how people and the environment are exposed to contamination.

Each RIR has the same basic structure. It includes an introduction and background section that summarizes operations, regulations, standards and chemicals of concern. The RIR then covers the AOI's environmental setting, characterization, fate and transport, and Conceptual Site Model. The RIR for each AOI differs due to differences in each AOI's physical and operational conditions. The next section of this report discusses common elements across the AOIs.

Sitewide Considerations for the RIRs

Environmental Setting

This part of each RIR describes general environment conditions across the AOIs, including below ground. Environmental media at the Site include soil, groundwater, surface water, sediment and air. Surface water includes on-site features such as ponds, as well as parts of the Schuylkill River that could be affected by contamination. Soils include surface soil (on the surface and generally less than 2 feet deep) and subsurface soil (from 2 feet down to the level of groundwater). Groundwater is water in the subsurface. This subsurface groundwater occurs in different units, often separated by layers of clay or silt.

The Site is located in a generally low-lying and fairly flat area. A layer of fill material is under the Site. Below the fill is peat and sand (close to the river) and some layers of gravel and mud (moving away from the river). Groundwater generally occurs in two units: the water table aquifer (shallow) and the lower aquifer (deep). In some places, an aquitard, a zone that prevents groundwater flow from one aquifer to another, separates these zones. However, in some areas of the Site, the aquitard is not present. In these areas, the water table and lower aquifer are hydraulically connected, meaning that groundwater can move between the zones (see Figure 3).

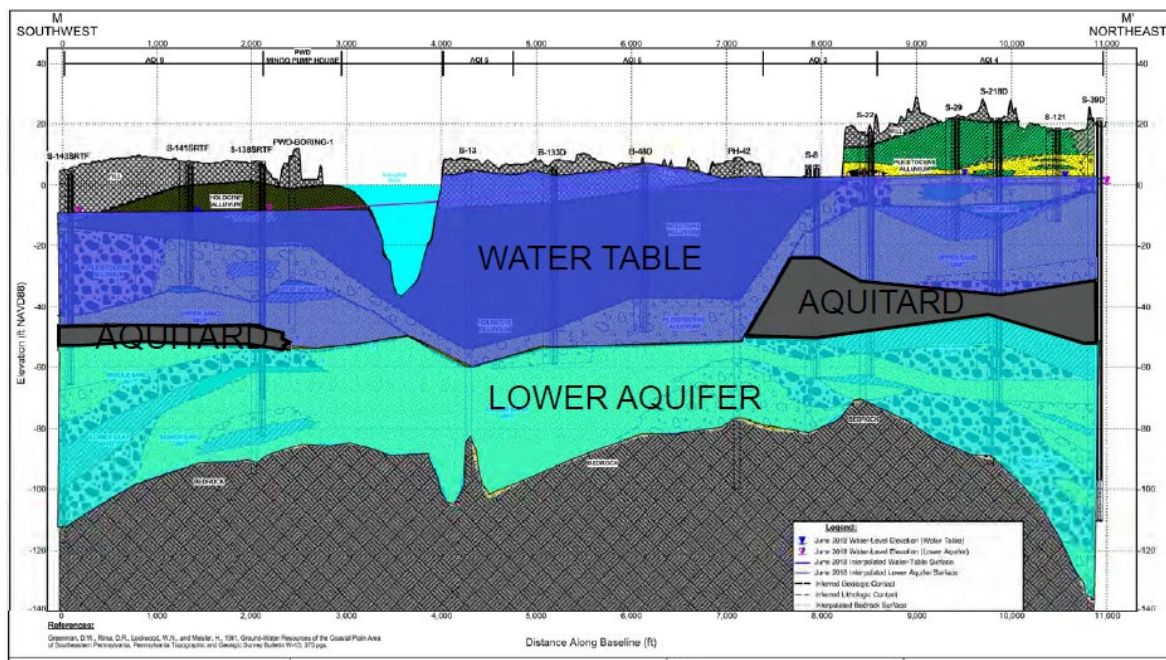


Figure 3. Hydrogeologic layers at the Site (Source: Evergreen)

Current and Future Use Scenarios and Assumptions

The Site is currently unoccupied. In the future, the Site will be used for industrial or commercial activities. The Site is not expected to ever be in residential use. For the purposes of characterization and cleanup planning, the Site's remedy will be protective for non-residential purposes (such as industrial and commercial uses) after cleanup. The Site's anticipated remedy will not be protective for residential use.

Standards

Act 2 standards are the concentrations of contaminants in soil or groundwater that are used in the development of a cleanup plan. They can be residential or non-residential, based on current or future use of the property. The standards for all areas of the Site are based on Act 2 non-residential statewide health standards for soil and groundwater. For the final cleanup, the remediator selects the standard to achieve at the Site. EPA and PADEP oversee the cleanup to ensure the standard is met appropriately.

There are three types of Act 2 standards:

Background: based on conditions in areas that are not affected by site contamination.

Statewide: established by PADEP.

Site-specific: calculated based on a risk assessment for the Site or based on pathway elimination.

In 2015, a human health risk assessment established a site-specific standard for lead in soils. If a sampling result is below the standard, more investigation is not required under the Act 2 regulation. If a sampling result is above the standard, more samples are collected until delineation is achieved (see description in the next section). Air sample results were compared to different standards, including PADEP Indoor Air Statewide Health Standards (IASHS) vapor intrusion screening levels, Occupational Safety and Health Administration (OSHA) screening levels, and National Institute for Occupational Safety and Health (NIOSH) standards, as well as EPA regional screening levels. EPA regional screening levels are generic values based on information about risk, exposure and toxicity for individual chemicals, to help determine if areas, contaminants, and conditions require further federal attention.

Site Characterization and Delineation Status

The RIRs discuss the investigation results in terms of whether contamination has been “delineated” and “characterized.” The box to the right explains what these terms mean.

All contamination at the AOIs has been characterized. All soil contamination has been delineated. Areas of groundwater and LNAPL contamination have yet not been delineated. Additional investigations and modeling for groundwater and LNAPL contamination will be part of an upcoming Act 2 report.

Delineation versus Characterization

Delineated: a chemical was detected in a sample above the standard, additional samples were collected surrounding the initial sample, and the results around the initial sample were below the standard. Under these circumstances, the contaminated area has been “delineated.”

Characterized: when environmental conditions are identified through sample collection and analysis.

Characterization and Contaminants of Concern (COCs)

To characterize, or investigate, the contamination in each AOI, four types of environmental samples were collected and analyzed. An overview of the sampled media is listed below. Figure 4 provides a visual representation of the sampling methods.

- *Light Non-Aqueous Phase Liquids (LNAPLs)* – oil refineries often leaked or spilled gasoline and other petroleum products onto the ground. This contamination is called free product. Certain types of free product are lighter than water, so they float on top of the groundwater. They are called LNAPLs. Groundwater and soil that comes into contact with free product becomes contaminated. Each RIR states if LNAPL is present in the AOI, its location and movement (if any), and the status of its removal or treatment.
- *Soil* – subsurface and surface samples were collected across the Site. The samples were compared to Act 2 standards or the site-specific standard for lead.
- *Groundwater* – samples were collected from wells and the results were compared to Act 2 standards (Figure 4).
- *Vapor Intrusion* – the movement of chemical vapors from contaminated soil and groundwater into nearby buildings. Indoor air samples (from occupied buildings), outdoor air samples (from above LNAPL areas) and ambient outside air samples (i.e., air samples determined to not be affected by site contamination) were collected from most AOIs.

