

Human Health Risk Assessment

UDEX Feed Underground Line Release

Former PES Refinery
3144 West Passyunk Avenue
Philadelphia, Pennsylvania
PADEP Facility ID No. 780190

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Acronyms / Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient Water Quality Criteria
BDH	Bellwether District Holdings, LLC
BTAG	Biological Technical Assistance Group
CA	Chemical Concentration in Air
CalEPA	California Environmental Protection Agency
CCC	Criteria Continuous Concentration
CDI	Chronic Daily Intake
CFS	Cubic Feet Per Second
CMC	Criteria Maximum Concentration
COPC	Chemical of Potential Concern
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
DF	Dilution Factor
EC	Exposure Concentration
EPC	Exposure Point Concentration
FCR	Fish Consumption Rate
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IR	Intake Rate
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk
LOAEL	Lowest Observed Adverse Effect Level
LNAPL	Light Non-Aqueous Phase Liquid
ORNL	Oak Ridge National Laboratory
MDC	Maximum Detected Concentration
NCI	National Cancer Institute
NOAEL	No Observed Adverse Effect Level
O&M	Operation and Maintenance
OSWER	Office of Solid Waste and Emergency Response
PAH	Polynuclear Aromatic Hydrocarbon
PES	Philadelphia Energy Solutions
PESRM	Philadelphia Energy Solutions Refining and Marketing
PPRTV	Provisional Peer Reviewed Toxicity Value
Q _R	River Flow rate
Q _{GW}	Groundwater Flow Rate
RAGS	Risk Assessment Guidance for Superfund
RAIS	Risk Assessment Information System
RfC	Reference Concentration
RfD	Reference Dose
RSC	Relative Source Contribution
RSL	Regional Screening Level
SDS	Safety Data Sheet
SEER	Surveillance Epidemiology and End Results
SF	Slope Factor



Human Health Risk Assessment

Acronyms / Abbreviations

SVOC
TCL
USEPA
VOC
7Q10

Semi-Volatile Organic Compound
Target Compound List
United States Environmental Protection Agency
Volatile Organic Compound
Lowest 7-Day Average Flow That Occurs Once Every 10 Years



1 Introduction

On behalf of Bellwether District Holdings, LLC (BDH), Stantec Consulting Services Inc. (Stantec) has prepared this Human Health Risk Assessment (HHRA) to evaluate potential human exposures to chemical contaminants in environmental media resulting from an underground petroleum release that occurred from an UDEX feed line (UDEX release) at the former Philadelphia Energy Solutions (PES) Refinery (hereafter referred to as the Site) located at 3144 West Passyunk Avenue, Philadelphia, Pennsylvania. The purpose of this HHRA is to determine if Site-related chemical constituents in environmental media (subsurface soil, groundwater, and subsequent transport to surface water) at the Site may pose unacceptable risks to people who work at the Site or use the adjacent Schuylkill River for recreation now and in the future. The HHRA is an integral component of the overall risk assessment and risk management process for the Site and follows the submission of the Remedial Investigation Report (UDEX RIR) (Stantec, 2025a) which presents the characterization data for the release.

1.1 Facility Description

The former PES Refinery facility is an approximately 1,300-acre property located in south Philadelphia (**Figure 1-1**). The portion of the facility on the east side of the Schuylkill River is currently being redeveloped as a multimodal industrial park with ancillary rail infrastructure, energy infrastructure, marine capabilities, and commercial uses (e-commerce, life sciences, and logistics). The UDEX release is located within the redevelopment area in the south yard of the (now former) Point Breeze Refinery Impoundment Area. The portion of the former facility where the UDEX release is located is owned by BDH (formerly Philadelphia Energy Solutions Refining & Marketing LLC [PESRM]). The UDEX release is also within the bounds of the Evergreen Resources Group, LLC (Evergreen)¹ Area of Interest (AOI) 3. Historical operations and investigations that occurred in this area unrelated to the UDEX release were previously described in Evergreen's *Area of Interest 3 Remedial Investigation Report* (Langan, 2017) which was approved by the Pennsylvania Department of Environmental Protection (PADEP) on June 14, 2017.

¹ Evergreen Resources Management Operations, a series of Evergreen Resources Group, LLC, is managing the legacy remedial work for Philadelphia Refinery Operations, a series of Evergreen Resources Group, LLC ("Evergreen") and Sunoco (R&M), LLC. For clarity, Sunoco, Inc. n/k/a ETC Sunoco Holdings LLC, Sunoco, Inc. (R&M) f/k/a Sunoco (R&M), LLC n/k/a Energy Transfer (R&M), LLC effective 4/19/2021 and Evergreen shall be referred to collectively as "Evergreen" in this Report.



1.2 Facility Operational and Regulatory History

The former PES Refinery ceased operations in 2019. Up until that point, the facility and its predecessor, the former Philadelphia Refinery, operated nearly continuously for over 100 years as a crude oil refinery. A brief timeline for the ownership and regulatory history relevant to the UDEX release is as follows:

- 2012: The former Philadelphia Refinery was transferred from Sunoco to PESRM and became known as the PES Refining Complex during the time that it was operated by PESRM.
- 2019: PESRM announced the closure of the former PES Refinery. All refinery operations ceased at this time.
- 2020: PESRM (now known as BDH) was purchased through a bankruptcy sale by HRP Philadelphia Holdings, LLC in June 2020.

Remediation activities are being conducted at the facility by both BDH, formerly PESRM, and Evergreen in accordance with the 2012 Consent Order & Agreement (CO&A) and the 2020 CO&A Amendment. In accordance with the CO&A, Sunoco/Evergreen is responsible for addressing Pre-Existing Contamination, and BDH is responsible for addressing Post-September 2012 Contamination.

1.3 Relevant Guidance and Policies

The HHRA for the Site was conducted in accordance with guidance set forth in the *Site-Specific Human Health Risk Assessment Guidance* as described in 25 PA Code §250.602 (c) (PA Act 2) and Risk Assessment Guidance for Superfund (RAGS), Volume I: Parts A, B, E, and F (USEPA, 1989, 1991a, 1991b, 2004, and 2009).

The methods and structure of the HHRA are consistent with US EPA RAGS and associated technical documents and reports. The receptors and pathways of exposure evaluated are based on site-specific conditions and characteristics of the UDEX release; and supports receptor-specific assessment of risk.

1.4 Organization of the Risk Assessment Report

This HHRA report is organized into the following major chapters:

- **Chapter 2 Environmental Data Used in the HHRA** – describes the database assessed in the HHRA and the identification of Constituents of Potential Concern (COPCs) quantitatively assessed in the HHRA.
- **Chapter 3 Exposure Assessment** – describes the Conceptual Site Model (CSM) for the Site, the receptors and pathways of exposure, the calculation of exposure point concentrations, and the methods used to quantify exposures.



- **Chapter 4 Toxicity Assessment** – discusses the carcinogenic and non-carcinogenic toxicity factors for the identified COPCs.
- **Chapter 5 Risk Characterization** – presents the methods used to quantify cancer risks and non-cancer hazards.
- **Chapter 6 Presentation and Discussion of Results** – presents the estimated cancer risks and non-cancer hazards for receptors identified at the Site.
- **Chapter 7 Uncertainties in the Human Health Risk Assessment** – describes the uncertainties in the estimated cancer risks and non-cancer hazards.
- **Chapter 8 Summary and Conclusions** – presents a summary of the methodologies used to assess human health risks/hazards and the results and conclusions of the HHRA
- **Chapter 9 References** – presents the references used in the HHRA.



2 Environmental Data Used in the HHRA

In the summer of 2018, Stantec performed a routine annual, sitewide well gauging event for the facility on behalf of Evergreen. During review and analysis of the gauging data, Stantec noted a first occurrence of apparent LNAPL in monitoring well S-414 and increased apparent LNAPL thicknesses (ANT) in wells S-283 and S-382, where LNAPL was first observed in 2017 and 2016, respectively. Stantec's field technician confirmed the gauging observations, and the findings were reported to Evergreen. Evergreen notified PESRM of the findings and on July 19, 2018, Stantec collected LNAPL samples from wells S-283, S-382, and S-414 in the presence of PES and Evergreen personnel. Stantec shipped the LNAPL samples to a contract laboratory for characterization on behalf of Evergreen, and duplicate LNAPL samples were provided to the onsite PES laboratory for analysis and fingerprinting to known products and refinery intermediates.

The PES laboratory indicated that the LNAPL was a refinery intermediate called reformat. Stantec's contracted laboratory provided a basic interpretation which indicated that the LNAPL collected from wells S-382 and S-414 was a light petroleum distillate of unknown weathering degree, and the LNAPL collected from well S-283 was chemically similar to the samples collected from wells S-382 and S-414 but also contained a relatively smaller amount of extremely weathered middle petroleum distillate. During late July 2018, PES identified the underground portion of a product line that conveyed reformat through the release area (a feed from an UDEX unit) and emptied, isolated, and bypassed that section of underground pipe. PES retained Stantec to assist on the project through characterization and initiation of remediation of the LNAPL present in the subsurface near the UDEX feed underground line release area.

In August 2018, Stantec began conducting remediation activities on behalf of PESRM in the UDEX release area. Stantec commenced passive LNAPL recovery in late August 2018. Active LNAPL recovery efforts were initiated in early November 2018. From the start of remediation in 2018 through November 2021 recovery efforts included the continued operation and maintenance (O&M) of pneumatic LNAPL skimming systems in three wells, and manual bailing/pumping of LNAPL from additional wells in the vicinity of the skimming wells. Approximately 96,228 gallons of LNAPL were recovered by these systems. Soil vapor extraction (2021) and later air sparge (2024) were initiated and operated through 2025. The soil vapor extraction/air sparge remediation period accounted for the vapor recovery equivalent of approximately 196,053 gallons of LNAPL bringing the total recovery for the remediation program to approximately 292,662 gallons through June 13, 2025.

The environmental media that form the basis of this HHRA consist of groundwater samples collected from monitoring wells located within the UDEX release area. Stantec put forth a concerted effort to include as many sample points/wells as possible to establish the conservative initial conditions for the UDEX release fate and transport assessment. This included a combination of data from all BDH monitoring wells plus a selection of Evergreen wells either impacted by the UDEX release, or adjacent to the release with non-detect results for benzene and toluene, thereby informing its delineation. Based on the estimated timing of the UDEX release and on the available groundwater sampling dataset, Stantec concluded that the initial



concentrations of benzene and toluene were the maximum concentrations from groundwater samples collected between February 2019 and January 2025 with the following exception: any well with post-2024 analytical data availability would have the maximum COPC concentrations selected from the period between January 2024 and January 2025. The resulting maximum contaminant concentration datasets formed the basis for the initial concentration data for the unconfined and lower aquifers, summarized in **Table 9-3** of the Remedial Investigation Report (RIR) (Stantec, 2025b). The locations of the groundwater monitoring wells used to characterize groundwater in the area of the UDEX release are presented in **Figure 2-1**.

2.1 Identification of COPCs

Through chemical fingerprinting and operational knowledge, the product released from the underground UDEX conveyance line is understood to be reformat, a highly volatile gasoline feedstock enriched in benzene and toluene. The constituents of potential concern (COPCs) for human health in groundwater are therefore limited to benzene and toluene as these two compounds are known constituents of reformat (see additionally PESRM safety data sheet [SDS] in **Appendix A**) and have been detected at elevated concentrations in the release area. Elevated detections of other volatile organic compounds (VOCs), semi-volatile compounds (SVOCs), or metals that have been confirmed to exist in soil and/or groundwater in proximity to the release generally predate the UDEX release and cannot be attributed to it; such legacy impacts have been characterized and are being addressed in Act 2 reporting completed by the former PES Refinery's previous owner/operator (prior to 2012), Philadelphia Refinery Operations, a series of Evergreen Resources Group, LLC (Evergreen; formerly Sunoco) (see **Appendix C**).

Based on this information, benzene and toluene are the sole COPCs for the Site and are the chemicals that are quantitatively assessed in the HHRA.



3 Exposure Assessment

The evaluation of potential risks from contact with contaminants in the environment hinges on the concept of completed pathways of exposure. Exposure pathways describe the ways by which a chemical (or physical or biological) agent can move from a source to a receptor (USEPA, 1989). Exposure means direct physical contact between the receptor (person) and the environmental media (e.g. surface water) that contains the chemical(s). Four elements must be present for an exposure pathway to be complete:

1. A source of the contaminant and a mechanism by which the chemical(s) is released into the environment;
2. Mechanisms by which the chemical or the environmental media containing the chemical(s) can be transported to locations where receptors are located;
3. A point or points of contact where the receptors and the environmental media containing the chemical(s) are both present at the same time; and
4. A route or routes of exposure by which the receptor gets the environmental media containing the chemical(s) into his or her body (e.g. ingestion, inhalation, dermal contact with absorption through the skin).

If any of these elements is absent, the pathway is not complete, and the person does not take the chemical into their body. Even if all the requirements are satisfied for a complete pathway of exposure, the amount of the chemical (the dose) that gets into the person's body must be sufficient to cause an adverse effect or increase the chances of an adverse effect occurring above levels of concern.

The exposure assessment for the Site has the following elements: development of a conceptual site model (CSM), identification and description of representative human receptors, calculation of exposure point concentrations (EPCs), and quantitative estimates of receptor daily intake of COPCs sometimes referred to as daily dose.

3.1 Conceptual Site Model for the HHRA

The Conceptual Site Model (CSM) developed for the HHRA reflects the relationship between the physical layout of the Site, the activity patterns of representative receptors (people) in the vicinity of the Site, and the possible ways they could come into contact with chemical constituents at the Site. The CSM for the HHRA is an analysis and representation of the physical pathways by which COPCs move from source(s) to locations where people (receptors) may come into direct physical contact with the media containing those chemicals through inhalation, ingestion, and skin contact (dermal contact or absorption through skin). The CSM is a tool to organize data gathering prior to initiating an investigation and to communicate the findings.

Pathways and routes of exposure are depicted on the CSM for each of the receptors evaluated in the HHRA. Pathways are identified as potentially complete or incomplete.



Potentially Complete Pathways of Exposure: There is reasonable evidence to suggest that the receptor comes into direct physical contact with the media containing the COPCs and internalizes a dose. Complete pathways of exposure are evaluated quantitatively in the HHRA.

Incomplete Pathways of Exposure: There is evidence to suggest that the receptor is unlikely to come in direct physical contact with the media containing the COPCs. Incomplete exposure pathways are not evaluated quantitatively in the HHRA.

The HHRA CSM is presented in **Figure 3-1**. Receptors and potential pathways of exposures for the UDEX Feed Underground Line Release are described in the following subsections.

3.2 Receptors and Pathways of Exposure

The receptors that are quantitatively evaluated in the HHRA for the UDEX Feed Underground Line Release are adults and children using the Schuylkill River adjacent to the Site for recreational purposes. Other potential exposures related to the UDEX Feed Underground Line Release have been determined to be incomplete, as shown in **Table 3-1**.

Assumptions related to potential human exposures are summarized below:

- The UDEX release area occupies approximately 8.4 acres of the former PES Refinery Point Breeze South Yard.
- BDH is responsible for overall security and oversight of contractor safety, and BDH implements personal protective equipment (PPE) and safety protocols that mitigate the potential for worker exposure to impacted subsurface soil, soil vapors, groundwater, and/or LNAPL through the direct contact pathway. As part of the 2020 Buyer-Seller Amendment BDH is obligated to “develop and implement a health and safety plan (HASP) to protect employees, on-site workers, and other persons visiting the Property (including, but not limited to, construction workers) from any contaminants they might encounter on the Property.” This obligation includes any future excavation work in the UDEX release area.
- There are no expected surface soil impacts from the UDEX release because the release occurred from a subsurface pipe located approximately 4 to 5 feet below grade. As such, there is no surface soil contamination related to the UDEX release, and there are no potential exposures to contaminated surface soil related to the UDEX release.
- Future redevelopment plans for the area include asphalt parking, roadways, and a slab on grade warehouse structure. There are currently no buildings above the UDEX release impacts. Per the 2020 Soil Management Plan, any future building will be required to have vapor barriers or a mitigation system which eliminates the potential for vapor intrusion from the UDEX release impacts that remain in the subsurface after redevelopment. No subsurface preferential pathways that could potentially allow for migration of vapors exist in the UDEX release area. Therefore, indoor air inhalation exposures are incomplete. Alternatively, the plan allows for BDH to “conduct sampling and analysis to demonstrate that such controls are not needed to mitigate potential vapor intrusion into such buildings or structures in accordance with PADEP guidance.”
- Benzene and toluene are the COPCs quantitatively evaluated.



