



pennsylvania

DEPARTMENT OF ENVIRONMENTAL PROTECTION

SOUTHEAST REGIONAL OFFICE

MEMO

TO Ragesh R. Patel, Regional Manager, Environmental Cleanup and Brownfields *rel*

FROM Richard M. Staron, LPG *RMS*

THROUGH C. David Brown, LPG Manager *CD3*

DATE March 22, 2018

RE ECB – Land Recycling Program
Act 2 Technical Memo Summary
Sunoco Philadelphia Refinery AOI-8
Remedial Investigation Report
eFACTS PF No. 749898
3144 Passyunk Avenue
City of Philadelphia
Philadelphia County

Property Owner Name and Address:

Owner	Remediator	Site
Philadelphia Energy Solutions Refining and Marketing LLC 3144 W. Passyunk Ave. Philadelphia, PA 19145	Evergreen Resources Management Operations 2 Righter Parkway, Suite 200 Wilmington, DE 19803	3144 W. Passyunk Ave. Philadelphia, PA 19145

Act 2 Standard(s) Sought:

Combination of site specific standards via pathway elimination and Statewide health standards for the crude oil shortlist (presented later in this memo).

Property Size:

250 acres

Project Site History:

The Area of Interest 8 (AOI8) is located along the eastern bank of Schuylkill River in south Philadelphia. AOI8 is also referred to as the Point Breeze Refinery North Yard. It is part of the

greater 1,400-acre PES Complex located along the banks of the Schuylkill River in south Philadelphia. The shoreline along the Schuylkill River has been hardened and consists of several steel and wood bulkheads. Sufficed to say, the area surrounding and including AOI8 has been used for refining and/or other industrial purposes since the latter half of the 19th century. Components of AOI8 were operational as late as 2009 (No. 22 Boiler House). Most refining ceased during the 1990's. AOI8 was predominantly used for the refining of crude oil throughout most of its history. The Storage Tank Act of 1989 post-dates the occurrence of most of the known/unknown incidents that have occurred at the facility. Therefore, the incidents of this area have been amalgamated to facilitate a comprehensive environmental characterization.

AOI8 is bisected to the north and south by an active CSX railway. Northern AOI8 contained several petroleum related ASTs associated with the Point Breeze No.3 Tank Farm. Currently 7 tanks operate in this area including tanks 663 (frac bottoms), 668 (wash oil), 672 (gas oil), M-12 (water), RM-39 (butane) and RM-41(butane). Southern AOI8 generally operated plants that produced petroleum byproducts such as paraffin wax and asphalt among other industrial substances.

It should also be noted that there were five storage tank incidents previously investigated and closed at this facility (51-19781) including Incident Nos. 5912, 31920, 34422, 45965 and 46786.

Site Findings:

Soil:

There several areas of concern within the greater AOI8. Characterization sampling for the AOI8 has been occurring since 2004. Soils have been delineated in several areas across AOI-8. Swaths of contaminated soil are found across the entire site, except for the above referenced storage tank incidents. It is not feasible to associate the delineation of any one incident as they have likely compiled and overlapped each other in the 120+ years that the refinery has been active. Much of the property is covered by anthropogenic fill. Some of these fill areas measure as much as 50 feet deep. As a result, some the metal and semivolatile contamination may not be a result of releases from refinery related activities. Much of south Philadelphia is covered in similarly contaminated fills. It is difficult to delineate semivolatiles and metals at the AOI-8 for this reason.

A total of 194 soil sample locations for all incidents associated with AOI8 were advanced to delineate soil contamination. Rationales for sample locations are discussed in detail in the report. These rationales include geologic characterization, storage tank incident characterization, historic incident COC characterization and specific compound delineation. A total of 169 samples have been collected in the AOI8 to delineate the 0-2-foot interval for the purposes of delineating the shallow direct contact standards. A total of 94 Samples were collected from deeper than two feet. Most of these were collected between 4-8 feet. However, several samples were collected as deep as 14-15 feet for COC characterization.