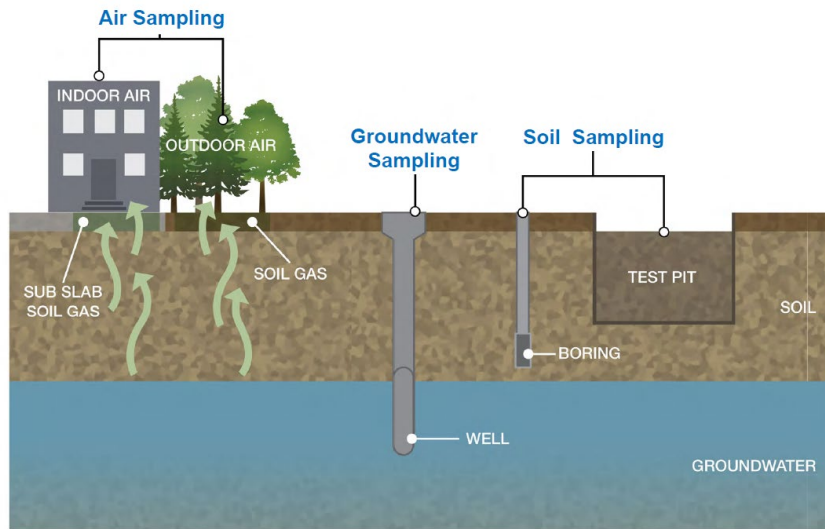


Figure 4. Methods of sampling (Source: Evergreen)

Site contaminants of concern (COCs) are mostly the same across the AOIs (Table 1). COCs are chemical substances found in soil, groundwater, surface water, sediments or air that have harmful effects on people or the environment.

The COCs include volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) and lead. AOI 10 has a larger list of COCs separated out by groundwater, soil, sediment and surface water.

| Volatile Organic Compounds | CAS No. |
|---------------------------------|-----------|
| Benzene | 71-43-2 |
| Cumene | 98-82-8 |
| Dichloroethane, 1,2- | 107-06-2 |
| Ethylbenzene | 100-41-4 |
| Ethylene Dibromide | 106-93-4 |
| Methyl tert butyl ether | 1634-04-4 |
| Toluene | 108-88-3 |
| Trimethylbenzene, 1,2,4- | 95-63-6 |
| Trimethylbenzene, 1,3,5- | 108-67-8 |
| Xylenes | 1330-20-7 |
| | |
| Semi Volatile Organic Compounds | CAS No. |
| Anthracene | 120-12-7 |
| Benzo(a)anthracene | 56-55-3 |
| Benzo(a)pyrene | 50-32-8 |
| Benzo(b)fluoranthene | 205-99-2 |
| Benzo(g,h,i)perylene | 191-24-2 |
| Chrysene | 218-01-9 |
| Fluorene | 86-73-7 |
| Naphthalene | 91-20-3 |
| Phenanthrene | 85-01-8 |
| Pyrene | 129-00-0 |
| | |
| Metals | CAS No. |
| Lead | 7439-92-1 |

Table 1. AOI 1 COCs (Source: Evergreen)

Sitewide Characterization

This section summarizes the results of completed investigations at the Site. Table 2 below describes the environmental media (soil, groundwater, LNAPL) sampled for each AOI, whether the environmental media have been delineated and any related follow-up actions. For groundwater, only the water table aquifer results are shown in Table 2. The table also does not include air sampling results, as vapor intrusion (the movement of chemical vapors from contaminated soil and groundwater into nearby buildings) will be part of the upcoming human health risk assessment. While some areas have not been delineated, per Act 2 guidance, all areas have been characterized. Appendix A provides a more detailed summary of each AOI and the remedial investigation results.

Table 2. RIR Status Summary

| AOI | Media | Delineation Yes/No/Not Needed* | Follow-up Actions |
|-------|-----------------|-----------------------------------|---|
| AOI 1 | Surface Soil | Yes | Soil from locations above standards will need further evaluation or remediation. |
| | Subsurface Soil | Not needed | None specified |
| | Groundwater | No | Benzene and methyl tert butyl ether (MTBE) contamination extends off site. Further characterization is needed. It will be part of the upcoming fate and transport Act 2 report. |
| | LNAPL | No | LNAPL has been observed off site to the east and northeast and will continue to be monitored. Fluids recovery is ongoing in this area. |
| AOI 2 | Surface Soil | Yes | None specified |
| | Subsurface Soil | Not needed | None specified |
| | Groundwater | No | Delineation is complete to the north, east and south, but not to the west. Fate and transport of groundwater in AOI 2 and an evaluation of surface water will be provided in a future Act 2 report. |
| | LNAPL | Yes | None specified |

| AOI | Media | Delineation Yes/No/Not Needed* | Follow-up Actions |
|-------|-----------------|-----------------------------------|--|
| AOI 3 | Surface Soil | Yes | None specified |
| | Subsurface Soil | Not needed | None specified |
| | Groundwater | Yes | None specified |
| | LNAPL | Yes | None specified |
| AOI 5 | Surface Soil | Yes | None specified |
| | Subsurface Soil | Yes | None specified |
| | Groundwater | Yes | None specified |
| | LNAPL | Yes | None specified |
| AOI 6 | Surface Soil | Yes | None specified |
| | Subsurface Soil | No | Additional samples are planned for the area around sample number AOI 6-16-025. |
| | Groundwater | No | Delineation was not possible near the bulkhead along the Schuylkill River. Fate and transport of groundwater in AOI 6 will be provided in a future Act 2 report. |
| | LNAPL | No | Delineation was not possible near the bulkhead along the Schuylkill River. Fate and transport of groundwater in AOI 6 will be provided in a future Act 2 report. |
| AOI 7 | Surface Soil | Yes | None specified |
| | Subsurface Soil | Not needed | None specified |
| | Groundwater | No | Additional sampling is planned and will be submitted in a future Act 2 report. |
| | LNAPL | Yes | LNAPL recovery is ongoing and will be part of the sitewide cleanup plan. |
| AOI 8 | Surface Soil | No | Delineation is complete to the north and east, but delineation was not possible to the west as soil contamination extended right up to the Schuylkill River. |
| | Subsurface Soil | Not needed | None specified |

| AOI | Media | Delineation Yes/No/Not Needed* | Follow-up Actions |
|---|-----------------|-----------------------------------|---|
| | Groundwater | No | Groundwater may be migrating from AOI 1 or other off-site sources and into sewers and the Schuylkill River. Fate and transport of groundwater in AOI 8 will be provided in a future Act 2 report. |
| | LNAPL | Yes | None specified |
| AOI 10 | Surface Soil | No | Additional delineation for lead and benzo(a)pyrene are planned. |
| | Subsurface Soil | No | Samples were only collected around waste areas. Additional subsurface sampling will be conducted. |
| | Groundwater | No | Modeling results showed benzene in well W-33 could migrate to Lands Creek. |
| | LNAPL | Yes | None specified |
| Notes: | | | |
| * There were no concentrations above the standards, so delineation is not needed. | | | |

Soil Investigation Results (All COCs Except Lead)

Sampling collected over 1,200 surface soil samples (0 to 2 feet deep) and just over 1,000 subsurface soil samples (2-15 feet deep) analyzed for all COCs except lead. Any samples above Act 2 standards were delineated (see red dots in Figure 5).

Soil Investigation Results (Lead Only)

Over 1,100 surface soil samples (0 to 2 feet deep) and just over 800 subsurface soil samples (2 to 15 feet deep) were collected across the Site and analyzed for lead. Any samples above the site-specific standard were delineated. No subsurface soils had COC concentrations above the site-specific standard. A summary of the sitewide results for surface and subsurface soil (not including lead) and surface soil (lead) are shown below (figures 5, 6 and 7, respectively).