- Surface water concentrations of benzene and toluene in the Schuylkill River are estimated through numerical groundwater modeling and analytical surface water modeling.
- As outlined in the numerical modeling in the UDEX RIR, groundwater does not migrate offsite except for the Schuylkill River.
- Outdoor air COPC concentrations resulting from volatilization from groundwater or subsurface soil to ambient air are assumed to be insignificant. The mass flux of volatile organic compounds from subsurface soil and/or groundwater into outdoor air is insignificant in the context of the instantaneous volumetric mixing that occurs. After mixing with ambient air, the concentrations of volatile organic compounds from subsurface soil and/or groundwater at breathing height are expected to be insignificant. As such, regulatory agencies do not have standardized methods for quantifying these potential exposures. Therefore, outdoor inhalation exposures are not quantified in this assessment.
- Onsite groundwater is not currently and will not be used for potable or non-potable purposes. Therefore, no direct exposures to onsite groundwater are quantified.
- Potential human health risk posed by fish ingestion is assessed via comparison of modeled surface water concentrations to the U.S. Environmental Protection Agency's (USEPA) ambient water quality criteria (AWQC) based on fish ingestion.
- Surface water ingestion and dermal absorption are assessed via standard recreational exposure methodologies.

The medium containing COPCs in the Schuylkill River is surface water. Recreators are assumed to have direct contact with COPCs through incidental ingestion of COPCs in surface water and dermal absorption of COPCs in surface water. Potential exposures to COPCs in the Schuylkill River via ingestion of recreationally caught fish are assessed through the comparison of surface water concentrations of COPCs in the Schuylkill River to applicable AWQC based on fish ingestion.

It should be noted that even though adult and child recreators are expected to be present in the Schuylkill River near the Site, an individual may not have actual physical contact with surface water or ingest fish due to the nature of their specific activities. Therefore, the assumptions about frequency and duration of exposure are protective, and more likely to overestimate rather than underestimate exposure.

3.3 Exposure Point Concentrations

The exposure point concentration (EPC) is the concentration of a COPC that could be contacted by a receptor over the exposure period (USEPA, 1989). The EPCs for surface water in the Schuylkill River are derived from fate and transport modeling of COPCs in groundwater with subsequent seepage and mixing in the Schuylkill River.

3.3.1 Groundwater Fate and Transport

The groundwater fate and transport assessment completed for the UDEX release RIR (Stantec, 2025b) included the application of an existing numerical groundwater flow model (GWF Model) developed by



Stantec (2025a) for the facility on behalf of Evergreen. Prior to using the GWF Model as a tool to simulate the fate and transport of UDEX release COPECs (i.e., benzene and toluene) in groundwater, the numerical model performance was validated against site-specific UDEX release data. After making small adjustments to the GWF Model in support of the calibration, it was coupled with a transport model to perform predictive simulations for benzene and toluene over a 30-year period (2025-2055) based on a conservative set of plume conditions where maximum initial concentrations from groundwater sampling and continuous, decaying sources were applied. The benzene transport simulation predicted that the dissolved benzene plume is present beyond the Schuylkill River bank to the northwest and forms a comparatively small seepage face where diffuse discharges to surface water may be occurring. In this area, the benzene mass discharge is predicted to peak in simulation year 28. The benzene plume then gradually decreases over time through natural attenuation and Natural Source Zone Depletion (NSZD) processes. The model results are interpreted to represent current conditions regarding plume extent that may be over-represented based on model construction and conservative input conditions. The toluene transport simulation indicated that the toluene plume gradually decreases in size and magnitude over time and does not reach the Schuylkill River at concentrations above the groundwater MSC. The groundwater transport model was used to estimate mass discharges to surface water which were applied in the PADEP Toxics Management Spreadsheet (TMS) surface water model to evaluate attainment of applicable surface water standards or other selected screening criteria. Surface water modeling supports the conclusion that the predicted levels of COPECs in the Schuylkill River are likely to be far below the published standards or screening criteria. Using the predictive simulation results, the maximum benzene and toluene groundwater concentrations resulting from the UDEX release numerical modeling are simulated to reach the river in year 28 at 3,288 micrograms per liter ($\mu\text{g/L}$) and 0.1 ($\mu\text{g/L}$), respectively.

A complex groundwater flow pattern exists in the UDEX release area. The mechanisms driving the pattern of water-table flow include topography, river tides, bulkheads, perched groundwater areas to the west, and likely interactions with deeper water-bearing layers. To the north, the water table surface generally mirrors the historical topography whereby there is an overall southerly flow from areas of higher topography. West of Schuylkill Avenue (River Road), groundwater perching in areas of fill behind the river bulkhead causes a small increase in hydraulic heads in neighboring wells screened along the edge of the Pleistocene terrace. In between these features, there is a small area of open river bank (near well S-430) where groundwater is inferred to seep into the Schuylkill River. Central to the UDEX release, most notably at well S-439, water-table groundwater elevations are anomalously low and create a convergent flow pattern.

3.3.2 Dilution Modeling

In order to estimate the concentrations of COPCs in Schuylkill River surface water a groundwater-to-surface water dilution factor was estimated. The groundwater flux at the seepage face from the groundwater flow model is 22.4 gallons per day, which equates to 0.000035 cubic feet per second (cfs). The lowest 7-day average flow that occurs (on average) once every ten years (7Q10) for the Schuylkill River at Philadelphia is 125 cfs (Baird, 2024). The dilution of groundwater discharging to the Schuylkill River is calculated as follows:



$$DF = (Q_R + Q_{GW}) \div Q_{GW}$$

Where:

DF	=	Dilution factor
Q _R	=	Schuylkill River flow rate (cfs)
Q _{GW}	=	Groundwater flow rate (cfs)

For the UDEX feed underground release, this equation yields a dilution factor of 3.57E+06. The maximum benzene concentration at the riverbed simulated seep is 3,288 µg/L and the maximum toluene concentration at the riverbed simulated seep is 0.1 µg/L. Applying the dilution factor calculated above, the maximum estimated concentrations of benzene and toluene in the Schuylkill River resulting from the UDEX release are 9.2E-04 µg/L and 2.8E-08 µg/L, respectively.

3.3.3 Schuylkill River Surface Water Sampling

Surface water sampling in the Schuylkill River was conducted in June/July 2024 for the purpose of characterizing surface water conditions adjacent to the former Philadelphia refinery in support of an Evergreen screening level ecological risk assessment (SLERA). Although these surface water samples were collected for the purpose of characterizing the Schuylkill River for use in an Evergreen SLERA, these surface water data are equally suitable for characterization of surface water conditions in the Schuylkill River applicable to human exposures. Twenty-nine surface water samples were collected from locations adjacent to and in the near vicinity of the former refinery from approximately mid-depth of the water column. Surface water sampling at locations adjacent to the Site were conducted within a four-hour period around low tide to bias sampling toward the time periods when modeling (Stantec, 2025b) has shown groundwater seeps are most likely to be active.

Surface water samples were analyzed for the following:

- Evergreen Petroleum Short List compounds: VOCs, SVOCs, lead (total and dissolved)
- Target Compound List (TCL) Polycyclic Aromatic Hydrocarbons (PAHs)
- Hardness
- Salinity

The analytical results of the Schuylkill River surface water samples showed that benzene was detected in 1 out of 29 samples at a concentration of 1.6 µg/L. Benzene was not detected in the other 28 surface water samples from the Schuylkill River both upstream and downstream of the UDEX release area. Toluene was not detected in any of the surface water samples from the Schuylkill River.



3.4 Quantification of Exposure

USEPA risk assessment algorithms are used to estimate receptor daily intake of COPCs from each complete pathway of exposure (USEPA, 1989; 2011; 2014a; and 2017a). Chronic daily intake (CDI) is derived from the EPC for each COPC and is expressed in units of milligrams of chemical per kilogram of body weight per day (mg/kg-day).

The HHRA assessed the recreational exposure scenario as described by the Oak Ridge National Laboratory (ORNL) Risk Assessment Information System (RAIS) online Risk Calculator. Output from the RAIS risk calculator is presented in **Appendix B. Table 3-2** summarizes the exposure parameters used in the quantification of exposures for the recreator which are embedded in the RAIS calculator.

3.4.1 Incidental Ingestion of Surface Water

Chronic daily intake (CDI) of COPCs from incidental ingestion of surface water are estimated using the following equations from the RAIS online calculator (USEPA, 2025):

Child Non-Carcinogenic Ingestion:

$$CDI_{\text{rec-wat-ingnc}} \left(\frac{\text{mg}}{\text{kg-day}} \right) = \frac{C_{\text{water}} \left(\frac{\mu\text{g}}{\text{L}} \right) \times \left(\frac{\text{mg}}{1000 \mu\text{g}} \right) \times EF_{\text{rec-c}} \left(\frac{45 \text{ days}}{\text{yr}} \right) \times ED_{\text{rec-c}} (6 \text{ yr}) \times ET_{\text{rec-c}} \left(\frac{1 \text{ hrs}}{\text{day}} \right) \times IRW_{\text{rec-c}} \left(\frac{0.12 \text{ L}}{\text{hr}} \right)}{AT_{\text{rec-c}} \left(\frac{365 \text{ days}}{\text{yr}} \times ED_{\text{rec-c}} (6 \text{ yr}) \right) \times BW_{\text{rec-c}} (15 \text{ kg})}$$

Where:

$CDI_{\text{rec-wat-ingnc}}$	=	Chronic Daily Intake of surface water for recreator from incidental ingestion – child, non-carcinogenic (mg/kg/day)
C_{water}	=	Water concentration (µg/L)
$EF_{\text{rec-c}}$	=	Exposure Frequency - child (days/year)
$ED_{\text{rec-c}}$	=	Exposure Duration – child (years)
$ET_{\text{event-rec-c}}$	=	Exposure Time – child (hours/event)
$IRW_{\text{rec-c}}$	=	Ingestion Rate of water – child (Liters/hour)
$AT_{\text{rec-c}}$	=	Averaging Time – child (days/year)
$BW_{\text{rec-c}}$	=	Body Weight – child (kg)

Adult Non-Carcinogenic Ingestion:



Human Health Risk Assessment
Exposure Assessment

$$CDI_{\text{rec-wat-ingna}} \left(\frac{\text{mg}}{\text{kg} \cdot \text{day}} \right) = \frac{C_{\text{water}} \left(\frac{\mu\text{g}}{\text{L}} \right) \times \left(\frac{\text{mg}}{1000 \mu\text{g}} \right) \times EF_{\text{rec-a}} \left(\frac{45 \text{ days}}{\text{yr}} \right) \times ED_{\text{rec}} (26 \text{ yr}) \times ET_{\text{rec-a}} \left(\frac{1 \text{ hrs}}{\text{day}} \right) \times IRW_{\text{rec-a}} \left(\frac{0.11 \text{ L}}{\text{hr}} \right)}{AT_{\text{rec-a}} \left(\frac{365 \text{ days}}{\text{yr}} \times ED_{\text{rec}} (26 \text{ yr}) \right) \times BW_{\text{rec-a}} (80 \text{ kg})}$$

Where:

- $CDI_{\text{rec-wat-ingna}}$ = Chronic Daily Intake of surface water for recreator from incidental ingestion - adult, non-carcinogenic (mg/kg/day)
- C_{water} = Water concentration ($\mu\text{g/L}$)
- $EF_{\text{rec-a}}$ = Exposure Frequency - adult (days/year)
- $ED_{\text{rec-a}}$ = Exposure Duration – adult (years)
- $ET_{\text{rec-a}}$ = Exposure Time – adult (hours/event)
- $IRW_{\text{rec-a}}$ = Ingestion Rate of water – adult (Liters/hour)
- $AT_{\text{rec-a}}$ = Averaging Time – adult (days/year)
- $BW_{\text{rec-a}}$ = Body Weight – adult (kg)

Age-Adjusted Non-Carcinogenic Ingestion:

$$CDI_{\text{rec-wat-ingnadj}} \left(\frac{\text{mg}}{\text{kg} \cdot \text{day}} \right) = \frac{C_{\text{water}} \left(\frac{\mu\text{g}}{\text{L}} \right) \times \left(\frac{\text{mg}}{1000 \mu\text{g}} \right) \times IFW_{\text{rec-adj}} \left(\frac{3.4 \text{ L}}{\text{kg}} \right)}{AT_{\text{rec-a}} \left(\frac{365 \text{ days}}{\text{yr}} \times ED_{\text{rec}} (26 \text{ yr}) \right)}$$

where:

$$IFW_{\text{rec-adj}} \left(\frac{3.4 \text{ L}}{\text{kg}} \right) = \left[\frac{EF_{\text{rec-c}} \left(\frac{45 \text{ days}}{\text{yr}} \right) \times ED_{\text{rec-c}} (6 \text{ yr}) \times EV_{\text{rec-c}} \left(\frac{1 \text{ event}}{\text{day}} \right) \times ET_{\text{event-rec-c}} \left(\frac{1 \text{ hrs}}{\text{event}} \right) \times IRW_{\text{rec-c}} \left(\frac{0.12 \text{ L}}{\text{hr}} \right)}{BW_{\text{rec-c}} (15 \text{ kg})} + \frac{EF_{\text{rec-a}} \left(\frac{45 \text{ days}}{\text{yr}} \right) \times ED_{\text{rec-a}} (20 \text{ yr}) \times EV_{\text{rec-a}} \left(\frac{1 \text{ event}}{\text{day}} \right) \times ET_{\text{event-rec-a}} \left(\frac{1 \text{ hrs}}{\text{event}} \right) \times IRW_{\text{rec-a}} \left(\frac{0.11 \text{ L}}{\text{hr}} \right)}{BW_{\text{rec-a}} (80 \text{ kg})} \right]$$

Where:

- $CDI_{\text{rec-wat-ingnadj}}$ = Chronic daily intake of surface water for recreator from incidental ingestion – age-adjusted (mg/kg/day)
- C_{water} = Water concentration ($\mu\text{g/L}$)
- $IFW_{\text{rec-adj}}$ = Age-adjusted ingestion rate (Liters/kg)



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AT_{rec-a}	=	Averaging Time (days/year)
ED_{rec}	=	Exposure Duration (years)
EF_{rec-c}	=	Exposure Frequency - child (days/year)
ED_{rec-c}	=	Exposure Duration – child (years)
EV_{rec-c}	=	Events – child (events/day)
$ET_{event-rec-c}$	=	Exposure Time – child (hours/event)
IRW_{rec-c}	=	Ingestion Rate of water – child (Liters/hour)
BW_{rec-c}	=	Body Weight – child (kg)
EF_{rec-a}	=	Exposure Frequency - adult (days/year)
ED_{rec-a}	=	Exposure Duration – adult (years)
EV_{rec-a}	=	Events – adult (events/day)
$ET_{event-rec-a}$	=	Exposure Time – adult (hours/event)
IRW_{rec-a}	=	Ingestion Rate of water – adult (Liters/hour)
BW_{rec-a}	=	Body Weight – adult (kg)

Carcinogenic Ingestion:

$$CDI_{rec-wat-ingc} \left(\frac{mg}{kg-day} \right) = \frac{C_{water} \left(\frac{\mu g}{L} \right) \times \left(\frac{mg}{1000 \mu g} \right) \times IFW_{rec-adj} \left(\frac{3.4 L}{kg} \right)}{AT_{rec} \left(\frac{365 \text{ days}}{yr} \times LT(70 \text{ yrs}) \right)}$$

where:

$$IFW_{rec-adj} \left(\frac{3.4 L}{kg} \right) = \left[\frac{EF_{rec-c} \left(\frac{45 \text{ days}}{yr} \right) \times ED_{rec-c} (6 \text{ yr}) \times EV_{rec-c} \left(\frac{1 \text{ event}}{\text{day}} \right) \times ET_{event-rec-c} \left(\frac{1 \text{ hrs}}{\text{event}} \right) \times IRW_{rec-c} \left(\frac{0.12 L}{hr} \right)}{BW_{rec-c} (15 \text{ kg})} + \frac{EF_{rec-a} \left(\frac{45 \text{ days}}{yr} \right) \times ED_{rec-a} (20 \text{ yr}) \times EV_{rec-a} \left(\frac{1 \text{ event}}{\text{day}} \right) \times ET_{event-rec-a} \left(\frac{1 \text{ hrs}}{\text{event}} \right) \times IRW_{rec-a} \left(\frac{0.11 L}{hr} \right)}{BW_{rec-a} (80 \text{ kg})} \right]$$