Soil to groundwater MSCs are exceeded for several compounds across the site. The following data illustrate the number of exceedances of the PADEP Soil to Groundwater NR SHS.

Volatile Organic Compounds:

benzene – 27 occurrences; maximum exceedance 26 mg/kg
naphthalene – 5 occurrences; maximum exceedance 53 mg/kg
ethylbenzene – 1 occurrence; maximum exceedance 343 mg/kg
total xylenes - 1 occurrence; maximum exceedance 1540 mg/kg
1,2,4-trimethylbenzene 2 occurrences; maximum exceedance 58.7 mg/kg

Semivolatile Organic Compounds:

benzo(a)pyrene 8 occurrences; maximum exceedance 37,000 mg/kg
benzo(b)fluoranthene 1 occurrence; maximum exceedance 80 mg/kg

Metals:

Lead – 36 occurrences; maximum exceedance of 3,890 mg/kg
Nickel- 1 occurrence; maximum exceedance 897 mg/kg

There were no exceedances of direct contact standards greater than two feet reported. The following data illustrate the number of exceedances of the PADEP Direct Contact (0-2 ft.) NR SHS. A site-specific lead Direct Contact standard of 2,240 mg/kg in the 0-2-foot interval has been previously established for the entire Philadelphia Refinery Complex and was approved by the Department.

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Lead – 5 occurrences; maximum exceedance of 3,890 mg/kg

Soil in AOI8 has been well delineated to the north and eastern property boundaries. It is bordered by the Philadelphia Gas Works Property to the south. None of the samples collected along this property boundary have been found in exceedance of a SHS. However, soil contamination is in fact found all the way to the Schuylkill River where it is bounded by the hard shore bulkhead.

Groundwater:

The subsurface hydrogeology has been extensively studied at the Philadelphia Refinery Complex. The AOI8 represents a fraction of this study area. There are 127 wells in the AOI-8 available for conducting a groundwater study. The subsurface at the site is complex. Two confining clay units have been identified at depth at the facility: a 2-foot upper clay unit (~10 to 35 ft. bgs to the top of the unit) and an 8-foot middle clay unit (approximately 30-45 ft. bgs to the top of the unit). The upper clay unit divides the aquifer beneath the site into an unconfined aquifer and a lower aquifer. Twenty-two wells are screened in the confined unit between the two clay units in in the upper sand unit. The remainder of the wells are screened in either modern fill materials and Pleistocene alluvium.

Unconfined aquifer

The average thickness of the water table aquifer is 5 to 30 feet. Field derived parameters have been developed. K values have been measured between 1 ft/d to 250 ft/day. Permeabilities range from 10^{-7} to 10^{-8} cm/s F_{oc} ranges between 0.8% to 4%. Effective porosities range between 15% to 30%. These values will be used in the development of a comprehensive groundwater model. The groundwater contours are very consistent across several rounds of gauging. Due to the inconsistent Pleistocene alluvium, two areas of perched water have been observed. Given the size of the site there are several areas of divergent groundwater flow. Overall groundwater at the site flows towards the southeast in the southern portion of the site. The remainder of the site groundwater generally flows west towards the Schuylkill River. However, there is significant variability in groundwater flow locally across the site. Likewise, groundwater depths vary significantly between approximately 10-50 feet bgs depending on varying elevations at the site and underground utilities which both greatly affect local groundwater flow. Among the utilities impacting groundwater are the Jackson Street sewer, Mifflin Street sewer, Rambo Creek sewer, and the deep Passyunk sewer. Hydraulic gradients are generally shallow at the site and measure between 0.0006 ft/ft to 0.02 ft/ft.