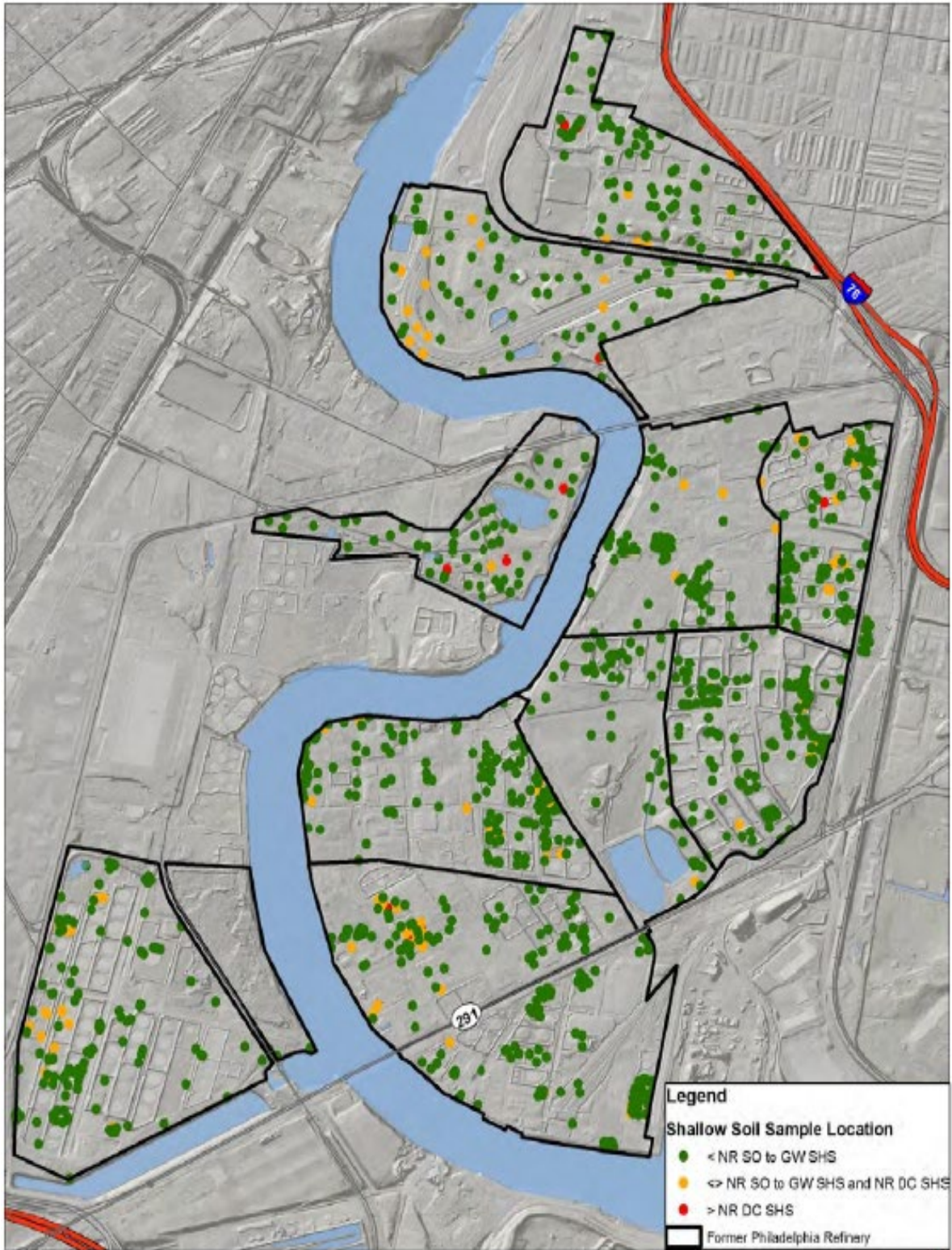


Figure 5. Surface soil investigation results (Source: Evergreen)

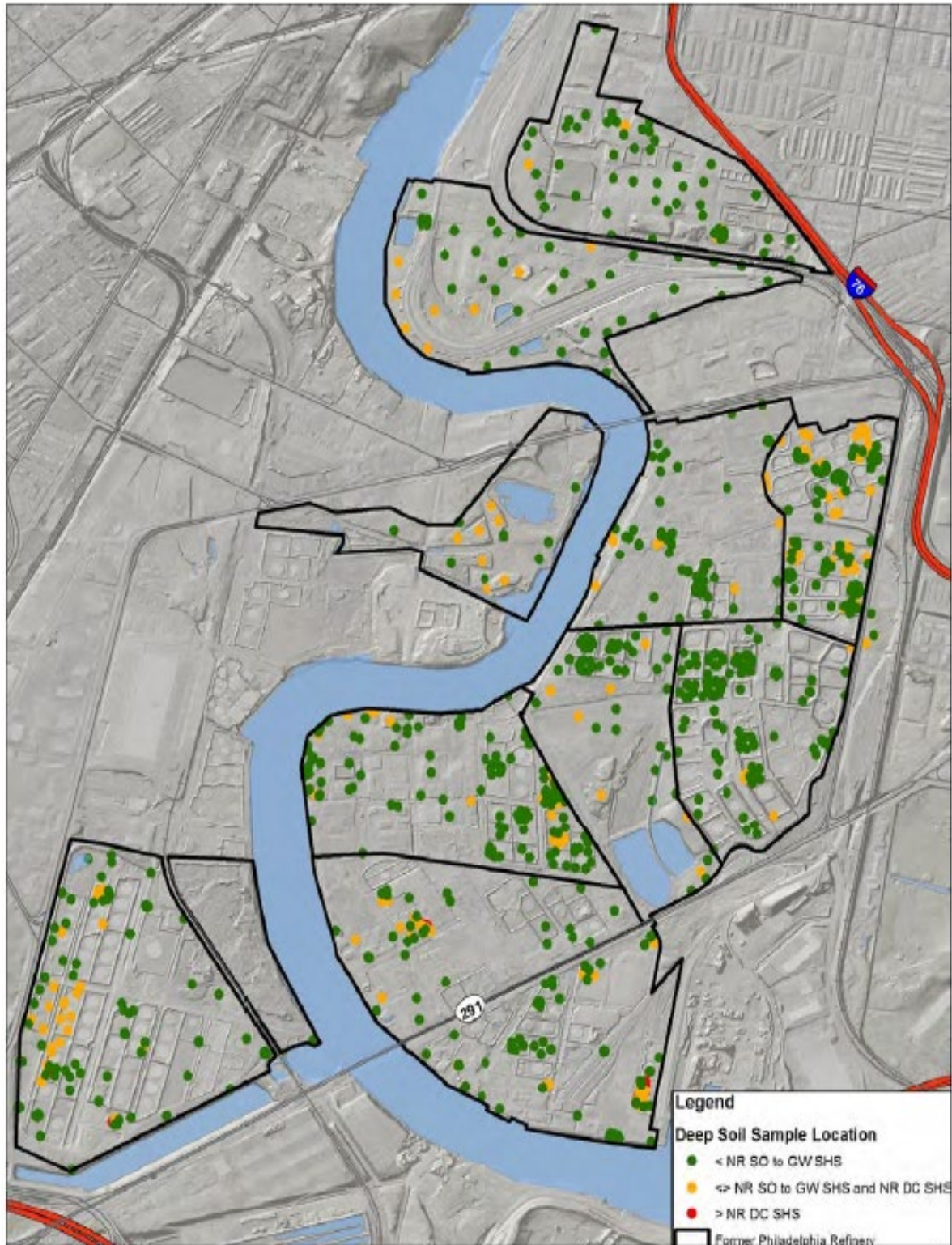


Figure 6. Subsurface soil investigation results (Source: Evergreen)