Where:

$CDI_{rec-wat-ingc}$ = Chronic Daily Intake of surface water for recreator from incidental ingestion, carcinogenic (mg/kg/day)



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C_{water}	=	Water concentration ($\mu\text{g/L}$)
$IFW_{\text{rec-adj}}$	=	Age-adjusted ingestion rate (Liters/kg)
$EF_{\text{rec-c}}$	=	Exposure Frequency - child (days/year)
$ED_{\text{rec-c}}$	=	Exposure Duration – child (years)
$EV_{\text{rec-c}}$	=	Events – child (events/day)
$ET_{\text{event-rec-c}}$	=	Exposure Time – child (hours/event)
$IRW_{\text{rec-c}}$	=	Ingestion Rate of water – child (Liters/hour)
AT_{rec}	=	Averaging Time (days/year)
LT	=	Lifetime (years)
$BW_{\text{rec-c}}$	=	Body Weight – child (kg)
$EF_{\text{rec-a}}$	=	Exposure Frequency - adult (days/year)
$ED_{\text{rec-a}}$	=	Exposure Duration – adult (years)
$EV_{\text{rec-a}}$	=	Events – adult (events/day)
$ET_{\text{event-rec-a}}$	=	Exposure Time – adult (hours/event)
$IRW_{\text{rec-a}}$	=	Ingestion Rate of water – adult (Liters/hour)
$BW_{\text{rec-a}}$	=	Body Weight – adult (kg)

3.4.2 Dermal Contact with Surface Water

The CDI from dermal contact with COPCs in solid material and subsequent absorption into the bloodstream are estimated using the following equation for dermal exposure to soils (USEPA, 2004):

Child Non-Carcinogenic Dermal Contact:



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$$CDI_{\text{rec-wat-dermc}} \left(\frac{\text{mg}}{\text{kg-day}} \right) = \frac{DA_{\text{event}} \left(\frac{\mu\text{g}}{\text{cm}^2\text{-event}} \right) \times \left(\frac{\text{mg}}{1000 \mu\text{g}} \right) \times EF_{\text{rec-c}} \left(\frac{45 \text{ days}}{\text{yr}} \right) \times ED_{\text{rec-c}} (6 \text{ yr}) \times EV_{\text{rec-c}} \left(\frac{1 \text{ event}}{\text{day}} \right) \times SA_{\text{rec-c}} (6,365 \text{ cm}^2)}{AT_{\text{rec-c}} \left(\frac{365 \text{ days}}{\text{yr}} \right) \times ED_{\text{rec-c}} (6 \text{ yr}) \times BW_{\text{rec-c}} (15 \text{ kg})}$$

where:

For Inorganics:

$$DA_{\text{event}} \left(\frac{\mu\text{g}}{\text{cm}^2\text{-event}} \right) = C_{\text{water}} \left(\frac{\mu\text{g}}{\text{L}} \right) \times \left(\frac{\text{L}}{1000 \text{ cm}^3} \right) \times K_p \left(\frac{\text{cm}}{\text{hr}} \right) \times ET_{\text{event-rec-c}} \left(\frac{1 \text{ hrs}}{\text{event}} \right)$$

For Organics:

IF $ET_{\text{event-rec-c}} \left(\frac{1 \text{ hrs}}{\text{event}} \right) \leq t^*$ (hrs), then:

$$DA_{\text{event}} \left(\frac{\mu\text{g}}{\text{cm}^2\text{-event}} \right) = C_{\text{water}} \left(\frac{\mu\text{g}}{\text{L}} \right) \times \left(\frac{\text{L}}{1000 \text{ cm}^3} \right) \times 2 \times FA \times K_p \left(\frac{\text{cm}}{\text{hr}} \right) \times \sqrt{\frac{6 \times \tau_{\text{event}} \left(\frac{\text{hrs}}{\text{event}} \right) \times ET_{\text{event-rec-c}} \left(\frac{1 \text{ hrs}}{\text{event}} \right)}{\pi}}$$

or:

IF $ET_{\text{event-rec-c}} \left(\frac{1 \text{ hrs}}{\text{event}} \right) > t^*$ (hrs), then:

$$DA_{\text{event}} \left(\frac{\mu\text{g}}{\text{cm}^2\text{-event}} \right) = C_{\text{water}} \left(\frac{\mu\text{g}}{\text{L}} \right) \times \left(\frac{\text{L}}{1000 \text{ cm}^3} \right) \times FA \times K_p \left(\frac{\text{cm}}{\text{hr}} \right) \times \left[\frac{ET_{\text{event-rec-c}} \left(\frac{1 \text{ hrs}}{\text{event}} \right)}{1 + B} + 2 \times \tau_{\text{event}} \left(\frac{\text{hrs}}{\text{event}} \right) \times \left(\frac{1 + 3B + 3B^2}{(1 + B)^2} \right) \right]$$

Where:

- $CDI_{\text{rec-wat-dermc}}$ = Chronic Daily Intake of surface water for recreator from dermal contact – child, noncarcinogenic (mg/kg/day)
- C_{water} = Concentration in water (µg/L)
- DA_{event} = Dermal absorption (µg/cm²-event)
- $EF_{\text{rec-c}}$ = Exposure Frequency – child (days/year)
- $ED_{\text{rec-c}}$ = Exposure Duration – child (years)
- $ET_{\text{event-rec-c}}$ = Exposure Time (hours/event)
- $EV_{\text{rec-c}}$ = Events – child (events/day)
- $SA_{\text{rec-c}}$ = Surface Area – child (cm²)
- $AT_{\text{rec-c}}$ = Averaging Time (days/year)
- $BW_{\text{rec-c}}$ = Body Weight – child (kg)



Adult Non-Carcinogenic Dermal Contact:

$$CDI_{\text{rec-wat-derna}} \left(\frac{\text{mg}}{\text{kg-day}} \right) = \frac{DA_{\text{event}} \left(\frac{\mu\text{g}}{\text{cm}^2\text{-event}} \right) \times \left(\frac{\text{mg}}{1000 \mu\text{g}} \right) \times EF_{\text{rec-a}} \left(\frac{\text{days}}{\text{yr}} \right) \times ED_{\text{rec}} (26 \text{ yr}) \times EV_{\text{rec-a}} \left(\frac{\text{event}}{\text{day}} \right) \times SA_{\text{rec-a}} (19,652 \text{ cm}^2)}{AT_{\text{rec-a}} \left(\frac{365 \text{ days}}{\text{yr}} \right) \times ED_{\text{rec}} (26 \text{ yr}) \times BW_{\text{rec-a}} (80 \text{ kg})}$$

where:

For Inorganics:

$$DA_{\text{event}} \left(\frac{\mu\text{g}}{\text{cm}^2\text{-event}} \right) = C_{\text{water}} \left(\frac{\mu\text{g}}{\text{L}} \right) \times \left(\frac{\text{L}}{1000 \text{ cm}^3} \right) \times K_p \left(\frac{\text{cm}}{\text{hr}} \right) \times ET_{\text{event-rec-a}} \left(\frac{\text{hrs}}{\text{event}} \right)$$

For Organics:

IF $ET_{\text{event-rec-a}} \left(\frac{\text{hrs}}{\text{event}} \right) \leq t^*$ (hrs), then:

$$DA_{\text{event}} \left(\frac{\mu\text{g}}{\text{cm}^2\text{-event}} \right) = C_{\text{water}} \left(\frac{\mu\text{g}}{\text{L}} \right) \times \left(\frac{\text{L}}{1000 \text{ cm}^3} \right) \times 2 \times FA \times K_p \left(\frac{\text{cm}}{\text{hr}} \right) \times \sqrt{\frac{6 \times \tau_{\text{event}} \left(\frac{\text{hrs}}{\text{event}} \right) \times ET_{\text{event-rec-a}} \left(\frac{\text{hrs}}{\text{event}} \right)}{\pi}}$$

or:

IF $ET_{\text{event-rec-a}} \left(\frac{\text{hrs}}{\text{event}} \right) > t^*$ (hrs), then:

$$DA_{\text{event}} \left(\frac{\mu\text{g}}{\text{cm}^2\text{-event}} \right) = C_{\text{water}} \left(\frac{\mu\text{g}}{\text{L}} \right) \times \left(\frac{\text{L}}{1000 \text{ cm}^3} \right) \times FA \times K_p \left(\frac{\text{cm}}{\text{hr}} \right) \times \left[\frac{ET_{\text{event-rec-a}} \left(\frac{\text{hrs}}{\text{event}} \right)}{1 + B} + 2 \times \tau_{\text{event}} \left(\frac{\text{hrs}}{\text{event}} \right) \times \left(\frac{1 + 3B + 3B^2}{(1 + B)^2} \right) \right]$$

Where:

- $CDI_{\text{rec-wat-derna}}$ = Chronic Daily Intake of surface water for recreator from dermal contact – adult, noncarcinogenic (mg/kg/day)
- C_{water} = Concentration in water ($\mu\text{g/L}$)
- DA_{event} = Dermal absorption factor ($\mu\text{g/cm}^2\text{-event}$)
- $EF_{\text{rec-a}}$ = Exposure Frequency – adult (days/year)
- $ED_{\text{rec-a}}$ = Exposure Duration – adult (years)
- $ET_{\text{event-rec-a}}$ = Exposure Time - adult (hours/event)
- $EV_{\text{rec-a}}$ = Events – adult (events/day)
- $SA_{\text{rec-a}}$ = Surface Area – adult (cm^2)
- $AT_{\text{rec-a}}$ = Averaging Time - adult (days/year)



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BW_{rec-a} = Body Weight – adult (kg)

Age-Adjusted Non-Carcinogenic Dermal Contact:

$$CDI_{rec-wat-dermaj} \left(\frac{mg}{kg-day} \right) = \frac{DA_{event} \left(\frac{\mu g}{cm^2-event} \right) \times \left(\frac{mg}{1000 \mu g} \right) \times DFW_{rec-adj} \left(\frac{335,655 cm^2-event}{kg} \right)}{AT_{rec-a} \left(\frac{365 days}{yr} \times ED_{rec}(26 yr) \right)}$$

where:

$$DFW_{rec-adj} \left(\frac{335,655 cm^2-event}{kg} \right) = \left(\frac{EF_{rec-c} \left(\frac{45 days}{yr} \right) \times ED_{rec-c}(6 yr) \times EV_{rec-c} \left(\frac{1 event}{day} \right) \times SA_{rec-c} (6,365 cm^2)}{BW_{rec-c} (15 kg)} + \frac{EF_{rec-a} \left(\frac{45 days}{yr} \right) \times ED_{rec-a}(20 yr) \times EV_{rec-a} \left(\frac{1 event}{day} \right) \times SA_{rec-a} (19,652 cm^2)}{BW_{rec-a} (80 kg)} \right)$$

and:

For Inorganics:

$$DA_{event} \left(\frac{\mu g}{cm^2-event} \right) = C_{water} \left(\frac{\mu g}{L} \right) \times \left(\frac{L}{1000 cm^3} \right) \times K_p \left(\frac{cm}{hr} \right) \times ET_{event-rec-adj} \left(\frac{1 hrs}{event} \right)$$

For Organics:

IF $ET_{event-rec-adj} \left(\frac{1 hrs}{event} \right) \leq t^*$ (hrs), then:

$$DA_{event} \left(\frac{\mu g}{cm^2-event} \right) = C_{water} \left(\frac{\mu g}{L} \right) \times \left(\frac{L}{1000 cm^3} \right) \times 2 \times FA \times K_p \left(\frac{cm}{hr} \right) \times \sqrt{\frac{6 \times \tau_{event} \left(\frac{hrs}{event} \right) \times ET_{event-rec-adj} \left(\frac{1 hrs}{event} \right)}{\pi}}$$

IF $ET_{event-rec-adj} \left(\frac{1 hrs}{event} \right) > t^*$ (hrs), then:

$$DA_{event} \left(\frac{\mu g}{cm^2-event} \right) = C_{water} \left(\frac{\mu g}{L} \right) \times \left(\frac{L}{1000 cm^3} \right) \times FA \times K_p \left(\frac{cm}{hr} \right) \times \left[\frac{ET_{event-rec-adj} \left(\frac{1 hrs}{event} \right)}{1 + B} + 2 \times \tau_{event} \left(\frac{hrs}{event} \right) \times \left(\frac{1 + 3B + 3B^2}{(1 + B)^2} \right) \right]$$

where:

$$ET_{event-rec-adj} \left(\frac{1 hrs}{event} \right) = \left(\frac{ED_{rec-c}(6 yr) \times ET_{event-rec-c} \left(\frac{1 hrs}{event} \right)}{ED_{rec}(26 yr)} + \frac{ED_{rec-a}(20 yr) \times ET_{event-rec-a} \left(\frac{1 hrs}{event} \right)}{ED_{rec}(26 yr)} \right)$$

Where:

$CDI_{rec-wat-dermaj}$ = Chronic Daily Intake of surface water for recreator from dermal contact – age-adjusted, noncarcinogenic (mg/kg/day)

C_{water} = Concentration in water ($\mu g/L$)



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DA_{event}	=	Dermal absorption factor ($\mu\text{g}/\text{cm}^2\text{-event}$)
$DFW_{\text{rec-adj}}$	=	Dermal Contact Factor – age-adjusted ($\text{cm}^2\text{-event}/\text{kg}$)
$EF_{\text{rec-c}}$	=	Exposure Frequency – child (days/year)
$ED_{\text{rec-c}}$	=	Exposure Duration – child (years)
$EV_{\text{rec-c}}$	=	Events – child (events/day)
$SA_{\text{rec-c}}$	=	Surface Area – child (cm^2)
$BW_{\text{rec-c}}$	=	Body Weight – child (kg)
$EF_{\text{rec-a}}$	=	Exposure Frequency – adult (days/year)
$ED_{\text{rec-a}}$	=	Exposure Duration – adult (years)
$ET_{\text{event-rec-adj}}$	=	Exposure Time (hours/event)
$EV_{\text{rec-a}}$	=	Events – adult (events/day)
$SA_{\text{rec-a}}$	=	Surface Area – adult (cm^2)
$AT_{\text{rec-a}}$	=	Averaging Time - adult (days/year)
$BW_{\text{rec-a}}$	=	Body Weight – adult (kg)

Carcinogenic Dermal Contact:



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$$CDI_{\text{rec-wat-derc}} \left(\frac{\text{mg}}{\text{kg-day}} \right) = \frac{DA_{\text{event}} \left(\frac{\mu\text{g}}{\text{cm}^2\text{-event}} \right) \times \left(\frac{\text{mg}}{1000 \mu\text{g}} \right) \times DFW_{\text{rec-adj}} \left(\frac{335,655 \text{ cm}^2\text{-event}}{\text{kg}} \right)}{AT_{\text{rec}} \left(\frac{365 \text{ days}}{\text{yr}} \times LT(70 \text{ yrs}) \right)}$$

where:

$$DFW_{\text{rec-adj}} \left(\frac{335,655 \text{ cm}^2\text{-event}}{\text{kg}} \right) = \left(\frac{EF_{\text{rec-c}} \left(\frac{45 \text{ days}}{\text{yr}} \right) \times ED_{\text{rec-c}}(6 \text{ yr}) \times EV_{\text{rec-c}} \left(\frac{1 \text{ event}}{\text{day}} \right) \times SA_{\text{rec-c}}(6,365 \text{ cm}^2)}{BW_{\text{rec-c}}(15 \text{ kg})} + \frac{EF_{\text{rec-a}} \left(\frac{45 \text{ days}}{\text{yr}} \right) \times ED_{\text{rec-a}}(20 \text{ yr}) \times EV_{\text{rec-a}} \left(\frac{1 \text{ event}}{\text{day}} \right) \times SA_{\text{rec-a}}(19,652 \text{ cm}^2)}{BW_{\text{rec-a}}(80 \text{ kg})} \right)$$

and:

For Inorganics:

$$DA_{\text{event}} \left(\frac{\mu\text{g}}{\text{cm}^2\text{-event}} \right) = C_{\text{water}} \left(\frac{\mu\text{g}}{\text{L}} \right) \times \left(\frac{\text{L}}{1000 \text{ cm}^3} \right) \times K_p \left(\frac{\text{cm}}{\text{hr}} \right) \times ET_{\text{event-rec-adj}} \left(\frac{1 \text{ hrs}}{\text{event}} \right)$$

For Organics:

IF $ET_{\text{event-rec-adj}} \left(\frac{1 \text{ hrs}}{\text{event}} \right) \leq t^*$ (hrs), then:

$$DA_{\text{event}} \left(\frac{\mu\text{g}}{\text{cm}^2\text{-event}} \right) = C_{\text{water}} \left(\frac{\mu\text{g}}{\text{L}} \right) \times \left(\frac{\text{L}}{1000 \text{ cm}^3} \right) \times 2 \times FA \times K_p \left(\frac{\text{cm}}{\text{hr}} \right) \times \sqrt{\frac{6 \times \tau_{\text{event}} \left(\frac{\text{hrs}}{\text{event}} \right) \times ET_{\text{event-rec-adj}} \left(\frac{1 \text{ hrs}}{\text{event}} \right)}{\pi}}$$

IF $ET_{\text{event-rec-adj}} \left(\frac{1 \text{ hrs}}{\text{event}} \right) > t^*$ (hrs), then:

$$DA_{\text{event}} \left(\frac{\mu\text{g}}{\text{cm}^2\text{-event}} \right) = C_{\text{water}} \left(\frac{\mu\text{g}}{\text{L}} \right) \times \left(\frac{\text{L}}{1000 \text{ cm}^3} \right) \times FA \times K_p \left(\frac{\text{cm}}{\text{hr}} \right) \times \left[\frac{ET_{\text{event-rec-adj}} \left(\frac{1 \text{ hrs}}{\text{event}} \right)}{1 + B} + 2 \times \tau_{\text{event}} \left(\frac{\text{hrs}}{\text{event}} \right) \times \left(\frac{1 + 3B + 3B^2}{(1 + B)^2} \right) \right]$$

where:

$$ET_{\text{event-rec-adj}} \left(\frac{1 \text{ hrs}}{\text{event}} \right) = \left(\frac{ED_{\text{rec-c}}(6 \text{ yr}) \times ET_{\text{event-rec-c}} \left(\frac{1 \text{ hrs}}{\text{event}} \right) + ED_{\text{rec-a}}(20 \text{ yr}) \times ET_{\text{event-rec-a}} \left(\frac{1 \text{ hrs}}{\text{event}} \right)}{ED_{\text{rec}}(26 \text{ yr})} \right)$$

Where:

$CDI_{\text{rec-wat-derc}}$ = Chronic Daily Intake of surface water for recreator from dermal contact, carcinogenic (mg/kg/day)

DA_{event} = Dermal absorption factor ($\mu\text{g}/\text{cm}^2\text{-event}$)

$DFW_{\text{rec-adj}}$ = Dermal contact factor – age-adjusted ($\text{cm}^2\text{-event}/\text{kg}$)

AT_{rec} = Averaging Time (days/year)



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LT	=	Lifetime (years)
EF _{rec-c}	=	Exposure Frequency – child (days/year)
ED _{rec-c}	=	Exposure Duration – child (years)
EV _{rec-c}	=	Events – child (events/day)
SA _{rec-c}	=	Surface Area – child (cm ²)
BW _{rec-c}	=	Body Weight – child (kg)
EF _{rec-a}	=	Exposure Frequency – adult (days/year)
ED _{rec-a}	=	Exposure Duration – adult (years)
EV _{rec-a}	=	Events – adult (events/day)
SA _{rec-a}	=	Surface Area – adult (cm ²)
BW _{rec-a}	=	Body Weight – adult (kg)

3.4.3 Ingestion of Recreationally Caught Fish

Potential exposures to COPCs from the ingestion of recreationally-caught fish from the Schuylkill River in the vicinity of the Site were quantified by comparing estimated surface water concentrations of COPCs in the Schuylkill River to ambient water quality criteria for the protection of human health based on fish ingestion.



4 Toxicity Assessment

The toxicity assessment weighs the available evidence regarding the potential for COPCs to cause adverse effects in exposed individuals (receptors) and provides, where possible, an estimate of the relationship between the extent of exposure to a COPC and the increased likelihood and/or severity of induced adverse health effects. Two broad categories of chemically-induced disease states are evaluated in the toxicity assessment of each identified COPC: carcinogenic effects; and non-carcinogenic effects.

As the exposure assessment attempts to define the chronic lifetime dosage of COPCs received by an individual in a given scenario, the toxicity assessment links adverse effects associated with exposure to the particular COPC. Establishing an association between exposure to a constituent with possible adverse effects is the major tenet of toxicology. The dose received determines the magnitude of any anticipated adverse effects related to the constituent's inherent toxicity.

Toxicity values are used in risk characterization to quantify the probability of observing cancer and non-cancer effects in a potentially exposed population. Two types of toxicity values are used to express a COPC's dose-response-effect relationship:

- A slope factor (SF) or inhalation unit risk (IUR) factor for estimating the likelihood of carcinogenic effects; and
- A reference dose (RfD) or reference concentration (RfC) for estimating possible non-carcinogenic effects.

In general, SF and RfD values, expressed in the units of $(\text{mg}/\text{kg}\text{-day})^{-1}$ and $\text{mg}/\text{kg}\text{-day}$, respectively, are derived from long-term animal studies and incorporate uncertainty factors to compensate for extrapolation of observed adverse effects in laboratory animals to estimate possible adverse effects in humans. If adequate human data from epidemiological studies are available, these data are used to reduce uncertainty in deriving toxicity values.

Toxicity values used in the HHRA were the toxicity values embedded in the RAIS on-line calculator. The RAIS calculator references values from the USEPA's Integrated Risk Information System (IRIS), California Environmental Protection Agency (CalEPA), USEPA's Health Effects Assessment Summary Tables (HEAST), Provisional Peer Reviewed Toxicity Values (PPRTV) for Superfund, Agency for Toxic Substances and Disease Registry (ATSDR), and USEPA's (1993a) Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons. These sources are up to date and reflect the most current evaluations by USEPA IRIS, Regional, and State (California) toxicologists. **Table 4-1** presents the toxicity factors for the COPCs that were quantitatively evaluated in the HHRA.

4.1 Toxicity Factors for Carcinogens

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen (i.e., incremental or excess individual



lifetime cancer risk). Based on the extent to which a constituent has been shown to be a carcinogen in animal studies, in humans, or in both, the agent is given a provisional weight-of-evidence classification. USEPA's current classification of the overall weight of evidence has the following five categories:

1. **Group A : Human Carcinogen** – Sufficient evidence from epidemiological studies substantiated by causal association between exposure and carcinogenicity;
2. **Group B : Probable Human Carcinogen**
 - o Group B1 – Limited evidence of carcinogenicity in humans from available epidemiological data;
 - o Group B2 – Sufficient evidence of carcinogenicity in animals, but inadequate or no evidence in humans;
3. **Group C : Possible Human Carcinogen** – Limited evidence of carcinogenicity in animals;
4. **Group D : Not Classifiable** – Inadequate evidence of carcinogenicity in animals to support classification;
5. **Group E : Not a Human Carcinogen** – No evidence of carcinogenicity in at least two adequate animal tests in different species or in both epidemiological and animal studies.

For chemicals that are classified as possible, probable, or known human carcinogens, USEPA calculates a Cancer Slope Factor (CSF) for oral exposures and an Inhalation Unit Risk (IUR) for inhalation exposures when sufficient information is available to support the calculation. In the absence of evidence to the contrary, USEPA guidance assumes that a linear, no-threshold dose-response model is appropriate for carcinogenic risk assessment (USEPA, 1996). In the HHRA, the CSF is used to estimate the probability of a cancer effect occurring in a receptor exposed over their lifetime. A CSF has units of excess cancer risk per milligrams of chemical per kilogram of body weight per day (mg/kg-day)⁻¹.

CSFs are derived from the dose-response data from chronic animal bioassays, although human data are used when available. The CSF represents the 95% upper confidence limit of the slope of the linear portion of the dose-response curve from the key study. CSF and IUR for the COPCs quantitatively evaluated in the HHRA are presented in **Table 4-1**.

4.2 Toxicity Factors for Non-Cancer Health Effects

In assessing the potential for non-cancer health effects, USEPA assumes there is a toxicological threshold below which no adverse health effects are observable (USEPA, 1993b). Effect thresholds are represented by reference doses (RfDs) for oral exposures and reference concentrations (RfCs) for inhalation exposures. The RfDs and RfCs are estimates (with uncertainty spanning in some cases several orders of magnitude) of daily exposures to the human population (including sensitive subgroups) that are likely to be without an appreciable risk of deleterious effects during a lifetime. USEPA derives RfDs and RfCs using a standardized approach, which considers available information from human and animal studies indicating the levels below which toxicological effects are not observed and the uncertainties inherent in the available information (USEPA, 1993b).



Non-carcinogenic effects, such as organ damage or reproductive effects are evaluated as RfDs. RfDs provide a benchmark for the daily dose to which humans, including sensitive populations such as children, may be subjected without an appreciable risk of deleterious effects. RfDs are presented in units of mg/kg-day. A chronic RfD is defined as the estimated daily exposure over an entire lifetime that is believed to be without adverse effects for all members of the population (USEPA, 1993b).

The basis of an RfD calculation is usually the highest dose level that causes the no-observed-adverse-effect-level (NOAEL) after chronic or sub-chronic exposure in animal experiments. The NOAEL is then divided by uncertainty factors (or safety factors), and occasionally an additional modifying factor, to obtain the RfD. Uncertainty factors are usually factors of 10 that account for inter-species variation and sensitive human populations. Additional uncertainty factors can be used if the RfD is based on the lowest-observed-adverse-effect-level (LOAEL) instead of the NOAEL, or an experiment that includes a less-than-lifetime exposure. RfD and RfC for the COPCs quantitatively evaluated in the HHRA are presented in **Table 4-1**.

Non-carcinogenic effects are not additive across target organs/systems and are evaluated for each specific target organ/system that the COPCs act upon. The USEPA IRIS designation of target organ/system for non-cancer health effects produced by a chemical coincides with the critical effects observed in the key study from which the oral or inhalation toxicity factor was derived (e.g. RfD or RfC). The target organ/system designations for non-cancer health effects for the COPCs quantitatively evaluated in the HHRA are summarized below and are consistent with the current listing on IRIS, HEAST, and PPRTV.

COPC	Target Organ/System
Benzene	Decreased lymphocyte count
Toluene	Kidney

4.3 Surface Water Quality Standards

Surface water quality standards potentially applicable to the Schuylkill River are based on the protection of human health and ecological receptors.

Human health-based surface water quality criteria potentially applicable to the Schuylkill River are summarized in **Table 4-2** below.



Table 4-2. Potentially Relevant Surface Water Quality Criteria

Constituent	PA Code Chapter 93 Criteria Continuous Conc. (µg/L)	PA Code Chapter 93 Criteria Maximum Conc. (µg/L)	USEPA Region 3 BTAG Screening Benchmark (µg/L)	USEPA Ambient Water Quality Criterion (cancer: organism only) (µg/L)	USEPA Ambient Water Quality Criterion (non-cancer: organism only) (µg/L)	PA Code Chapter 93 Human Health Criteria (µg/L)
Benzene	130	640	370	16 - 58	90	0.58
Toluene	330	1700	2	NA	520	57

NA – Not Available

The PA Code Chapter 93 Criteria Continuous Concentration (CCC) and Criteria Maximum Concentration (CMC) for benzene and toluene represent chronic and acute surface water concentrations, respectively, that the PA Department of Environmental Protection considers protective of aquatic ecological receptors. The USEPA Region 3 Biological Technical Assistance Group (BTAG) Screening Benchmark (USEPA, 2006) represents a surface water screening level considered by USEPA Region 3 to be protective of aquatic ecological receptors. The PA Code Chapter 93 CCC and CMC and USEPA Region 3 BTAG criteria are based on the protection of ecological receptors and are not applicable to human health.

In developing Ambient Water Quality Criteria (AWQC), USEPA follows the assessment methodology outlined in its 2000 Methodology (USEPA, 2000). The 2000 Methodology describes different approaches for addressing water and non-water exposure pathways to derive human health AWQC depending on the toxicological endpoint of concern, the toxicological effect (non-carcinogenic or carcinogenic), and whether toxicity is considered a linear or threshold effect. Water sources of exposure include both consuming drinking water and consumption of fish or shellfish that have been exposed to contaminants in the water body. For non-carcinogens and non-linear carcinogens, USEPA applies a relative source contribution (RSC) factor to account for other potential human exposures to the constituent of concern (USEPA, 2000). Other sources of exposure that the RSC accounts for include, but are not limited to, ocean fish and shellfish consumption, non-fish food consumption (e.g., consumption of fruits, vegetables, grains, meats, or poultry), dermal exposure, and inhalation exposure.

For carcinogenic substances, only exposure from drinking water and fish ingestion are reflected in the human health AWQC. The resulting criterion represents the water concentration that is expected to increase an individual's lifetime cancer risk from exposure to the particular contaminant by no more than one chance in one million (1 E-06) for the general population. The 2000 Methodology recommends that



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states set human health criteria cancer risk levels for the target general population at either 1 E-05 or 1 E-06.

Human health AWQC for contaminants are necessary to protect any designated uses related to ingestion of water and ingestion of aquatic organisms. These uses can include, but are not limited to, recreation in and on the water, consumption of fish or shellfish, and protection of drinking water supplies. USEPA considers the following two primary pathways of human exposure to contaminants present in a particular water body when deriving human health AWQC: 1). Direct ingestion of drinking water obtained from the water body and 2). consumption of fish or shellfish obtained from the water body. USEPA derives recommended human health AWQC based on the consumption of both water and aquatic organisms and based on the consumption of aquatic organisms alone. The use of one criterion or the other depends on the designated use of the particular water body (i.e., drinking water source and/or fishable waters). USEPA recommends applying organism-only AWQC to a water body where the designated use includes supporting fishable uses under Section 101(a) of the Clean Water Act, but the water body is not a drinking water supply source (USEPA, 2000).

USEPA AWQC for benzene are human health risk-based criteria based on a cancer risk level of 1E-06 (cancer endpoint) and hazard quotient of 1 (non-cancer endpoint) and ingestion of organisms only. USEPA AWQC for toluene is a human health risk-based criterion based on a hazard quotient of 1 (non-cancer endpoint; toluene is not classified as a carcinogen) and ingestion of organisms only. The PA Code Chapter 93 Human Health Criteria for benzene and toluene in surface water includes probable modes of exposure (such as but not limited to ingestion from drinking water and fish consumption, inhalation and dermal absorption) and are based on a cancer risk level of 1E-06 for benzene and hazard quotient of 1 for toluene.

It is important to note that per Title 25 Pennsylvania Code Section 93.9(e), the tidal Schuylkill River is not classified as a potable water source, and as such, the PA Code Chapter 93 Human Health Criteria for benzene and toluene in surface water are not applicable to the lower tidal Schuylkill River. There are no PA Code Chapter 93 Human Health Criteria for ingestion of organisms only. As such, per Section 250.406(c), BDH is requesting a waiver of the PA Code Chapter 93 human health surface water quality criteria for benzene and toluene as they do not apply to surface water in the tidal Schuylkill River. However, the USEPA AWQC for benzene (USEPA, 2015a) and toluene (USEPA, 2015b) are based on ingestion of organisms only and as such are applicable to the lower tidal Schuylkill River since ingestion of recreationally-caught fish is not prohibited.