The lower aquifer is typically confined in PRM lower and middle sand units. Along the Schuylkill River the lower semi-confined aquifer occurs in Pleistocene alluvium where the lower clay aquitard is absent. The middle clay unit creates the sole confining unit at this location. The thickness of the lower confined unit across the site varies generally between 10-50 ft in thickness. Bedrock beneath the unconsolidated materials dips generally to the southeast. However, it also dips drastically towards the Schuylkill River. This causes the unconsolidated materials to thicken in those directions. Bedrock measures anywhere between 30 to 100 ft. bgs at the site. K values measure approximately 34 ft/day and 850 ft/day. F_{oc} ranges approximately 0.6%. Groundwater in the lower aquifer generally flows from the north in a radial pattern. The predominant flow is towards the Schuylkill River. The lower aquifer experiences diurnal tidal influences, usually less than a foot in elevation. Hydraulic head gradients usually measure between 0.002 ft and 0.006 ft/ft.

Vertical head potentials between the unconfined aquifer and lower aquifer usually show a downward flowing aquifer which becomes more prominent near the Schuylkill River. This would also help explain why the lower aquifer is more influenced by tides than the unconfined aquifer.

Two rounds of sampling were performed in conjunction with this RIR. The following compounds were found above SHS:

unconfined aquifer

1,2,4-TMB, 1,3,5-TMB, 2-methylnaphthalene, anthracene, benzene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, BEHP, chrysene, cobalt, ethylbenzene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, lead, naphthalene, nickel, pyrene, toluene, vanadium, and zinc.

lower aquifer

benzene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, BEHP, chrysene, dibenz(a,h)anthracene, naphthalene.

A qualitative fate and transport model was developed for the AOI8 as a more robust model is in development for the greater Philadelphia Refining Complex. Benzene will be used to approximate the contaminant plume due to its solubility and for other regulatory reasons. The fate and transport model for all the above listed compounds was developed solely on the characteristics of benzene and the measured field parameters. Furthermore, benzene concentrations have been found to be stable at the site.

The qualitative model for the AOI8 shows three general areas of benzene contamination at the site.

- The PGW border the south of the site.
- Northern portion of AOI8 near the Verizon SDWC property.
- The western portion of the site near the Schuylkill River bulk head.

The benzene plume near the PGW is evidently, in part, coming from AO-1 and the PGW facility. However it is likely that historical sources of benzene are also present on the AOI8 property associated with this plume. The groundwater flow at this point of the property doesn't exactly match this hypothesis. However, given the very large scale of the site, there must be more to groundwater transport in the unconfined aquifer than what can be visualized with groundwater contour maps. The highest concentrations in this area appear in the northern portion of AOI1. Those concentrations decline as they cross the PGW property and continue to decline onto the southern portion of AOI8.

The Northern portion of the property has its own isolated benzene plume which is characterized offsite to the Verizon SDWC property to the north. Offsite activities to the north may have also contributed to this area of groundwater contamination. The plume will need continued monitoring.

Contamination in the western portion of the site seems to be exclusively from AOI8. The contamination stems from the former Asphalt Plant, Acid Plant, and Wax Plant areas near the Schuylkill River. The unconfined unit appears to be contaminated right up to the river. A risk assessment will be performed in a future Act 2 deliverable to evaluate ecological conditions at the site.

Both benzene and lead in the lower aquifer have not been contoured as the spacing of the wells is too broad to make an accurate contour. The lower aquifer will be modelled with a MODFLOW model in the future to determine the fate and transport of contamination from the greater Philadelphia Refining Complex. Benzene has not been observed at concentrations at similar concentrations as the unconfined aquifer. The highest concentration of benzene over the two characterization rounds appeared in the northern portion of the property near the property boundary with the Verizon SDWC at concentrations of 546 µg/l. Lead contamination has also historically been found at the highest concentrations in the northern portion of the property at concentrations in the 100's of µg/l. This area will also require continued monitoring. Lead was not sampled for in the characterization sampling for this report.