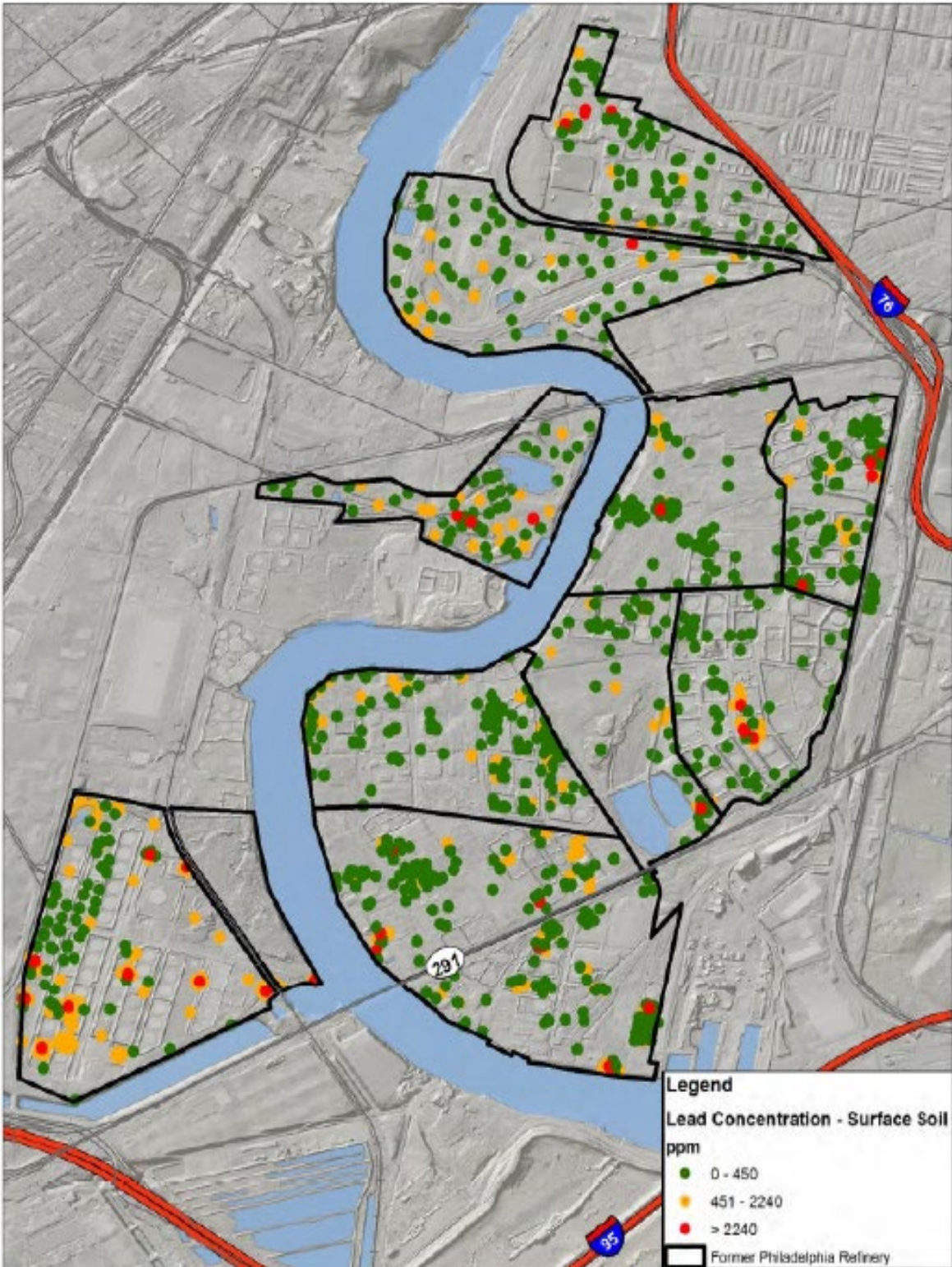


Figure 7. Lead surface soil investigation results (Source: Evergreen)

LNAPL Investigation Results

LNAPL is present under the Site above the groundwater surface in all AOIs, as shown in Figure 8. All LNAPL areas have been characterized. LNAPL in most areas is not spreading and does not appear to be contributing to groundwater contamination.

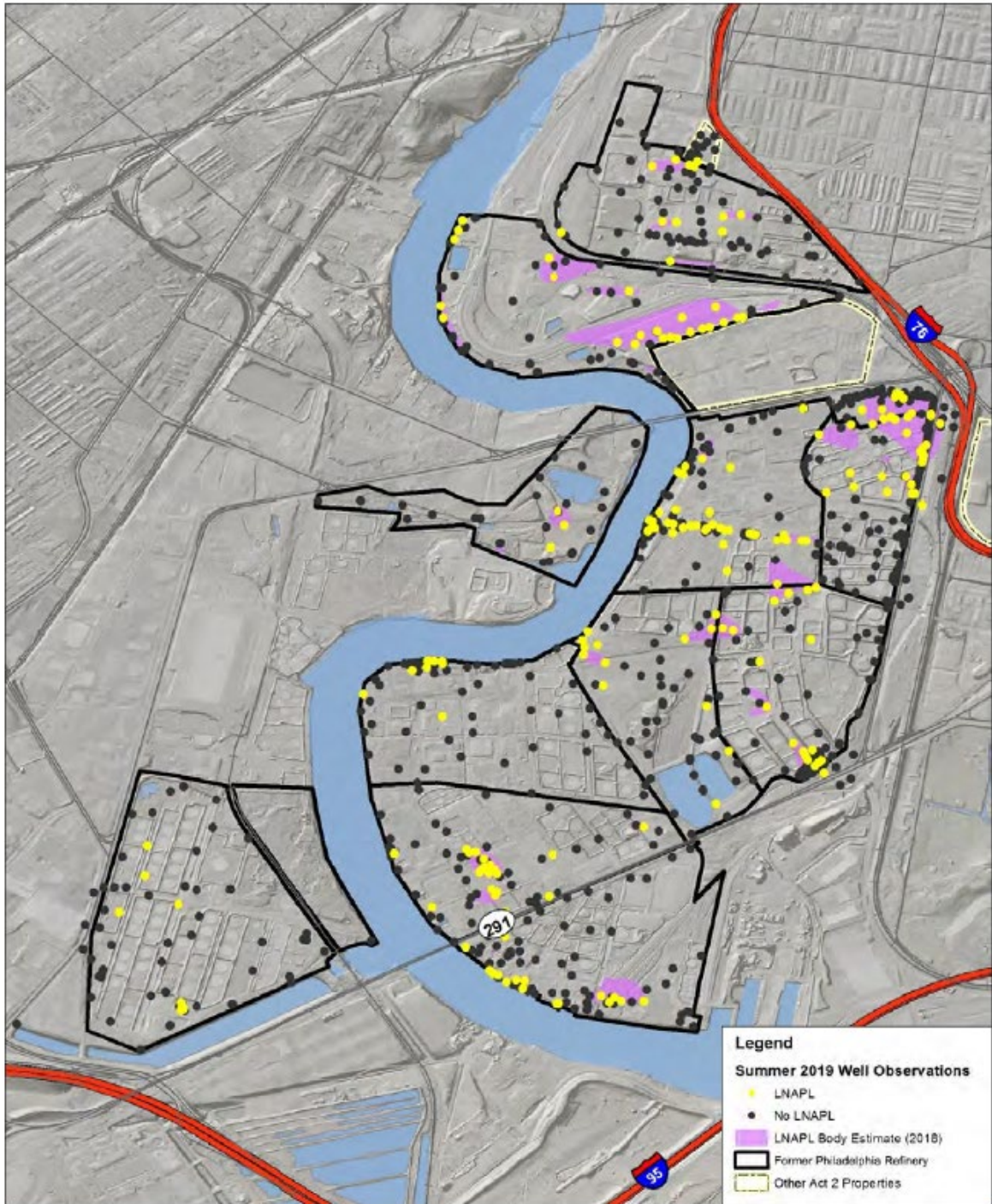


Figure 8. LNAPL Distribution 2018-2019 (Source: Evergreen)

Groundwater Investigation Results

Benzene, a VOC, is the primary groundwater contaminant at the Site. In the water table aquifer, benzene contamination extends off site and may have come from other facilities. Areas above the “statewide non-residential, used aquifer, statewide health” standards are shown in green. The darker areas correspond to higher concentrations (data were collected from 2014 to 2019). Groundwater fate and transport across the entire Site will be analyzed in a future Act 2 deliverable.