The Update of Human Health Ambient Water Quality Criteria: Benzene (USEPA, 2015a) presents risk-based AWQC for benzene in surface water derived using both carcinogenic and non-carcinogenic endpoints. The human health AWQC for benzene in surface water based on non-carcinogenic effects and ingestion of organisms only is 90 µg/L. The human health AWQC for benzene in surface water based on carcinogenic effects (cancer risk = 1E-06) and ingestion of organisms only ranges from 16 – 58 µg/L, depending on the cancer slope factor used to calculate the AWQC.

The USEPA Office of Solid Waste and Emergency Response (OSWER, 1991) recommends a risk management range of 1E-04 to 1E-06 as a point of departure for making risk management decisions and



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often defers to the mid-point of this range (1E-05) as the level at which risk management decisions are made. Using a cancer risk of 1E-05 as the target cancer risk level, and the methodology presented in the Update of Human Health Ambient Water Quality Criteria: Benzene (USEPA, 2015a), the AWQC for benzene based on ingestion of organisms only is calculated as the range between 160 - 580 µg/L.

USEPA considered all available toxicity values for both carcinogenic and non-carcinogenic toxicological effects in the development of the human health AWQC for benzene. As described in the 2000 Methodology (USEPA, 2000), where data are available USEPA derives AWQC for both carcinogenic and non-carcinogenic endpoints and recommends the more protective value(s) for the human health AWQC. Using this protocol, the most appropriate human health-based criterion for benzene in surface water is 90 µg/L as it is the most protective value based on carcinogenic and non-carcinogenic human health endpoints.

The Update of Human Health Ambient Water Quality Criteria: Toluene (USEPA, 2015b) presents risk-based AWQC for toluene in surface water derived using non-carcinogenic endpoints only as toluene is not classified as a carcinogen. The human health AWQC for toluene in surface water based on non-carcinogenic effects and ingestion of organisms only is 520 µg/L.

USEPA considered all available toxicity values for non-carcinogenic toxicological effects in the development of the human health AWQC for toluene. As described in the 2000 Methodology (USEPA, 2000), where data are available USEPA derives AWQC for both carcinogenic and non-carcinogenic endpoints and recommends the more protective value(s) for the human health AWQC. Using this protocol, the most appropriate human health-based screening level for toluene in surface water is 520 µg/L as it is the most protective value based on non-carcinogenic human health endpoints.



5 Risk Characterization

Risk Characterization combines the information presented in the Exposure Assessment with the information presented in the Toxicity Assessment to describe the type and magnitude of potential carcinogenic risks and non-carcinogenic hazards due to exposure to COPCs in surface water at the Site. The magnitude and types of risks depend on the nature, duration, and frequency of exposure to COPCs, and the characteristics of the exposed populations. The risk characterization step applies toxicity factors to the quantitative estimates of daily intake (in mg chemical per kg body weight per day) to calculate unitless estimates of cancer risk and non-cancer hazard.

Cancer risk and non-cancer hazard from exposure to COPCs in surface water at the Site are estimated using standard equations in USEPA RAGS (USEPA, 1989; 2004 and 2009) that are embedded in the RAIS risk calculator.

5.1 Cancer Risk

Based on the evidence that a constituent is a known or probable human carcinogen, cancer risks (CR) are estimated as the incremental excess probability of an individual developing cancer over a lifetime (70 years) associated with exposure to chemical carcinogens in the environmental media of interest (e.g., surface water). A critical assumption of this approach is that the dose-response relationship is a linear relationship in the low-dose portion of the dose-response curve. Under this assumption, the CSF is a constant and risk will be directly related to intake. Thus, the linear form of the carcinogenic risk equation is usually applicable for estimating site risks (USEPA, 1989). This linear low-dose equation is defined as:

$$CR = CDI \times CSF$$

where:

- CR = Incremental lifetime cancer risk (unitless);
- CDI = Chronic daily intake, averaged over 70 years (mg/kg-day);
- CSF = Cancer slope factor (mg/kg-day)⁻¹.

For any given receptor, cancer risk from exposure to multiple chemical carcinogens is assumed to be additive across all pathways and routes of exposure relevant to that receptor (USEPA, 1989):

$$\text{Multiple Substance Risk} = \sum_{i=1}^N \text{Risk}_i$$

where:

- Multiple Substance Risk = Total CR from multiple substances, unitless probability;



$Risk_i$ = ILCR for the i^{th} chemical (a total of N).

And where:

Total Risk = Risk pathway₁ + Risk pathway₂ + ... Risk pathway_i

The additive model treats “cancer” as a generic outcome and does not distinguish between chemicals with regards to mode of action, types of associated cancers, and weight of evidence (as documented by human and/or laboratory animal evidence).

5.2 Non-Cancer Hazard

For non-carcinogenic constituents, the measure used to describe the potential for non-carcinogenic toxicity to occur in an individual is evaluated by comparing the estimated exposure level over a specified time period (e.g., exposure duration) with the appropriate non-cancer toxicity value (i.e., RfD or RfC). As discussed previously in Chapter 3, calculation of daily intake for non-cancer health effects differs from calculation of daily intake for cancer in that the dose for non-cancer effects is averaged over the duration of the exposure rather than averaged over a 70-year lifetime. Non-cancer hazard quotients (HQ) for individual chemicals are derived by dividing the estimated CDI (in mg chemical per kg body weight-day) by the RfD or RfC (USEPA, 1989) to form a simple ratio:

$$HQ = Intake \div RfD$$

where:

HQ = Hazard quotient (unitless);
Intake = Intake of chemical (mg/kg-day);
RfD = Reference dose (mg/kg-day)

The non-carcinogenic hazard quotient assumes that there is a level of exposure (e.g., RfD or RfC) below which it is unlikely for even sensitive subpopulations to experience adverse health effects.

For assessing the health impacts of several non-carcinogenic constituents, RfDs or RfCs are compared to exposure-specific intake rates of each COPC. For any given receptor, non-cancer hazard from exposure to multiple chemicals may initially be considered additive across all pathways and routes of exposure relevant to that receptor (USEPA, 1989). A summation of these hazard quotients is termed the hazard index (HI). The aggregate HI is expressed as:

$$HI_T = \sum_k \frac{CDI_j}{RfD_j}$$

where:

HI_T = total hazard index for cumulative exposure scenarios for an individual;



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k = k^{th} exposure pathway;

CDI_j = chronic daily exposure for the j^{th} constituent in each exposure medium;

RfD_j = Reference dose for the j^{th} constituent.

If this ratio of the daily intake to the RfD or RfC exceeds 1.0 (unity) for the defined exposure scenario, this provides an indication that further evaluation should be undertaken. If the ratio is below unity, then it is generally assumed that no adverse impact to human health has or will occur.

The HI approach does have limitations and should be interpreted carefully based on the known aspects of additive toxic effects from exposure to mixtures of chemicals. First, because both the HQ and HI are ratios, after unity has been exceeded, the magnitude of the index has little bearing on the potential severity of adverse effects that may be anticipated. An HI of five does not indicate the non-cancer hazard is greater than an HI of three. Secondly, it is generally inappropriate to sum non-cancer hazard quotients for constituents that do not have similar toxic modes of action or that do not affect the same organ system. Unlike the additivity assumption that treats all cancer probability estimates the same (regardless of weight of evidence or type of cancer), evaluation of non-cancer health effects allows for segregation of chemicals based on the type of non-cancer health effects in the key study used to derive the RfD and/or RfC. If the pathway HI exceeds 1 but no individual HQs exceed 1, COPCs may be segregated by target organ or critical effect and the pathway HI recalculated.



6 Presentation and Discussion of Results

The findings of the HHRA are summarized in the following Sections. The RAIS output files for the risk calculations are presented in **HHRA Appendix B**.

6.1 Recreational Risks/Hazards

As discussed in Chapter 3, the receptors evaluated for the UDEX release are adult and child recreators who use the Schuylkill River for recreational activities (e.g., boating and fishing). These recreators are assumed to be present in the area of maximum groundwater seepage for the entirety of their exposure periods and are exposed to constituents in surface water via incidental ingestion and dermal absorption. Cancer risks and non-cancer health hazards were estimated for the COPCs associated with the UDEX release (benzene and toluene). Estimated cancer risks and non-cancer hazard indices for recreators in the Schuylkill River are summarized in **Table 6-1** below.

Table 6-1. Estimated Cancer Risks and Non-Cancer Hazard Indices for Recreational Exposures in the Schuylkill River

Receptors	Child Non-Cancer Hazard Index	Adult Non-Cancer Hazard Index	Age-Adjusted Non-Cancer Hazard Index	Cumulative Cancer Risk
Recreators in Schuylkill River	5.1E-07	2.0E-07	2.7E-07	2.2E-11

The estimated cancer risks for recreators using the Schuylkill River are less than the USEPA OSWER (USEPA, 1991b) risk management range of 1E-06 to 1E-04 and the estimated non-cancer hazard indices are less than the OSWER (USEPA, 1991b) non-cancer threshold of 1.

It is important to note that these calculated cancer risks and non-cancer hazard indices were estimated assuming maximum modeled COPC concentrations in the Schuylkill River. Contaminant levels are expected to decrease over time as the underground source of benzene and toluene is expected to decrease in concentration and the mass of these constituents entering the Schuylkill River will decrease.

6.2 Risks/Hazards from Fish Ingestion

Ingestion of recreationally caught fish was assessed via the comparison of estimated concentrations of COPCs in surface water in the Schuylkill River to AWQC based on ingestion of fish and shellfish.



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Table 6-2. Comparison of COPC Concentrations in Schuylkill River Surface Water to AQWC Based on Fish Ingestion

COPC	USEPA Ambient Water Quality Criterion (cancer: organism only)^a (µg/L)	USEPA Ambient Water Quality Criterion (non-cancer: organism only)^b (µg/L)	Predicted Schuylkill River Surface Water Conc. (µg/L)
Benzene	160 - 580	90	9.2E-04
Toluene	NA	520	2.8E-08

a – based on a cancer risk = 1 E-05

b – based on a non-cancer hazard index = 1

As presented in the table above, maximum predicted surface water concentrations of benzene and toluene in the Schuylkill River are several orders of magnitude less than their applicable AWQC based on fish ingestion.



7 Uncertainties in the Human Health Risk Assessment

The approach to the HHRA for the UDEX Feed Underground Line Release is based on USEPA methodology and is inherently conservative - meaning that exposures and subsequent cancer risks and non-cancer hazards are more likely to be overestimated rather than underestimated. Uncertainties associated with the variable values used in standard equations to estimate internal dose, extrapolation of toxicity factors derived from laboratory animal studies to humans, and representativeness of the sampling scheme, analytical data, and groundwater fate and transport modeling are common elements in most, if not all, risk assessments for contaminated sites. Some sources of uncertainty specific to evaluating human health risks for receptors related to the UDEX release are described in the following sections.

7.1 Current and Future Land Use

The former PES Philadelphia Refining Complex Point Breeze Refinery is currently undergoing significant re-development. As such, the current state of the Site is in flux and the exact future use of the Site is unknown. However, because the UDEX release was a subsurface release, the subsurface conditions are unlikely to change significantly. Above-ground conditions are likely to change in the future, and as such, any above ground site development will be required to take into account the presence of subsurface and groundwater contamination and take appropriate actions to mitigate potential risks. As outlined in Chapter 3 and Table 3-1, many onsite pathways are considered to be incomplete because of the existence of administrative controls outlined in the 2020 Buyer Seller Amendment and Soil Reuse Plan. Further documentation of these controls will be outlined in the Cleanup Plan and Final Report.

7.2 Identification of Chemicals of Potential Concern

There is little uncertainty associated with characterization of the UDEX Feed Underground Line Release or the datasets available for identifying COPCs. Through chemical fingerprinting and operational knowledge, the product released from the underground UDEX conveyance line is understood to be reformate, a highly volatile gasoline feedstock enriched in benzene and toluene. The COPCs for human health in groundwater are therefore limited to benzene and toluene as these two compounds are known constituents of reformate and have been detected at elevated concentrations in the release area. The COPCs addressed in the HHRA were inclusive and resulted in a conservative evaluation.

7.3 Exposure Assessment

There are a number of sources of uncertainty inherent in the assumptions used to generate estimates of daily intake (dose) of COPCs from the UDEX release. The USEPA paradigm for conducting human health risk assessments presently requires the use of point estimates for all parameters (e.g., chemical concentration, body weight, length of exposure, etc.) to establish risk estimates for exposure scenarios.



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Furthermore, the inherent conservatism in the upper-bound point estimate approach is an attempt to account for both variability and uncertainty with the use of conservative assumptions.

As single-point estimates do not provide a vehicle for conveying the heterogeneity or variability of the data, no associated measure of confidence can be provided as a means of examining exposure assessment or the completed risk analysis. An example of a conservative point estimate used in the exposure assessment is the use of an exposure frequency of 45 days per year and exposure duration of 26 years for adult and child recreators in the Schuylkill River. These single point estimates are used under the assumption that an adult or child recreator participates in recreational activities in the Schuylkill River 45 days per year for 26 years and is exposed to COPCs in Schuylkill River surface water in the same volume and frequency for 26 years.

Many of the variable values and assumptions used in this HHRA are USEPA “defaults” embedded in the RAIS calculator that are intended to result in high-end estimates of dose, and subsequent high-end estimates of cancer risk and non-cancer hazard.

7.3.1 Intake of COPCs

As discussed in the preceding section, physical contact (exposure) with COPCs in surface water is a function of receptor activity patterns. The risk assessment process assumes that physical contact results in COPCs being taken into the body of the receptor and quantifies daily intake or dose from incidental ingestion of surface water, absorption of COPCs through the skin into the bloodstream, and ingestion of recreationally caught fish. There are multiple uncertainties associated with the assumptions used to estimate daily intake that are much more likely to over-estimate rather than under-estimate dose.

Surface Water Ingestion Rates

Incidental ingestion of surface water can occur when individuals are involved in recreational activities such as boating, swimming, or fishing. The amount of surface water that is ingested depends on the specific activities that the individual is engaged in (i.e., swimmers tend to ingest more water than boaters).

The HHRA used the RAIS default values referenced from the Exposure Factors Handbook (USEPA, 2011 and 2019) for children and adults. The default variable values used to estimate daily intake of COPCs from incidental ingestion of surface water are uncertain and much more likely to over-estimate rather than under-estimate exposure.

Dermal Absorption of COPCs from Surface Water

The HHRA followed USEPA guidance (USEPA, 2004) and used standard default exposure factors (USEPA, 2014) to estimate daily intake from absorption of COPCs in surface water through the skin. There are a number of factors that effect dermal absorption of contaminants through the skin, including age and condition of the skin and skin thickness. The surface area of the skin that is exposed to surface water has a significant impact on the total dermal absorption of contaminants from surface water. The dermal absorption scenario quantified in the HHRA assumed 100 percent of the body surface area is exposed to contaminants in surface water. This assumption is defensible for someone who is swimming



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in the Schuylkill River; however, it may not be accurate for someone who is boating or engaged in a similar activity and is exposed to surface water via splashing or submerging only a portion of their body (e.g., hands or feet) in the water. The assumption that a recreational receptor's entire body is exposed to Schuylkill River surface water likely overestimates exposures for the majority of receptors.

Fish Ingestion Rates

Fish ingestion for this HHRA was assessed via a comparison of estimated concentrations of COPCs in surface water to AWQC based on fish ingestion. The AWQC for benzene and toluene were derived using the updated fish consumption rate (FCR) for the general adult population of 22.0 grams per day, or 0.0220 kilograms per day (USEPA 2014, Table 9a). This FCR represents the 90th percentile per capita consumption rate of fish from inland and nearshore waters for U.S. adults ages 21 years and older based on NHANES data from 2003–2010, and as such, represents a conservative estimate of fish ingestion.

7.3.2 Exposure Point Concentrations

The HHRA made the basic assumption that the surface water that a receptor contacts actually contains the COPCs at the concentrations derived by groundwater transport modeling and mixing with surface water to represent where the exposure occurs. This may be a somewhat defensible assumption for someone involved in a recreational activity directly adjacent to the Site. But the concentrations of COPCs in surface water at locations other than directly adjacent to the Site are less certain and are considerably lower. Additionally, benzene and toluene are highly volatile and will volatilize from the moving surface water of the Schuylkill River, thus further reducing their concentrations in the Schuylkill River.