LNAPL has been delineated well at the site. There are seventeen individual areas of LNAPL release and are broken out in the following contaminates:

heavy distillates:	8
heavy/middle distillates:	4
middle distillates:	1
light/heavy distillates:	1
light/middle distillates:	2
light distillates:	1

The areas are presented in Figure 6-1 of the report. The LNAPL plumes cover 10's of acres at the AOI8 site. The three most notable areas where LNAPL is observed are straddling the southern property boundary adjacent to the PGW facility. LNAPL reaches more than 6 feet in thickness in this area. Another area of concern is the two NAPL plumes that are observed adjacent to the Schuylkill River bulkhead on the western portion of the property. In this portion of the property LNAPL is observed greater than 0.5 feet in thickness. Finally, the northern portion of the site near the Verizon SDWC property is another area of where several grades of LNAPL are found straddling the property boundary. Product thickness in this vicinity reaches as much as 2 feet in thickness. Central to the property another large LNAPL plume exists with product as thick as 2 feet. Recovery wells are not currently in operation. This will be a remedy discussed in future Act 2 submittals.

Vapor Intrusion:

Vapor intrusion evaluation was performed for all occupied buildings at the site. Samples were screened against appropriate EPA RSLs for their respective sample types which included indoor air, sub-slab, soil gas, and ambient air samples. The following locations were sampled:

AOI 8 occupied buildings: 2012 through 2017 - sub-slab and ambient air
Philadelphia Fire Department building: 2009 - sub-slab and ambient air
Verizon SDWC Property: 2011 through 2017- sub-slab, ambient air, and soil gas
Jackson Street Sewer: 2009 indoor air

2016-217 investigation:

Although in 2013 there were exceedances of contaminants of indoor and ambient air samples, none of the 2016-2017 collected within AOI8 and the Verizon SDWC property exceeded EPA RSLs.

None of the sub-slab air samples collected at the Verizon SDWC property exceeded any EPA RSLs after applying attenuation factors.

Previous investigations:

In 2009, soil gas sample was collected on the Philadelphia Fire Department building that exceed EPA RSLs. However concurrent indoor and ambient air samples within the building passed EPA

RSLs. This was based only on one round of sampling. More data will be collected and reported in a future Act-2 submittal.

VI conclusion: Two rounds of samples were collected for all areas of concern spread out over many years. The exception to this would be the firehouse which was only sampled once. Even though the recent sampling has shown that EPA RSLs have not been exceeded, the pathway is still assumed to be potentially complete. Pathways will need to be eliminated to attain closure at the site. It is understood that additional indoor air samples will be collected and submitted in future Act 2 deliverables.

A PNDI survey was performed on October 31, 2016 which showed potential impact to endangered species. PADNCR responded to the PNDI on November 4, 2016, indicating that no impact to endangered species was expected. However, the PAFBC commented on November 28, 2016 that portions of AOI8 may serve as potential habitat for Eastern Redbelly Turtles. A comprehensive ecological risk assessment will have to be developed to evaluate potential threats to these turtles and other impacted habitats at the site. This risk assessment is expected in a future Act 2 deliverable.

Site Cleanup History:

During the 1980s, a Land Treatment Unit was operated in the Northern AOI8 until 2000. Furthermore, a leaded sludge weathering pad was operated under RCRA between until circa 1990.

A Solid Waste Management Unit (SWMU2) was operated in the southern AOI8 between the 1950's and the 1970's. This SWMU2 was closed by RCRA in 2016.

Several Remediation systems exist at the property including the Jackson Street Water Curtain. This system is operational and designed to minimize vapor intrusion risks associated with onsite plumes. The PGW Border System, North Yard Bulkhead System, and the Jackson Street fluid recovery system component were no currently. They were used to collect product found in the environment. Information is available in Appendix L of the report. However, remediation systems will be discussed in further detail in future Act 2 deliverables.