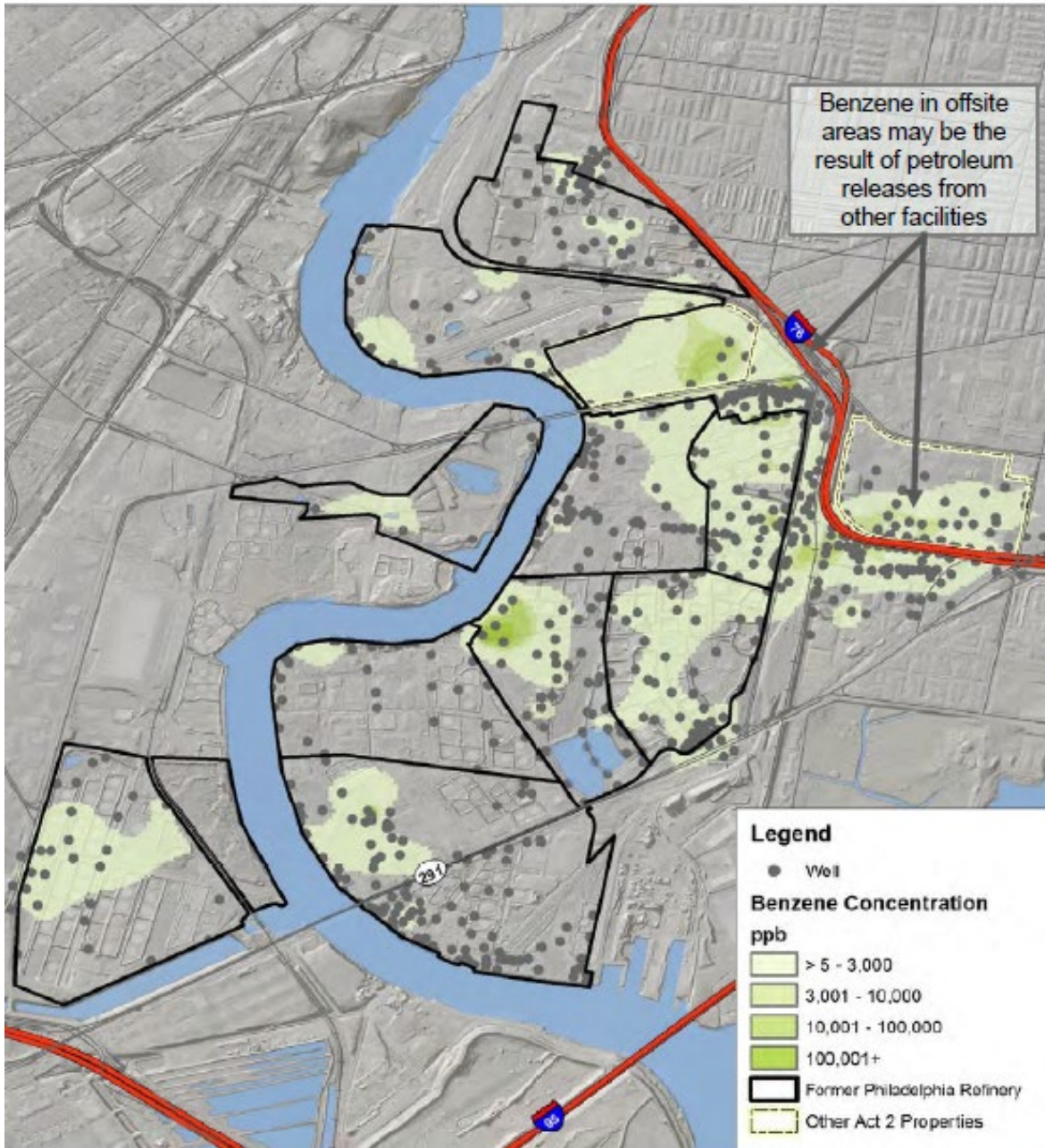


Figure 9. Benzene results in the water table aquifer, 2014 to 2019 (Source: Evergreen)

In the lower aquifer, fewer wells were installed, so areas of contamination cannot be shown as they are in the Figure 9 for the water table aquifer. Concentrations of benzene in the lower aquifer are much lower and there are fewer wells with concentrations above the standard.

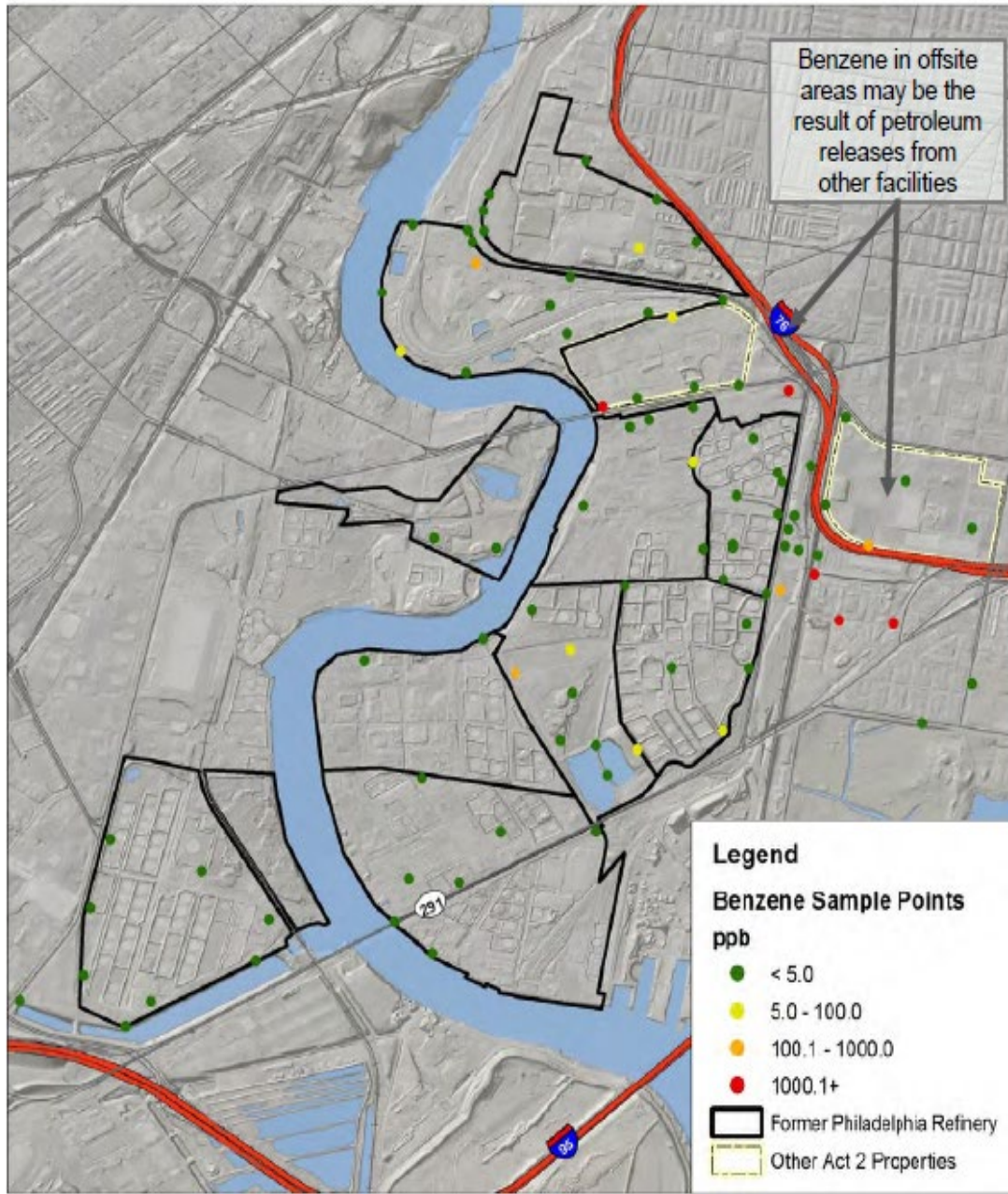


Figure 10. Benzene results in the lower aquifer (Source: Evergreen)

Air Investigation Results

Across the Site, over 200 air samples were collected. Most of the samples were indoor samples, taken in occupied buildings and buildings that could be occupied. Some of the samples were taken outside. Fewer than 10 of the samples came from the subsurface. Some samples were above standards or screening levels. They are discussed in more detail in the AOI sections below. Some buildings were occupied during the RIR process. There are currently no occupied buildings on site. Vapor intrusion is not currently a concern. However, it could be in the future, after site redevelopment. The sitewide human health risk assessment will evaluate this potential concern.

Cleanup Methods Used at Other Oil Refinery Sites

After the RIRs, sitewide fate and transport, human health and ecological risk assessments are submitted, approved by PADEP, and go through the public review period, Evergreen will submit a sitewide cleanup plan for PADEP approval and public review. This section describes common cleanup methods used at other oil refinery sites. All these methods may not be suitable for the Site.

A common way to clean up contaminated groundwater and LNAPL is **pumping and treatment**. Contaminated groundwater and LNAPL are pumped out of the ground using wells. The wells can collect LNAPL, groundwater or both (both is called dual-phase extraction). Collection trenches can help collect groundwater so it can be pumped out. The contaminated groundwater can then be treated at a wastewater treatment plant or in a treatment wetland. Recovered LNAPL can be disposed of or recycled. Injecting special additives into the ground that help flush out LNAPL and groundwater contamination can enhance the pump-and-treat process.

Other methods used to clean up groundwater at refinery sites include:

- **Air sparging:** pump air into the groundwater to collect contaminants and to stimulate microorganisms (bacteria) that break down contaminants. Air sparging is often combined with **soil vapor extraction**, in which the air with its collected contaminants is sucked out of the ground and treated.
- **Enhanced biodegradation:** inject nutrients and other additives into the ground to help microorganisms break down contaminants.
- **Monitored natural attenuation:** sample groundwater routinely to determine whether natural processes will reduce contamination to acceptable levels in a reasonable period.