The use of the highest predicted surface water concentrations to represent the EPC in the exposure algorithms is likely to over-estimate actual exposures.

7.4 Toxicity Assessment

There is considerable uncertainty associated with the toxicity data used in human health risk assessments. USEPA provides an assessment of their confidence in RfDs, RfCs, CSFs and IURs for the substances listed in IRIS (USEPA, 2025b). These assessments should be considered prior to making remedial decisions based on the findings of an HHRA.

Toxicity assessment relies upon the use of toxicity values (cancer SF, non-cancer RfDs) developed by the USEPA to evaluate potential chronic toxicity of COPCs. These toxicity values may be estimated from human data, but the process is largely dependent upon laboratory animal data generated from a variety of toxicology and safety testing studies conducted on constituents.

The carcinogenic toxicity values, CSFs, are derived from cancer bioassay or epidemiologic dose-response data to estimate carcinogenic risk at constituent concentrations that may be several orders of magnitude lower than the given dose or estimated exposure observed in the studies that form the basis of the assessment. A number of uncertainties are associated with this methodology.



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- The extrapolation of observed carcinogenic effects at high doses used in animal cancer studies to possible cancer effects at substantially lower doses is based on the hypothesis that there is no threshold dose for carcinogens. No experimental evidence is available to support this thesis.
- The extrapolation of carcinogenic and non-carcinogenic effects in animals to effects in humans may not be appropriate for all constituents, particularly if there are large species differences in metabolism of the constituent.
- While the USEPA has established a weight-of-evidence classification for carcinogens, the cancer risk algorithm does not utilize this weight-of-evidence and sums all carcinogen risks equally, whether a COPC is a known human carcinogen or only a suspected carcinogen.

Each of these three uncertainty factors tend to overestimate cancer risk.

Toxicity values derived to estimate chronic dosages that may induce non-cancer adverse effects also have a number of limitations. Unlike cancer risk assessment, by convention, non-cancer adverse effects are assumed to occur in a dose-response manner only after a threshold dose has been exceeded. This is the basis for the use of the RfD or RfC in estimating the hazard quotient (HQ). If this ratio is greater than 1.0, such exposures may be considered hazardous. The HQ can only be used to qualitatively rank the possibility of adverse non-cancer effects occurring. The following uncertainties are associated with the use of the hazard index to describe non-cancer health hazards:

- RfDs are derived from NOAEL or LOAEL dose rates determined from animal studies or human exposure investigations. Depending on the quality of the available data, the NOAEL or LOAEL is divided by an uncertainty factor ranging from 1 to 10,000. Large uncertainty factors used in extrapolating animal effects to human effects may over-estimate non-cancer hazards.
- The hazard quotient approach initially assumes that all noncancer adverse effects are additive. While this approach may be sound for assessing a series of constituents that have similar modes of action and act on the same target organ, it is clearly not appropriate for combining potential adverse effects for constituents with very different target organs and toxic insult outcomes.
- Summation of HQs to calculate a cumulative hazard index (HI) for an exposure scenario can generate a large number. The HI is a ratio of estimated exposure compared to a "safe" exposure dose. Further evaluation may be warranted if this ratio exceeds 1. The magnitude of a calculated HI greater than 1 has little bearing on the potential severity of adverse effects.

There are uncertainties associated with route-to-route extrapolation of dermal toxicity values. Dermal contact with some chemicals can contribute to systemic toxicity via percutaneous absorption and/or result in direct toxicity at the site of application (e.g., allergic contact dermatitis, urticarial reactions, chemical irritation, and skin cancer). USEPA (2004) outlines a process of adjusting oral RfDs and slope factors for the assessment of systemic toxicity but does not have recommended toxicity values for evaluating potential adverse effects that can occur at the skin surface. This lack of compound-specific dermal toxicity



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values is a significant uncertainty in the evaluation of the dermal pathway for the COPCs in the Schuylkill River (USEPA, 2004).

7.5 Risk Characterization

The uncertainties inherent in the exposure and toxicity assessment steps of the HHRA are compounded by the risk characterization methodology used to derive numerical estimates of cancer risk and non-cancer hazard. The risk assessment process is designed to provide a somewhat objective basis for making public health decisions about managing exposures to contaminants in environmental media. Numerical estimates of cancer risk and non-cancer hazard depend on the assumptions about exposure, intake of COPCs (dose), and dose-response (toxicity factors) used in the HHRA being satisfied (e.g. the assumptions are true). As briefly discussed above, there are multiple uncertainties associated with almost all the variable values and assumptions used in the HHRA.

As discussed in an insightful article, Bernard Goldstein (2011) comments that lifetime cancer risk levels of $1E-06$ to $1E-04$ (attributed to environmental exposures) “are simply too low to provide the opportunity to demonstrate in a classic scientific manner that a decline in exposure levels will lead to a decrease in adverse outcomes.” According to the American Cancer Society (2017), the lifetime risk of developing (incidence rate, not mortality) any type of invasive cancer for members of the U.S. population is approximately 40%; 42% for men and 38% for women. In other words, the background cancer risk in the U.S. population is 4 out of 10 or $4E-01$. The American Cancer Society lifetime risks are based on the National Cancer Institute (NCI) Surveillance Epidemiology and End Results (SEER) database for 2010-2012. The additional levels of risk used to make decisions about regulating and managing exposures to contaminants in the environment are very small compared to the population background risks.

Compared to the high background rate of cancer in the U.S. population, the estimated excess lifetime risks of cancer predicted by the HHRA are insignificant and could be as low as zero.



8 Summary and Conclusions

A Human Health Risk Assessment (HHRA) was conducted to evaluate potential risks/hazards related to human exposures to chemical contaminants in environmental media resulting from an underground petroleum release that occurred from an UDEX feed line at the former PES Refinery located at 3144 West Passyunk Avenue, Philadelphia, Pennsylvania. The purpose of the HHRA was to determine if Site-related chemical constituents in environmental media at the Site may pose unacceptable risks to people who work at the Site or use the adjacent Schuylkill River for recreation now and in the future.

The HHRA for the Site was conducted in accordance with guidance set forth in the *Site-Specific Human Health Risk Assessment Guidance* as described in 25 PA Code §250.602 (c) (PA Act 2) and *Risk Assessment Guidance for Superfund (RAGS)*, Volume I: Parts A, B, E, and F (USEPA, 1989, 1991a, 1991b, 2004, and 2009).

Through chemical fingerprinting and operational knowledge, the product released from the underground UDEX conveyance line is understood to be reformate, a highly volatile gasoline feedstock enriched in benzene and toluene. The COPCs for human health in groundwater are therefore limited to benzene and toluene as these two compounds are known constituents of reformate and have been detected at elevated concentrations in the release area.

The initial groundwater concentrations of benzene and toluene were best represented by the maximum reported benzene and toluene concentrations from groundwater samples collected between February 2019 and January 2025 with the following exception: any well with post-2024 analytical data availability would have the maximum COPEC concentrations selected from the period between January 2024 and January 2025. The resulting maximum contaminant concentration datasets formed the basis for the initial concentration data for the unconfined and lower aquifers.

The receptors that were quantitatively evaluated in the HHRA for the UDEX Feed Underground Line Release were adults and children using the Schuylkill River adjacent to the Site for recreational purposes. Other potential exposures related to the UDEX Feed Underground Line Release have been determined to be incomplete.

Assumptions related to potential human exposures are summarized below:

- The UDEX release area occupies approximately 8.4 acres of the former PES Refinery Point Breeze South Yard.
- BDH is responsible for overall security and oversight of contractor safety, and BDH implements personal protective equipment (PPE) and safety protocols that mitigate the potential for worker exposure to impacted subsurface soil, soil vapors, groundwater, and/or LNAPL through the direct contact pathway. As part of the 2020 Buyer-Seller Amendment BDH is obligated to “develop and implement a health and safety plan (HASP) to protect employees, on-site workers, and other persons visiting the Property (including, but not limited to, construction workers) from any contaminants they might encounter on the Property.” This obligation includes any future excavation work in the UDEX release area.



Human Health Risk Assessment Summary and Conclusions

- There are no expected surface soil impacts from the UDEX release because the release occurred from a subsurface pipe located approximately 4 to 5 feet below grade. As such, there is no surface soil contamination related to the UDEX release, and there are no potential exposures to contaminated surface soil related to the UDEX release.
- Future redevelopment plans for the area include asphalt parking, roadways, and a slab on grade warehouse structure. There are currently no buildings above the UDEX release impacts. Per the 2020 Soil Management Plan, any future building will be required to have vapor barriers or a mitigation system which eliminates the potential for vapor intrusion from the UDEX release impacts that remain in the subsurface after redevelopment. No subsurface preferential pathways that could potentially allow for migration of vapors exist in the UDEX release area. Therefore, indoor air inhalation exposures are incomplete. Alternatively, the plan allows for BDH to “conduct sampling and analysis to demonstrate that such controls are not needed to mitigate potential vapor intrusion into such buildings or structures in accordance with PADEP guidance.”
- Benzene and toluene are the COPCs quantitatively evaluated.
- Surface water concentrations of benzene and toluene in the Schuylkill River are estimated through numerical groundwater modeling and analytical surface water modeling.
- As outlined in the numerical modeling in the UDEX RIR, groundwater does not migrate offsite except for the Schuylkill River.
- Outdoor air COPC concentrations resulting from volatilization from groundwater or subsurface soil to ambient air are assumed to be insignificant. The mass flux of volatile organic compounds from subsurface soil and/or groundwater into outdoor air is insignificant in the context of the instantaneous volumetric mixing that occurs. After mixing with ambient air, the concentrations of volatile organic compounds from subsurface soil and/or groundwater at breathing height are expected to be insignificant. As such, regulatory agencies do not have standardized methods for quantifying these potential exposures. Therefore, outdoor inhalation exposures are not quantified in this assessment.
- Onsite groundwater is not currently and will not be used for potable or non-potable purposes. Therefore, no direct exposures to onsite groundwater are quantified.
- Potential human health risk posed by fish ingestion is assessed via comparison of modeled surface water concentrations to the U.S. Environmental Protection Agency’s (USEPA) ambient water quality criteria (AWQC) based on fish ingestion.
- Surface water ingestion and dermal absorption were assessed via standard recreational exposure methodologies.

The EPCs for surface water in the Schuylkill River were derived from fate and transport modeling of COPCs in groundwater with subsequent seepage and mixing in the Schuylkill River.

The groundwater fate and transport assessment completed for the UDEX release RIR (Stantec, 2025b) included the application of an existing numerical groundwater flow model (GWF Model) developed by Stantec (2025a) for the facility on behalf of Evergreen. It was coupled with a transport model to perform predictive simulations for benzene and toluene over a 30-year period (2025-2055) based on a



Human Health Risk Assessment
 Summary and Conclusions

conservative set of initial plume conditions where maximum concentrations from groundwater sampling were applied. The groundwater transport model was used to estimate mass discharges to surface water. Using the predictive simulation results, the maximum concentrations of benzene and toluene in groundwater resulting from the UDEX release numerical modeling were simulated to reach the river in year 28 at 3,288 ppb and 0.1 ppb, respectively.

In order to estimate the concentrations of COPECs in Schuylkill River surface water a groundwater-to-surface water dilution factor was estimated. The groundwater flux at the seepage face from the groundwater flow model is 22.4 gallons per day, which equates to 0.000035 cubic feet per second (cfs). The 7Q10 flow for the Schuylkill River at Philadelphia is 125 cfs (Baird, 2024). The dilution of groundwater discharging to the Schuylkill River was calculated to be 3.57E+06. Applying this dilution factor to the maximum benzene and toluene concentrations at the riverbed simulated seep resulted in maximum estimated concentrations of benzene and toluene in the Schuylkill River resulting from the UDEX release of 9.2E-04 µg/L and 2.8E-08 µg/L, respectively.

USEPA risk assessment algorithms were used to estimate receptor daily intake of COPCs from each complete pathway of exposure. The HHRA assessed the recreational exposure scenario as described by the ORNL RAIS online Risk Calculator for children and adults.

Toxicity values used in the HHRA were the toxicity values embedded in the RAIS on-line calculator, which for the COPCs benzene and toluene are referenced from USEPA’s IRIS. AWQC based on fish ingestion were used to assess the fish ingestion pathway.

The receptors evaluated for the UDEX release were adult and child recreators who use the Schuylkill River for recreational activities (e.g., boating and fishing). These recreators were assumed to be present in the area of maximum groundwater seepage for the entirety of their exposure periods and are exposed to constituents in surface water via incidental ingestion and dermal absorption. Cancer risks and non-cancer health hazards were estimated for the COPCs associated with the UDEX release (benzene and toluene). Estimated cancer risks and non-cancer hazard indices for recreators in the Schuylkill River are summarized below.

Receptors	Child Non-Cancer Hazard Index	Adult Non-Cancer Hazard Index	Age-Adjusted Non-Cancer Hazard Index	Cumulative Cancer Risk
Recreators in Schuylkill River	5.1E-07	2.0E-07	2.7E-07	2.2E-11

The estimated cancer risks for recreators using the Schuylkill River are less than the USEPA OSWER (USEPA, 1991b) risk management range of 1E-06 to 1E-04 and the estimated non-cancer hazard indices are less than the OSWER (USEPA, 1991b) non-cancer threshold of 1.

Per Title 25 Pennsylvania Code Section 93.9(e), the tidal Schuylkill River is not classified as a potable water source, and as such, the PA Code Chapter 93 Human Health Criteria for benzene and toluene in



Human Health Risk Assessment
 Summary and Conclusions

surface water are not applicable to the lower tidal Schuylkill River. There are no PA Code Chapter 93 Human Health Criteria for ingestion of organisms only. As such, per Section 250.406(c), BDH is requesting a waiver of the PA Code Chapter 93 human health surface water quality criteria for benzene and toluene as they do not apply to surface water in the tidal Schuylkill River. However, the USEPA AWQC for benzene (USEPA, 2015a) and toluene (USEPA, 2015b) are based on ingestion of organisms only and as such are applicable to the lower tidal Schuylkill River since ingestion of recreationally-caught fish is not prohibited. Ingestion of recreationally caught fish was assessed via the comparison of estimated concentrations of COPCs in surface water in the Schuylkill River to AWQC based on ingestion of fish and shellfish.

COPC	USEPA Ambient Water Quality Criterion (cancer: organism only)^a (µg/L)	USEPA Ambient Water Quality Criterion (non-cancer: organism only)^b (µg/L)	Predicted Schuylkill River Surface Water Conc. (µg/L)
Benzene	160 - 580	90	9.2E-04
Toluene	NA	520	2.8E-08

a – based on a cancer risk = 1 E-05

b – based on a non-cancer hazard index = 1

As presented in the table above, maximum predicted surface water concentrations of benzene and toluene in the Schuylkill River are several orders of magnitude less than their applicable AWQC based on fish ingestion.

The results of the HHRA indicate the COPCs associated with the UDEX release do not pose unacceptable risk/hazard to recreators in the lower Schuylkill River.



9 References

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Stantec is a global leader in sustainable architecture, engineering, and environmental consulting. The diverse perspectives of our partners and interested parties drive us to think beyond what's previously been done on critical issues like climate change, digital transformation, and future-proofing our cities and infrastructure. We innovate at the intersection of community, creativity, and client relationships to advance communities everywhere, so that together we can redefine what's possible.