Discussion of Cleanup Involved and Demonstration of Attainment:

Evergreen proposes to attain a combination of nonresidential Statewide health standards and site specific standards for groundwater via pathway elimination for all the above listed compounds.

Evergreen proposes to attain a combination of nonresidential Statewide health standards and site specific standards for soil via pathway elimination for all the above listed compounds. Lead is evaluated using a risk derived 2,240 mg/kg site specific standard.

VI standards will be compared to appropriate NR EPA RSLs for all the above listed VOCs.

The maintenance of eliminated pathways and/or remediation will be discussed in a future Act-2 deliverable.

The following represents a list of all compounds associated with the crude oil shortlist being considered in the Act 2 process for this site:

VOCs	DC 0-2' (mg/kg)	DC 2-15' (mg/kg)	Soil-GW (mg/kg)	GW (µg/L)
Benzene	290	330	0.5	5
Butylbenzene, sec-	10,000	10,000	2,800	12,000
Butylbenzene, tert-	10,000	10,000	2,200	12,000
Cumene	10,000	10,000	2,500	3,500
Cyclohexane	10,000	10,000	6,900	53,000
Ethylbenzene	890	1,000	70	700
Hexane	10,000	10,000	5,600	6,200
Pyridine	3,200	10,000	12	120
Toluene	10,000	10,000	100	1,000
Trimethylbenzene, 1,2,4-	560	640	35	62
Trimethylbenzene, 1,3,5-	10,000	10,000	210	1,200
Xylenes	8,000	9,100	1,000	10,000
Xylenes	8,000	9,100	1,000	10,000
Metals	DC 0-2' (mg/kg)	DC 2-15' (mg/kg)	Soil-GW (mg/kg)	GW (µg/L)
Cobalt	960	190,000	160	35
Nickel	64,000	190,000	650	100
Vanadium	220	190,000	820	8.2
Zinc	190,000	190,000	12,000	2,000
SVOCs	DC 0-2' (mg/kg)	DC 2-15' (mg/kg)	Soil-GW (mg/kg)	GW (µg/L)
Acenaphthene	190,000	190,000	4,700	3,800
Anthracene	190,000	190,000	350	66
Benzo(a)anthracene	130	190,000	430	4.9
Benzo(a)pyrene	12	190,000	46	0.2
Benzo(b)fluoranthene	76	190,000	170	1.2
Benzo(g,h,i)perylene	190,000	190,000	180	0.26
Benzo(k)fluoranthene	76	190,000	610	0.55
Biphenyl, 1,1-	11,000	190,000	190	430
Bis(2-ethylhexyl) phthalate	6,500	10,000	130	6
Chrysene	760	190,000	230	1.9
Cresol, m- (3-methylphenol)	10,000	10,000	580	5,800
Cresol, o- (2-methylphenol)	160,000	190,000	580	5,800
Cresol, p- (4-methylphenol)	16,000	190,000	58	580
Dibenzo(a,h)anthracene	22	190,000	270	0.6
Dibutyl phthalate, n-	10,000	10,000	4,900	12,000
Diethyl phthalate	10,000	10,000	9,300	93,000
Dimethylphenol, 2,4-	10,000	10,000	230	2,300
Dinitrophenol, 2,4-	6,400	190,000	23	230
Fluoranthene	130,000	190,000	3,200	260
Fluorene	130,000	190,000	3,800	1,900
Indeno(1,2,3-cd)pyrene	76	190,000	22,000	2.8
Methylnaphthalene, 2-	13,000	190,000	1,900	470
Naphthalene	760	190,000	25	100
Nitrophenol, 4-	26,000	190,000	6	60
Phenanthrene	190,000	190,000	10,000	1,100
Phenol	16,000	18,000	200	2,000
Pyrene	96,000	190,000	2,200	130
Quinoline	30	10,000	0.37	1.1

DEP Final Action Approval/Disapproval Letter:

The December 21, 2017 Remedial Investigation Report is recommended for approval.

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