Other methods used to clean up LNAPL at refinery sites include:

- **Sheet pile walls:** build an underground wall to stop LNAPL from spreading. These walls sometimes are made of metal sheets called sheet piles that are driven into the ground side by side. Underground barriers can also be used that absorb the LNAPL.
- **Soil washing:** flood an area with special liquids that enhance the removal of LNAPL.

Various cleanup methods have been used to clean up soil at refinery sites:

- **Excavation:** dig up contaminated soil and other materials. These materials can then be disposed of in a landfill or incinerated. The landfill can be on site or off site.

- **Capping:** cover contaminated areas with clean soil or other materials. The cover keeps people from being exposed to the contamination and keeps rainwater from soaking into the contamination.
- **Stabilization:** mix cement into the soil to prevent the contaminants from moving.
- **Bioremediation:** stimulate the growth of microorganisms that break down contaminants.
- **Phytoremediation:** plant trees or other plants that can help break down contaminants.
- **Soil vapor extraction:** pull contaminated air out of the ground and treat it.

Some sites are cleaned up to levels safe for industrial and commercial uses but not residential and other uses. At such sites, restrictions called “**institutional controls**” prevent the land or groundwater from being used in ways that would not be safe.

Discussion and Conclusions

Evergreen has completed eight of the RIRs following Act 2 program guidance. PADEP has approved them. These area-specific RIRs are generally focused on the soil and groundwater contamination within the boundary of each AOI. Vapor intrusion was characterized for occupied or potentially-occupied buildings and outdoor and ambient air in areas that are above groundwater or LNAPL contamination. Contamination was generally delineated on site. When this was not possible for groundwater, contamination was characterized as much as possible. Future Act 2 deliverables will assess groundwater fate and transport. LNAPL was also delineated when possible or characterized as immobile, which means that it is not moving.

Several upcoming Act 2 documents will evaluate conditions sitewide. Using computer simulations, a sitewide groundwater fate and transport model will show groundwater flow and chemical movement across the Site. After approval of all of the RIRs, Evergreen will also prepare and submit a human health risk assessment. It will consider people who could potentially be exposed to chemicals on site or off site, as well as the pathways these chemicals could take and the potential risk of exposure to these chemicals. Evergreen will also prepare an ecological risk assessment that applies to the entire Site and focuses on ecological receptors (such as birds, plants and fish). These documents, combined with the individual AOI RIRs, will inform the selection of the final cleanup plan for the Site.

Through the Act 2 process, the public has the right to participate and comment on Act 2 submittals and the cleanup plan. There are currently several ways for the public to provide comments, including through the website, via email and in person during public meetings. As the process continues, there will be additional opportunities for public involvement.

The community has expressed concerns about air quality near the Site. The review of the RIRs did not identify ambient air quality issues. However, emissions from the facility when it was active were not evaluated. The facility is currently inactive, so facility emissions that could affect local air quality no longer exist. There is a risk of vapor intrusion from shallow groundwater contamination that may extend off site. The upcoming groundwater fate and transport and human health risk assessment should evaluate any potential for vapor intrusion off site.

The characterization activities took place before the June 2019 explosion and facility shutdown. Due to the possible changed site conditions resulting from the explosion, the community may want to inquire if additional investigation activities are planned to evaluate possible changes to site conditions.

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Appendix A: RIR Review – AOIs 1, 2, 3, 5, 6, 7, 8 and 10

AOI 1 – No. 1 Tank Farm and No. 2 Tank Farm

Overview

AOI 1 covers about 67 acres on the eastern bank of the Schuylkill River along 26th Street (Figure A-1). In the 2016 RIR, the AOI consisted of 35 aboveground storage tanks, which had been used to store various petroleum products. Soil, groundwater and air samples were collected as part of the remedial investigation. PADEP and EPA reviewed the 2016 RIR for AOI 1. PADEP approved it in November 2016.

Two cleanup systems operate in AOI 1. The 26th Street North Remediation System pumps groundwater and LNAPL from 15 wells. The Packer Avenue and 26th Street Ventilation System and Biofilter System pulls and treats vapors from the sewers.



Figure A-1. AOI 1 (Source: Evergreen)

Findings

Overall findings of the AOI RIR for soil, groundwater, air and LNAPL are provided below.

Evergreen sampled AOI 1 soils in 2013 and 2015 for the RIR. The goal of sampling soil at AOI 1 was to characterize soil in potential source areas, including former tank areas and historic release areas. Soil samples were collected throughout AOI 1 at two depth ranges (surface from 0 to 2 feet deep, and subsurface from 2 to 15 feet deep). The RIR included the findings listed below:

- Lead and 1,2,4-trimethylbenzene were found above their standards in surface soil.
- All other COCs were below their standards including subsurface soil.
- Lead and 1,2,4-trimethylbenzene were delineated horizontally and vertically within AOI 1.
- Soil from locations that were above the lead and 1,2,4-trimethylbenzene standards will need further evaluation or remediation.

Groundwater occurs in two zones under AOI 1, the shallow water table aquifer and the lower aquifer. AOI 1 RIR findings for groundwater include:

- In the shallow water table aquifer, several contaminants were found above the Act 2 standards, including benzene, 1,2-dichloroethane, ethylbenzene, ethylene dibromide, MTBE, toluene, 1,2,4 trimethylbenzene, 1,3,5-trimethylbenzene, xylenes, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, naphthalene and lead.
- Groundwater in the shallow water table aquifer flows toward the 26th Street Intercepting Sewer and the Pollock Street/Packer Avenue Sewer.
- Benzene and MTBE, the most widespread and consistent shallow groundwater contaminants, extend east of AOI 1 to the 26th Street Intercepting Sewer.
- The intercepting sewer is likely receiving contaminated shallow groundwater. Evergreen considers the sewer the boundary for shallow groundwater contamination east of AOI 1.
- Benzene and MTBE were also found off site, east of the AOI, beyond the remediation system at 26th Street.
 - The RIR indicated several possible reasons, including LNAPL or groundwater migration or contamination from nearby facilities.
- A groundwater flow model is being developed to evaluate the fate and transport of contaminants in groundwater under AOI 1. Monitoring along the eastern boundary will continue.
- Benzene, MTBE and lead were found above standards in the lower aquifer under AOI 1. Groundwater contaminants, especially benzene and MTBE, could migrate off site and affect the water supply for New Jersey.

Indoor and outdoor air samples were collected near a previously-occupied building. Concentrations were below the PADEP IASHS screening levels. Benzene was found in ambient area and indoor air higher than the EPA regional screening level. 1,2,4-Trimethylbenzene was also found higher than the EPA regional screening level.

LNAPL was found under AOI 1 and subdivided into eight bodies or areas. The RIR found that most of the LNAPL appeared to be left over from historical petroleum hydrocarbon releases. Along the eastern boundary, a small area of LNAPL was found extending across 26th Street. This area will continue to be monitored for potential movement off site. The RIR also indicated a potential need for a vapor intrusion evaluation above the LNAPL areas at AOI 1.

AOI 2 – Point Breeze Processing Area

Overview

Area 2 covers about 111 acres on the east side of the Schuylkill River, west of AOI 1. At the time of the 2017 RIR, the area consisted of a pier along the western boundary, office buildings and paved parking areas. A sheet pile bulkhead separates AOI 2 from the river. Soil, groundwater and air samples were collected as part of the remedial investigation. The 2017 RIR includes results from sampling between 2010 and 2016. PADEP approved the RIR in October 2017.

Findings

From 2010 to 2016, over 70 surface soil samples were collected from AOI 2. Soil samples were collected from distinct areas of AOI 2, including areas around active and closed-in-place tanks. Between 2013 and 2016, about 60 subsurface soil samples were collected from between 2 feet deep and the water table.

Overall AOI 2 RIR conclusions for soil include:

- Benzo(a)pyrene and lead were above standards at four locations. Two of these locations were tank areas.
- No other contaminants were above standards in surface soil.
- No subsurface soil samples were above standards.