TABLE 3-1 Identification of Complete/Incomplete Exposure Pathways

Table 3-1
Identification of Complete/Incomplete Exposure Pathways
UDEX Feed Underground Line Release

Receptor	Exposure Medium	Exposure Route	Complete/ Incomplete	Rationale	
On-Site Indoor Worker	Surface Soil	Ingestion	Incomplete	UDEX release was subsurface, no surface contamination	
		Dermal Absorption	Incomplete	UDEX release was subsurface, no surface contamination	
		Inhalation	Incomplete	UDEX release was subsurface, no surface contamination	
	Subsurface Soil	Ingestion	Incomplete	Indoor workers not exposed to subsurface soil	
		Dermal Absorption	Incomplete	Indoor workers not exposed to subsurface soil	
		Inhalation	Incomplete	Indoor workers not exposed to subsurface soil	
	Groundwater	Ingestion	Incomplete	On-site groundwater not used for potable purposes	
		Dermal Absorption	Incomplete	On-site groundwater not used for potable purposes	
		Inhalation	Incomplete	On-site groundwater not used for potable purposes	
	Indoor Air	Inhalation	Incomplete	Future buildings will have vapor intrusion controls or sampling	
	On-Site Outdoor Worker	Surface Soil	Ingestion	Incomplete	UDEX release was subsurface, no surface contamination
			Dermal Absorption	Incomplete	UDEX release was subsurface, no surface contamination
Inhalation			Incomplete	UDEX release was subsurface, no surface contamination	
Subsurface Soil		Ingestion	Incomplete	Outdoor workers not exposed to subsurface soil	
		Dermal Absorption	Incomplete	Outdoor workers not exposed to subsurface soil	
		Inhalation	Incomplete	Outdoor workers not exposed to subsurface soil	
Groundwater		Ingestion	Incomplete	Outdoor workers are not exposed to groundwater	
		Dermal Absorption	Incomplete	Outdoor workers are not exposed to groundwater	
		Inhalation	Incomplete	Outdoor workers are not exposed to groundwater	
On-Site Excavation Worker	Surface Soil	Ingestion	Incomplete	UDEX release was subsurface, no surface contamination	
		Dermal Absorption	Incomplete	UDEX release was subsurface, no surface contamination	
		Inhalation	Incomplete	UDEX release was subsurface, no surface contamination	
	Subsurface Soil	Ingestion	Incomplete	Health & safety protocols will mitigate potential exposures	
		Dermal Absorption	Incomplete	Health & safety protocols will mitigate potential exposures	
		Inhalation	Incomplete	Health & safety protocols will mitigate potential exposures	
	Groundwater	Ingestion	Incomplete	Health & safety protocols will mitigate potential exposures	
		Dermal Absorption	Incomplete	Health & safety protocols will mitigate potential exposures	
		Inhalation	Incomplete	Health & safety protocols will mitigate potential exposures	
	Trench Air	Inhalation	Incomplete	Health & safety protocols will mitigate potential exposures	
	Off-Site Recreator	Surface Soil	Ingestion	Incomplete	UDEX release was subsurface, no surface contamination
			Dermal Absorption	Incomplete	UDEX release was subsurface, no surface contamination
Inhalation			Incomplete	UDEX release was subsurface, no surface contamination	
Subsurface Soil		Ingestion	Incomplete	Recreators not exposed to subsurface soil	
		Dermal Absorption	Incomplete	Recreators not exposed to subsurface soil	
		Inhalation	Incomplete	Recreators not exposed to subsurface soil	
Groundwater		Ingestion	Incomplete	Recreators are not exposed to groundwater	
		Dermal Absorption	Incomplete	Recreators are not exposed to groundwater	
		Inhalation	Incomplete	Recreators are not exposed to groundwater	
Surface water		Ingestion	Complete	Recreators may incidentally ingest surface water	
		Dermal Absorption	Complete	Recreators may absorb COPCs in surface water through skin	
		Inhalation	Incomplete	Insignificant due to mixing with outdoor air	
Sediment		Ingestion	Incomplete	Volatile COPCs are unlikely to partition to sediment	
		Dermal Absorption	Incomplete	Volatile COPCs are unlikely to partition to sediment	
		Inhalation	Incomplete	Volatile COPCs are unlikely to partition to sediment	
Fish	Ingestion	Complete	Individuals may ingest recreationally-caught fish		

Table 3-1
Identification of Complete/Incomplete Exposure Pathways
UDEX Feed Underground Line Release

Receptor	Exposure Medium	Exposure Route	Complete/ Incomplete	Rationale	
Off-Site Resident	Surface Soil	Ingestion	Incomplete	UDEX release was subsurface, no surface contamination	
		Dermal Absorption	Incomplete	UDEX release was subsurface, no surface contamination	
		Inhalation	Incomplete	UDEX release was subsurface, no surface contamination	
	Subsurface Soil	Ingestion	Incomplete	No subsurface soil contamination off-Site	
		Dermal Absorption	Incomplete	No subsurface soil contamination off-Site	
		Inhalation	Incomplete	No subsurface soil contamination off-Site	
	Groundwater	Ingestion	Incomplete	Groundwater does not migrate off-Site in residential areas	
		Dermal Absorption	Incomplete	Groundwater does not migrate off-Site in residential areas	
		Inhalation	Incomplete	Groundwater does not migrate off-Site in residential areas	
	Indoor Air	Inhalation	Incomplete	Groundwater does not migrate off-Site in residential areas	
	Off-Site Indoor Worker	Surface Soil	Ingestion	Incomplete	UDEX release was subsurface, no surface contamination
			Dermal Absorption	Incomplete	UDEX release was subsurface, no surface contamination
Inhalation			Incomplete	UDEX release was subsurface, no surface contamination	
Subsurface Soil		Ingestion	Incomplete	Indoor workers not exposed to subsurface soil	
		Dermal Absorption	Incomplete	Indoor workers not exposed to subsurface soil	
		Inhalation	Incomplete	Indoor workers not exposed to subsurface soil	
Groundwater		Ingestion	Incomplete	On-site groundwater not used for potable purposes	
		Dermal Absorption	Incomplete	On-site groundwater not used for potable purposes	
		Inhalation	Incomplete	On-site groundwater not used for potable purposes	
Indoor Air		Inhalation	Incomplete	Groundwater does not migrate off-Site in commercial areas	
Off-Site Outdoor Worker		Surface Soil	Ingestion	Incomplete	UDEX release was subsurface, no surface contamination
			Dermal Absorption	Incomplete	UDEX release was subsurface, no surface contamination
	Inhalation		Incomplete	UDEX release was subsurface, no surface contamination	
	Subsurface Soil	Ingestion	Incomplete	Outdoor workers not exposed to subsurface soil	
		Dermal Absorption	Incomplete	Outdoor workers not exposed to subsurface soil	
		Inhalation	Incomplete	Outdoor workers not exposed to subsurface soil	
	Groundwater	Ingestion	Incomplete	Outdoor workers are not exposed to groundwater	
		Dermal Absorption	Incomplete	Outdoor workers are not exposed to groundwater	
		Inhalation	Incomplete	Outdoor workers are not exposed to groundwater	
	Off-Site Excavation Worker	Surface Soil	Ingestion	Incomplete	UDEX release was subsurface, no surface contamination
			Dermal Absorption	Incomplete	UDEX release was subsurface, no surface contamination
			Inhalation	Incomplete	UDEX release was subsurface, no surface contamination
Subsurface Soil		Ingestion	Incomplete	No subsurface soil contamination off-Site	
		Dermal Absorption	Incomplete	No subsurface soil contamination off-Site	
		Inhalation	Incomplete	No subsurface soil contamination off-Site	
Groundwater		Ingestion	Incomplete	Groundwater not used for potable purposes	
		Dermal Absorption	Incomplete	Groundwater not used for potable purposes	
		Inhalation	Incomplete	Groundwater not used for potable purposes	
Trench Air		Inhalation	Incomplete	Groundwater does not migrate off-Site except Schuuykill R.	

TABLE 3-2 Human Health Risk Assessment Exposure Parameters

Table 3-2
Human Health Risk Assessment Exposure Parameters
UDEX Feed Underground Line Release

Exposure Parameter		Value	Reference
Body Weight - adult (kg)	BW _{rec-a}	80	USEPA, 2014
Body Weight - child (kg)	BW _{rec-c}	15	USEPA, 2014
Body Weight - 0-2 Years (kg)	BW ₀₋₂	15	USEPA, 2014
Body Weight - 2-6 Years (kg)	BW ₂₋₆	15	USEPA, 2014
Body Weight - 6-16 Years (kg)	BW ₆₋₁₆	80	USEPA, 2014
Body Weight - 16-26 Years (kg)	BW ₁₆₋₂₆	80	USEPA, 2014
Exposure Duration - adult (years)	ED _{rec-a}	20	USEPA, 2014
Exposure Duration - child (years)	ED _{rec-c}	6	USEPA, 2014
Exposure Duration - 0-2 Years (years)	ED ₀₋₂	2	USEPA, 2014
Exposure Duration - 2-6 Years (years)	ED ₂₋₆	4	USEPA, 2014
Exposure Duration - 6-16 Years (years)	ED ₆₋₁₆	10	USEPA, 2014
Exposure Duration - 16-26 Years (years)	ED ₁₆₋₂₆	10	USEPA, 2014
Exposure Frequency - adult (days/year)	EF _{rec-a}	45	USEPA, 2018
Exposure Frequency - child (days/year)	EF _{rec-c}	45	USEPA, 2018
Exposure Frequency - 0-2 Years (days/year)	EF ₀₋₂	45	USEPA, 2018
Exposure Frequency - 2-6 Years (days/year)	EF ₂₋₆	45	USEPA, 2018
Exposure Frequency - 6-16 Years (days/year)	EF ₆₋₁₆	45	USEPA, 2018
Exposure Frequency - 16-26 Years (days/year)	EF ₁₆₋₂₆	45	USEPA, 2018
Exposure Time - child (hours/event)	ET _{event-rec-c}	1	Reasonable Estimate
Exposure Time - adult (hours/event)	ET _{event-rec-a}	1	Reasonable Estimate
Exposure Time (hours/event)	ET _{event-rec(0-2)}	1	Reasonable Estimate
Exposure Time (hours/event)	ET _{event-rec(2-6)}	1	Reasonable Estimate
Exposure Time (hours/event)	ET _{event-rec(6-16)}	1	Reasonable Estimate
Exposure Time (hours/event)	ET _{event-rec(16-26)}	1	Reasonable Estimate
Events - child (events/day)	EV _{rec-c}	1	Reasonable Estimate
Events - adult (events/day)	EV _{rec-a}	1	Reasonable Estimate
Events (events/day)	EV ₀₋₂	1	Reasonable Estimate
Events (events/day)	EV ₂₋₆	1	Reasonable Estimate
Events (events/day)	EV ₆₋₁₆	1	Reasonable Estimate
Events (events/day)	EV ₁₆₋₂₆	1	Reasonable Estimate
Ingestion Rate - Child (L/hour)	IRW _{rec-c}	0.12	USEPA, 2011, Table 3.5
Ingestion Rate - Adult (L/hour)	IRW _{rec-a}	0.11	USEPA, 2019. Time-weighted average calculated based on the upper percentile from Table 3.7.
Ingestion Rate - 0-2 years (L/hour)	IRW ₀₋₂	0.12	USEPA, 2011, Table 3.5
Ingestion Rate - 2-6 years (L/hour)	IRW ₂₋₆	0.12	USEPA, 2011, Table 3.5

Table 3-2
Human Health Risk Assessment Exposure Parameters
UDEX Feed Underground Line Release

Exposure Parameter		Value	Reference
Ingestion Rate - 6-16 years (L/hour)	IRW_{6-16}	0.124	USEPA, 2019. Time-weighted average calculated based on the upper percentile from Table 3.7.
Ingestion Rate - 16-26 years (L/hour)	IRW_{16-26}	0.0985	USEPA, 2019. Time-weighted average calculated based on the upper percentile from Table 3.7.
Ingestion Rate - Age-adjusted (L/kg)	$IFW_{rec-adj}$	3.4	Calculated using the age-adjusted intake factors equation
Mutagenic Ingestion Rate - Age-adjusted (L/kg)	$IFWM_{rec-adj}$	14	Calculated using the mutagenic age-adjusted intake factors equation
Surface area - child (cm ²)	SA_{rec-c}	6,365	USEPA, 2014
Surface area - adult (cm ²)	SA_{rec-a}	19,652	USEPA, 2014
Surface area 0-2 years (cm ²)	SA_{0-2}	6,365	USEPA, 2014
Surface area 2-6 years (cm ²)	SA_{2-6}	6,365	USEPA, 2014
Surface area 6-16 years (cm ²)	SA_{6-16}	19,652	USEPA, 2014
Surface area 16-26 (cm ²)	SA_{16-26}	19,652	USEPA, 2014
Dermal contact factor- age-adjusted (cm ² -event/kg)	$DFW_{rec-adj}$	335,655	Calculated using the age-adjusted intake factors equation
Mutagenic dermal contact factor- age-adjusted (cm ² -event/kg)	$DFWM_{rec-adj}$	1,053,210	Calculated using the mutagenic age-adjusted intake factors equation
Averaging time (days/year)	AT_{rec}	365 x LT	USEPA, 2014
Averaging time (days/year)	AT_{rec-c}	365 x ED_{rec-c}	USEPA, 2014
Averaging time (days/year)	AT_{rec-a}	365 x ED_{rec-a}	USEPA, 2014

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TABLE 4-1 Toxicity Data for COPCs

**Table 4-1
Toxicity Data for COPCs
UDEX Feed Underground Line Release
Philadelphia, Pennsylvania**

COPCs	C.A.S. No.	SF _o (mg/kg-day) ⁻¹	Ref.	IUR (µg/m ³) ⁻¹	Ref.	Chronic RfD _o (mg/kg-day)	Ref.	Sub-Chronic RfD _o (mg/kg-day)	Ref.	Chronic RfC _i (mg/m ³)	Ref.	Sub-Chronic RfC _i (mg/m ³)	Ref.	Volatile	Mutagen	ABS _{GI}	ABS _{Derm}	C _{sat} (mg/kg)
Volatile Organic Compounds :																		
Benzene	71-43-2	5.5E-02	IRIS	7.8E-06	IRIS	4.0E-03	IRIS	1.0E-02	PPRTV	3.0E-02	IRIS	8.0E-02	PPRTV	Yes	No	1	--	1.8E+03
Toluene	108-88-3	NA		NA		8.0E-02	IRIS	8.0E-01	PPRTV	5.0E+00	IRIS	5.0E+00	PPRTV	Yes	No	1	--	8.2E+02

NA - Not Available

IRIS - USEPA Integrated Risk Information System

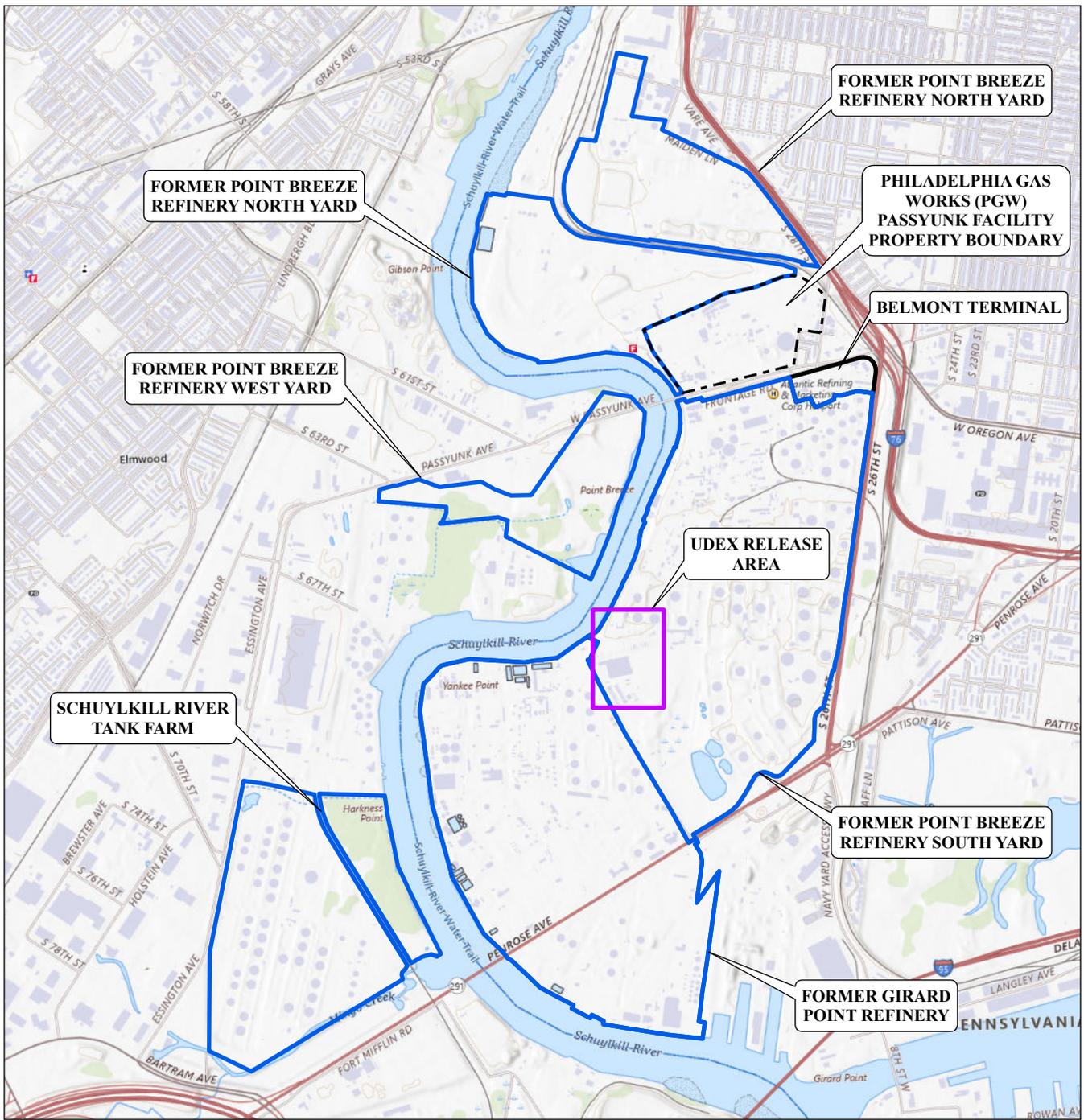
CalEPA - California Environmental Protection Agency