Figure A-2. AOI 2 (Source: Evergreen)

There are 107 wells to monitor the shallow water table aquifer and four wells to monitor the lower aquifer in AOI 2. Groundwater samples were collected in 2010, 2013 and 2016. The AOI 2 RIR presented the following conclusions for groundwater:

- Except for a few contaminants (1,2-dichloroethane, 1,3,5-trimethylbenzene, cumene, toluene, xylenes, fluorene and phenanthrene), all site contaminants were above standards in the shallow water table aquifer.
- No site contaminants were above standards in the lower aquifer during recent 2016 sampling events.

Based on several factors, including flow and concentration trends, the RIR indicates that groundwater contamination is delineated to the north, east and south. Groundwater contamination in the western part of AOI 2 is characterized but not delineated. It is possible that groundwater contamination is controlled by the active remedial systems. Release of contaminated groundwater to the river might also be prevented by a sheet pile wall, but details on the sheet pile wall were not available. The fate and transport of groundwater in AOI 2 and an evaluation of surface water will be provided in a future Act 2 report.

In 2012, 14 indoor air samples were collected from buildings in AOI 2. One outdoor air sample was collected near four buildings outside the Point Breeze Gate Area. In 2016, six indoor air samples and one outdoor air sample were collected. Outdoor work air sampling was also done to assess potential exposure for people working near LNAPL or dissolved groundwater contamination areas. Results were below standards. Some results were above the IASHS screening levels and EPA regional screening levels. All buildings are vacant because the facility is closed. Vapor intrusion into indoor air will be studied further as part of an upcoming sitewide human health risk assessment. Concentrations in outdoor air were below the screening levels for all contaminants.

There is LNAPL in AOI 2. Most of the LNAPL is near the remedial systems. It is being actively controlled and removed. Monitoring wells were installed between a vertical wall and the river. LNAPL was not found in these wells, indicating that LNAPL has not moved past the vertical wall. Based on the findings of the RIR, LNAPL does not appear to be moving off site or to be a source of groundwater contamination.

AOI 3 – Point Breeze North Yard

Overview

Area 3 covers about 107 acres on the east side of the Schuylkill River. The river is the northwestern border of AOI 3. Also known as the Impoundment Area, AOI 3 is within the historical Point Breeze South Yard. Historically, AOI 3 consisted of a tank farm (six aboveground storage tanks), an unlined stormwater pond, capped past disposal areas, and former ballfields used for waste disposal. Initial site characterization took place in 2010. The 2010 Site Characterization Report/RIR summarized the results. Based on the findings, additional characterization work took place from 2013 to 2016. The 2017 RIR includes the 2010, 2013 and 2016 investigation results. PADEP approved the RIR in June 2017. Soil, groundwater and air samples were collected and studied as part of the remedial investigation.

Findings

From 2010 to 2016, 53 surface soil samples were collected throughout AOI 3. From 2013 to 2015, 32 subsurface soil samples were collected. Overall RIR conclusions for soil include:

- Lead was found at concentrations greater than the site-specific standard in four surface soil locations.
- All four areas above the standard were delineated.
- In subsurface soil, no contaminants were above standards.

Groundwater monitoring took place in 2010, 2013, 2015 and 2016. Groundwater under AOI 3 occurs in a perched, isolated shallow zone above the shallow water table aquifer and the lower aquifer. Overall RIR conclusions for groundwater included:

- Sampling found contaminants above standards in the perched, water table and lower aquifers of AOI 3.
 - Perched Aquifer: 1,2-Dibromoethane, benzene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,hi,)perylene, chrysene, lead, MTBE and toluene.
 - Water Table Aquifer: 1,2,4-Trimethylbenzene, ethylene dibromide, benzene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,hi,)perylene, chrysene, lead, MTBE, naphthalene and toluene.



Figure A-3. AOI 3 (Source: Evergreen)

- Lower Aquifer: Lead, benzene and MTBE
- Contaminants in AOI 3 groundwater are not expected to be above standards at the boundary. However, benzene appears to be increasing in the water table and lower aquifers, moving toward the middle of AOI 3, and further affecting the lower aquifer.
- A planned sitewide fate and transport Act 2 deliverable will evaluate the fate and transport of contaminated groundwater across the entire Site.

Nine indoor air samples and one outdoor air sample were collected in 2016. Outdoor air worker sampling was also done. During air sampling, no concentrations were found above PADEP IASHS screening levels. However, benzene and ethylbenzene were above other screening levels, including EPA’s regional screening level. A human health risk assessment will evaluate indoor and outdoor air quality across the Site.

During groundwater monitoring, LNAPL was found in several wells; samples were collected where measurable (greater than 0.01 feet) LNAPL was found. AOI 3 LNAPL was delineated. The RIR found that LNAPL was likely not moving or affecting groundwater quality.

AOI 5 – Girard Point South Tank Field Area

Overview

Area 5 covers about 114 acres on the east bank of the Schuylkill River and is the southernmost area of the Site. AOI 5, commonly known as the Girard Point South Tank Field Area, has historically consisted of aboveground storage tanks holding various types of oil, packaging facilities, transfer facilities, a marine unloading/loading facility, and three solid waste management units (SWMUs). A sheet pile bulkhead extends along the river at the southern AOI 5 boundary.

An “SWMU” is a place where solid or hazardous wastes are placed at any time, or where wastes have been routinely and systematically released.

Initial site characterization activities took place in 2007. A site characterization report summarized them. Additional activities took place in 2009. A second report summarized them. Based on these two reports, additional studies took place in 2013 and 2016. They form the basis for the 2017 RIR. PADEP approved the RIR in May 2017. Soil, groundwater and air samples were collected as part of the remedial investigation.



Figure A-4. AOI 5 (Source: Evergreen)

Findings

Fifty-two surface soil samples were collected from 2007 to 2014. Between 2012 and 2014, 22 subsurface soil samples were collected to vertically delineate previously-identified contamination. Other surface and subsurface samples were collected during supplemental tank investigations. Overall conclusions for soil include:

- Outside of the SWMUs, surface and subsurface soil samples had contaminants above the standards. Most of these samples were in the eastern tank farm area.
- Lead and benzo(a)pyrene were above standards in surface soil.
- Benzene and cumene were above standards in subsurface soil.
- All soil areas were delineated.
- Lead was the only contaminant above the standard in the SWMUs. These areas were delineated.

Groundwater monitoring took place in 2007, 2011 and from 2014 to 2016. Lower aquifer wells were sampled in 2007. They were not sampled during the 2014-to-2016 sampling. Groundwater in AOI 5 flows south and southwest toward the river. 1,2,4-Trimethylbenzene, benzene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, lead and pyrene were above their standards. While some contaminants were above standards near the

river, the sheet pile wall stops contaminated groundwater from flowing into the river. Groundwater COCs are delineated within the boundary of the Site.

In 2012, one indoor and one outdoor air sample were collected. In 2016, six indoor air and one outdoor air sample were collected. Outdoor worker air sampling took place based on PADEP vapor intrusion guidance for areas near LNAPL or shallow groundwater contamination. As in other areas, no contaminants were found in indoor air above the PADEP IASHS screening levels. Benzene concentrations in indoor and outdoor air samples were above EPA regional screening levels. A human health risk assessment will evaluate indoor and outdoor air quality across the Site.

Groundwater monitoring found LNAPL in several wells. Samples were collected where there was measurable (greater than 0.01 feet) LNAPL. LNAPL was delineated in AOI 5. The RIR found that LNAPL was not likely moving or affecting groundwater quality. In addition, signs of LNAPL have not been seen on the river side of the sheet pile bulkhead.

AOI 6 – Girard Point Chemicals Processing Area

Overview

AOI 6, also known as the Girard Point Chemicals Processing Area, covers 100 acres on the east side of the Schuylkill River. A sheet pile wall runs along the western boundary of AOI 6. Historically, AOI 6 consisted of aboveground tanks holding chemicals such as benzene, toluene and other fuel stocks. AOI 6 also included processing and treating units. In 2017, AOI 6 included 16 routinely-occupied or potentially-occupied buildings.

There are two leached-tank SWMUs in AOI 6. AOI 6 also has an LNAPL recovery system, the 27 Pump House Total Fluids Recovery System. This system started operating in 2001, changed from active to passive in 2010, and stopped operating in 2015. Initial AOI 6 studies took place for the 2006 and 2013 site characterization reports. Additional studies took place in 2016 and 2017 for the 2017 RIR. The RIR came out in 2017 and PADEP approved it in February 2018. Soil, groundwater and air samples were collected and evaluated for the remedial investigation.



Figure A-5. AOI 6 (Source: Evergreen)

Findings

Fifty-seven soil borings were taken from 2006 to 2012. Soil sampling in 2016 and 2017 focused on areas with contaminants above standards. Soil sampling in AOI 6 generally focused on areas with known releases or on tank areas. Surface soil samples had concentrations above the standard for benzo(a)pyrene, lead and benzene. Subsurface soil samples had concentrations above the

Soil boring is a way to collect soil samples from under the surface using a drill rig.

benzene standard. Most areas have been delineated, but additional samples are planned in one area to further delineate benzene (subsurface sample number AOI 6-16-025). This sample is located in the center of AOI 6.

Groundwater monitoring was done in May and August 2016. Benzene, isopropyl benzene, 1,2-dibromoethane, toluene, 1,2,4-trimethylbenzene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)pyrene, benzo(b)fluoranthene, chrysene, naphthalene and lead were above their respective standards. However, these contaminants have generally been delineated. Benzene was the most widespread contaminant. Some areas near the sheet pile wall had groundwater above standards and had LNAPL, but delineation in this area is not possible because of the bulkhead. The areas near the bulkhead will be evaluated in the upcoming sitewide fate and transport report.

In 2011, a sheen (shiny substance near the water surface) was seen on the Schuylkill River. The source of the sheen was a part of the sewer system. Repairs were completed and an extraction system with an oil/water separator recovered the LNAPL. Operation of this system is ongoing. Work has been done to characterize AOI 7 since at least 2010, when Evergreen submitted the first site characterization report. Evergreen submitted a second site characterization report in 2012. The 2017 RIR presents studies done since the 2012 report. PADEP approved the RIR in August 2017. Soil, groundwater and air samples were collected and evaluated as part of the remedial investigation.

Findings

Soil samples focused on tank areas, areas of known releases, and other potential source areas. Benzo(a)pyrene was the only contaminant above its standard in surface soil; it was only found in one surface soil sample. This sample was delineated. All other surface and subsurface soil samples were below standards.

| |
|---|
| A source area is a place where contaminants were released to the environment. |
|---|

Groundwater sampling took place in May, July/August and August/September 2016. Benzene, isopropyl benzene, 1,2-dibromoethane, toluene, 1,2,4-trimethylbenzene, xylenes, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)pyrene, benzo(b)fluoranthene, chrysene, naphthalene and lead were above their standards in the AOI 7 water table aquifer. No contaminants were above standards in the lower aquifer. Groundwater will be further evaluated in a future Act 2 deliverable.

Indoor and outdoor air were sampled in the eight occupied buildings; no samples were above PADEP or EPA screening levels. In 2016, two air samples were collected over the LNAPL area in AOI 7. The results were compared to ambient air quality in the area as well as EPA's indoor air background concentrations for residential use. The results were similar to background levels for this area and below EPA's background indoor air concentrations for residential use.

Many monitoring wells across AOI 7 have measurable amounts of LNAPL. LNAPL was found near the river bulkhead. This LNAPL was delineated as much as possible. However, its location near the bulkhead made delineation hard. Sheening of the river has been seen there. Recovery of LNAPL in the northwest part of AOI 7 is ongoing.

AOI 8 – Point Breeze Refinery North Yard

Overview

AOI 8 covers about 250 acres on the northern end of the Site, on the east bank of the Schuylkill River. AOI 8 was home to the former Point Breeze Refinery. Historically, various industrial processing units associated with crude oil refining operated in AOI 8. During operations, this area had several aboveground storage tanks, processing areas, a land treatment unit, various plants and one SWMU. AOI 8 has hardened shoreline consisting of steel and wooden bulkheads. These bulkheads are probably from the late 1800s or early 1900s. AOI 8 also contains sewers, which cross the area and carry stormwater and sewage. Site characterization activities at AOI 8 have been done since 2008. Evergreen submitted a site characterization report in 2008 and 2012. Additional studies took place in 2016 and 2017 to support the RIR. The RIR came out in 2017 and PADEP approved it in March 2018. Soil, groundwater and air samples were collected and evaluated as part of the remedial investigation.

Findings

Based on sampling from 2008 to 2017, soil contamination is widespread in AOI 8. Lead, benzo(a)pyrene and benzo(b)fluoranthene were found in surface soils above standards. These areas have been delineated horizontally to the north and east, but delineation to the west was not possible because soil contamination extended right up to the Schuylkill River. Vertically, there no were contaminants above the standards below 2 feet.



Figure A-7. AOI 8 (Source: Evergreen)

There are 127 wells in the AOI 8 area. Almost all contaminants were above their standards in the water table and lower aquifer, but benzene was the most widespread. A fate and transport model was developed for AOI 8 as part of the RIR. The model showed three general areas of benzene contamination: the southern border, the northern portion and the western portion (near the bulkhead) of the AOI. The southern and northern benzene contamination areas may be migrating from AOI 1 or other off-site activities. The western contamination appears to be from AOI 8. Benzene and lead concentrations in the lower aquifer were above standards.

The RIR concluded that groundwater is moving into the Jackson Street and Mifflin Street sewers. Groundwater may also be able to move into the Rambo Creek Sewer.

Several contaminants were found above standards in the lower aquifer. Contamination in the lower aquifer is not completely delineated and some contaminants, such as benzene, could migrate off site. AOI 11 and the sitewide fate and transport report will further evaluate deep groundwater.

Vapor intrusion was studied in and near all buildings with people in them during the investigation activities. Indoor, outdoor and sub-slab air was not above EPA regional screening levels, except for one soil gas sample above the benzene screening level. Evergreen runs the Jackson Street Water Curtain to prevent vapor intrusion.

LNAPL is present under AOI 8 in 17 areas. The most notable LNAPL areas are in the benzene contamination areas described above. The RIR reported that LNAPL was delineated during the remedial investigation process and does not appear to be moving or affecting groundwater quality.

AOI 10 – Point Breeze West Yard

Overview

AOI 10, also known as the Point Breeze West Yard, covers about 80 acres on the west side of the Schuylkill River. Lands Creek crosses the southern part of AOI 10. There are four past disposal areas in AOI 10, including former lagoons and landfills. All four areas have been capped. Together, they are called the corrective action management unit or CAMU. Historically, AOI 10 also contained a tank area and two fuel docks. The facilities were all demolished in 2005.

Site characterization activities took place in 2011. The RIR came out in 2011 and PADEP approved it in January 2012. Soil, groundwater, surface water and sediment were collected and evaluated as part of the remedial investigation.



Figure A-8. AOI 10 (Source: Evergreen)

Findings

Forty-five soil samples were collected within AOI 10 but outside the CAMU areas. There were nine soil borings in CAMU areas; the borings were from 20 to 30 feet deep. Surface soil concentrations of benzene, benzo(a)pyrene, tetrachloroethene, arsenic, manganese and lead were above standards; lead and benzo(a)pyrene were not delineated as of the 2011 RIR. Subsurface soil samples were collected only around the perimeter of the CAMU areas. Several contaminants, including benzene, benzo(a)pyrene, naphthalene, arsenic, barium, cobalt, lead, manganese, mercury, nickel and thallium were above standards in the waste material and underlying soil in the CAMU. The RIR indicated that this contamination did not appear to be migrating to groundwater.

Groundwater sampling took place in April 2011. Groundwater contamination, including benzene, was found in eight AOI 10 wells. Modeling predicted that groundwater would not migrate past the boundary except for benzene in well W-33, which modeling found could reach Lands Creek.

Because there are no occupied buildings in AOI 10, soil sample results were used to evaluate the risk of vapor intrusion using PADEP guidance. Based on this evaluation, there were no concentrations above the EPA or OSHA screening values for non-residential use.

LNAPL was found in three AOI 10 wells. The remedial investigation concluded that LNAPL is not moving and is not affecting groundwater quality.

Surface water samples were collected from Lands Creek. Results were compared to PADEP screening criteria for fish and aquatic life. No concentrations were above the screening criteria. In a 2016 response, PADEP requested the use of human health criteria for fish consumption as a standard.

Sediment samples were also collected from Lands Creek. Results were compared to EPA Region 3 sediment and surface water benchmarks. Concentrations of volatiles and metals were found above the benchmarks. Lands Creek is fenced and within the limits of AOI 10, so there is no human contact with sediment.