HEAST - Health Effects Assessment Summary Tables

PPRTV - Provisional Peer Reviewed Toxicity Value for Superfund

ATSDR - Agency for Toxic Substances and Disease Registry

FIGURE 1-1 Site Location Map



FORMER POINT BREEZE REFINERY NORTH YARD

FORMER POINT BREEZE REFINERY NORTH YARD

PHILADELPHIA GAS WORKS (PGW) PASSYUNK FACILITY PROPERTY BOUNDARY

FORMER POINT BREEZE REFINERY WEST YARD

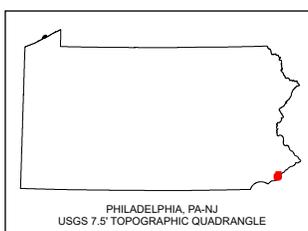
BELMONT TERMINAL

UDEX RELEASE AREA

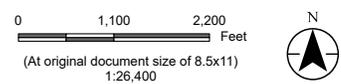
SCHUYLKILL RIVER TANK FARM

FORMER POINT BREEZE REFINERY SOUTH YARD

FORMER GIRARD POINT REFINERY



- Legend**
- UDEX Release Area
 - Former PES Refinery
 - Belmont Terminal
 - Philadelphia Gas Works (PGW)
 - Passyunk Facility Property Boundary



Stantec

Project Location
City of Philadelphia, Philadelphia County, PA

Prepared by GWC on 2025-05-29
TR Review by ADK on 2025-07-15
IR Review by JKK on 2025-07-21

Client/Project
BELLWETHER DISTRICT HOLDINGS, LLC
FORMER PES REFINERY
3144 PASSYUNK AVENUE, PHILADELPHIA, PA 19145

195603450

Figure No.
1-1
Title
Site Location Map

Notes

1. Coordinate System: NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet
2. Data Sources: Stantec, USGS
3. Background: USGS Topo Layers (TMN); USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road data; Natural Earth Data; U.S. Department of State HIU; NOAA National Centers for Environmental Information. Data refreshed July, 2025.

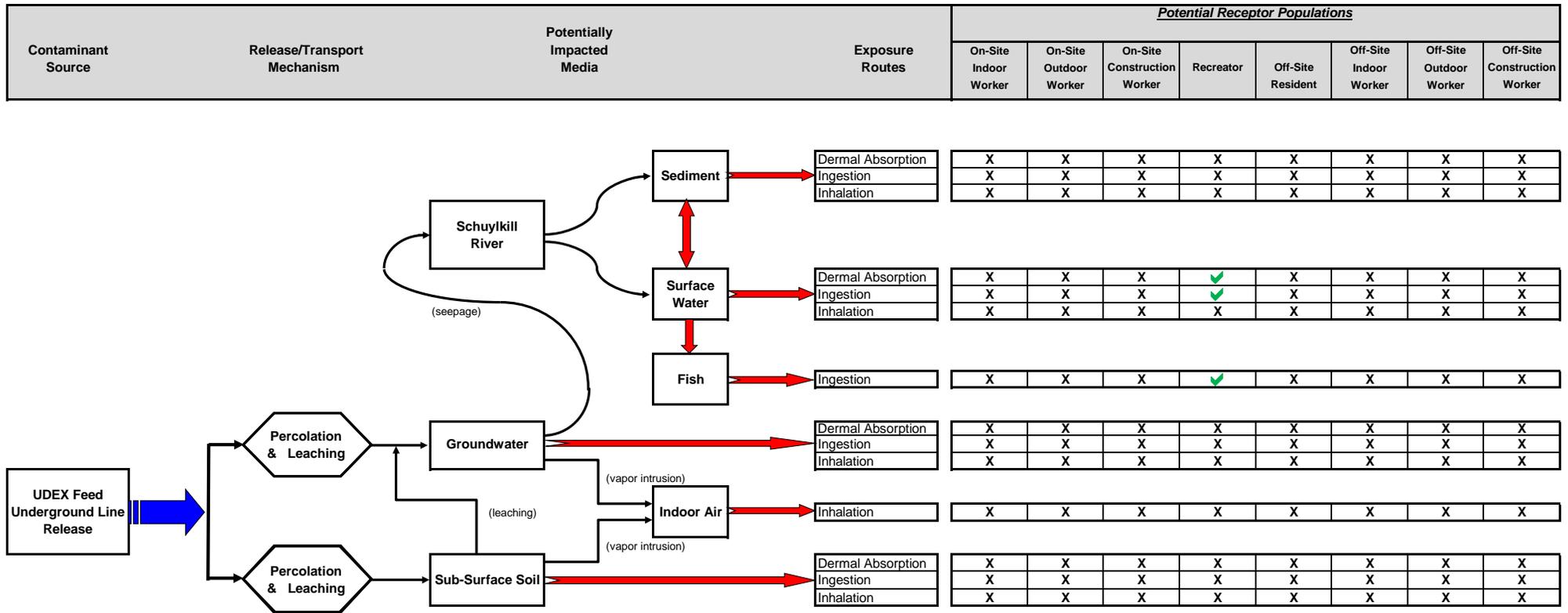
I:\us0245-pbls01\shared_projects\19560345003_data\gis_cad\gis\PRO\index_rfr_sec1.aprx Revised: 2025-08-19 By: gcurry

Disclaimer: This document has been prepared based on information provided by others as cited in the Notes section. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

FIGURE 2-1 UDEX Investigation Site Plan

FIGURE 3-1 Human Health Risk Assessment Conceptual Site Model

Figure 3-1
Human Health Risk Assessment Conceptual Site Model
UDEX Feed Underground Line Release



Key To Potential Exposure Routes

- ✓ - Potentially complete exposure pathway
- X - Incomplete exposure pathway

APPENDIX A Reformat Safety Data Sheet

SAFETY DATA SHEET

1. Identification

Product identifier REFORMATE LIGHT MTR
Other means of identification None.
Recommended use Motor Fuel
Recommended restrictions None known.

Manufacturer/Importer/Supplier/Distributor information

Manufacturer

Company name Philadelphia Energy Solutions
Address 3144 W. Passyunk Ave
 Philadelphia, Pennsylvania, 19145
E-mail msds@PES-Companies.com
Emergency phone number
24 Hours Information (215) 339-5400
Product Safety Information (215) 339-2000

2. Hazard(s) identification

Physical hazards Flammable liquids Category 2
Health hazards Germ cell mutagenicity Category 1B
 Carcinogenicity Category 1B
 Aspiration hazard Category 1
Environmental hazards Hazardous to the aquatic environment, acute hazard Category 2
OSHA defined hazards Not classified.
Label elements



Signal word Danger

Hazard statement Highly flammable liquid and vapor. May be fatal if swallowed and enters airways. Causes skin irritation. May cause drowsiness or dizziness. May cause genetic defects. May cause cancer. Very toxic to aquatic life. Toxic to aquatic life with long lasting effects.

Precautionary statement

Prevention Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Keep away from heat/sparks/open flames/hot surfaces. - No smoking. Keep container tightly closed. Ground/bond container and receiving equipment. Use explosion-proof electrical/ventilating/lighting equipment. Use only non-sparking tools. Take precautionary measures against static discharge. Avoid breathing mist or vapor. Wash thoroughly after handling. Use only outdoors or in a well-ventilated area. Avoid release to the environment. Wear protective gloves/protective clothing/eye protection/face protection.

Response If swallowed: Immediately call a poison center/doctor. If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower. If skin irritation occurs: Get medical advice/attention. If inhaled: Remove person to fresh air and keep comfortable for breathing. If exposed or concerned: Get medical advice/attention. Call a poison center/doctor if you feel unwell. Do NOT induce vomiting. Take off contaminated clothing and wash before reuse. In case of fire: Use appropriate media to extinguish. Collect spillage.

Storage Store in a well-ventilated place. Keep container tightly closed. Store in a well-ventilated place. Keep cool. Store locked up.

Disposal Dispose of contents/container in accordance with local/regional/national/international regulations.

Hazard(s) not otherwise classified (HNOC)

Static accumulating flammable liquid can become electrostatically charged even in bonded and grounded equipment. Sparks may ignite liquid and vapor. May cause flash fire or explosion.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Catalytic Reformed Light Naphtha	64741-63-5	100

Constituents

Chemical name	CAS number	%
Benzene	71-43-2	0 - 20
Toluene	108-88-3	0 - 20
Naphtha (petroleum), light straight-run	64741-46-4	10
Xylene	1330-20-7	0 - 10

Composition comments

Occupational Exposure Limits for constituents are listed in Section 8.

4. First-aid measures

Inhalation

If breathing is difficult, remove to fresh air and keep at rest in a position comfortable for breathing. Call a physician if symptoms develop or persist.

Skin contact

Take off immediately all contaminated clothing. Rinse skin with water/shower. Get medical attention if irritation develops and persists.

Eye contact

Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Get medical attention if irritation develops and persists.

Ingestion

Call a physician or poison control center immediately. Rinse mouth. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs.

Most important symptoms/effects, acute and delayed

Aspiration may cause pulmonary edema and pneumonitis. Direct contact with eyes may cause temporary irritation.

Indication of immediate medical attention and special treatment needed

Provide general supportive measures and treat symptomatically. Thermal burns: Flush with water immediately. While flushing, remove clothes which do not adhere to affected area. Call an ambulance. Continue flushing during transport to hospital. Keep victim under observation. Symptoms may be delayed.

General information

Take off all contaminated clothing immediately. IF exposed or concerned: Get medical advice/attention. If you feel unwell, seek medical advice (show the label where possible). Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance. Wash contaminated clothing before reuse.

5. Fire-fighting measures

Suitable extinguishing media

Water fog. Foam. Carbon dioxide (CO₂). Dry chemical powder, carbon dioxide, sand or earth may be used for small fires only.

Unsuitable extinguishing media

Do not use water jet as an extinguisher, as this will spread the fire.

Specific hazards arising from the chemical

Vapors may form explosive mixtures with air. Vapors may travel considerable distance to a source of ignition and flash back. This product is a poor conductor of electricity and can become electrostatically charged. If sufficient charge is accumulated, ignition of flammable mixtures can occur. To reduce potential for static discharge, use proper bonding and grounding procedures. This liquid may accumulate static electricity when filling properly grounded containers. Static electricity accumulation may be significantly increased by the presence of small quantities of water or other contaminants. Material will float and may ignite on surface of water. During fire, gases hazardous to health may be formed.

Special protective equipment and precautions for firefighters

Self-contained breathing apparatus and full protective clothing must be worn in case of fire.

Fire fighting equipment/instructions

In case of fire and/or explosion do not breathe fumes. Move containers from fire area if you can do so without risk.

Specific methods

Use standard firefighting procedures and consider the hazards of other involved materials.

General fire hazards

Highly flammable liquid and vapor.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Wear appropriate protective equipment and clothing during clean-up. Avoid breathing mist or vapor. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ventilate closed spaces before entering them. Use appropriate containment to avoid environmental contamination. Transfer by mechanical means such as vacuum truck to a salvage tank or other suitable container for recovery or safe disposal. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.

Methods and materials for containment and cleaning up

Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Take precautionary measures against static discharge. Use only non-sparking tools. Keep combustibles (wood, paper, oil, etc.) away from spilled material. This product is miscible in water.

Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Cover with plastic sheet to prevent spreading. Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. Prevent product from entering drains. Following product recovery, flush area with water.

Small Spills: Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal. Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination.

Environmental precautions

Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.

Avoid release to the environment. Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground. Inform appropriate managerial or supervisory personnel of all environmental releases. Use appropriate containment to avoid environmental contamination.

7. Handling and storage

Precautions for safe handling

Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not handle, store or open near an open flame, sources of heat or sources of ignition. Protect material from direct sunlight. When using do not smoke. Explosion-proof general and local exhaust ventilation. Minimize fire risks from flammable and combustible materials (including combustible dust and static accumulating liquids) or dangerous reactions with incompatible materials. Handling operations that can promote accumulation of static charges include but are not limited to: mixing, filtering, pumping at high flow rates, splash filling, creating mists or sprays, tank and container filling, tank cleaning, sampling, gauging, switch loading, vacuum truck operations. Take precautionary measures against static discharges. All equipment used when handling the product must be grounded. Use non-sparking tools and explosion-proof equipment. Should be handled in closed systems, if possible. Wear appropriate personal protective equipment. Wash hands thoroughly after handling. Observe good industrial hygiene practices.

For additional information on equipment bonding and grounding, refer to the Canadian Electrical Code in Canada, (CSA C22.1), or the American Petroleum Institute (API) Recommended Practice 2003, "Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents" or National Fire Protection Association (NFPA) 77, "Recommended Practice on Static Electricity" or National Fire Protection Association (NFPA) 70, "National Electrical Code".

Conditions for safe storage, including any incompatibilities

Store locked up. Keep away from heat, sparks and open flame. Prevent electrostatic charge build-up by using common bonding and grounding techniques. Eliminate sources of ignition. Avoid spark promoters. Ground/bond container and equipment. These alone may be insufficient to remove static electricity. Store in a cool, dry place out of direct sunlight. Store in original tightly closed container. Store in a well-ventilated place. Keep in an area equipped with sprinklers. Store away from incompatible materials (see Section 10 of the SDS).

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Constituents	Type	Value
Benzene (CAS 71-43-2)	STEL	5 ppm
	TWA	1 ppm

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Constituents	Type	Value
Xylene (CAS 1330-20-7)	PEL	435 mg/m ³
		100 ppm

US. OSHA Table Z-2 (29 CFR 1910.1000)

Constituents	Type	Value
Benzene (CAS 71-43-2)	Ceiling	25 ppm
	TWA	10 ppm
Toluene (CAS 108-88-3)	Ceiling	300 ppm
	TWA	200 ppm

US. ACGIH Threshold Limit Values

Constituents	Type	Value
Xylene (CAS 1330-20-7)	STEL	150 ppm
	TWA	100 ppm
Benzene (CAS 71-43-2)	STEL	2.5 ppm
	TWA	0.5 ppm
Toluene (CAS 108-88-3)	TWA	20 ppm

US. NIOSH: Pocket Guide to Chemical Hazards

Constituents	Type	Value
Xylene (CAS 1330-20-7)	STEL	655 mg/m ³
		150 ppm
	TWA	435 mg/m ³
Benzene (CAS 71-43-2)		100 ppm
	STEL	1 ppm
Toluene (CAS 108-88-3)	TWA	0.1 ppm
	STEL	560 mg/m ³
		150 ppm
	TWA	375 mg/m ³
		100 ppm

Biological limit values

ACGIH Biological Exposure Indices

Constituents	Value	Determinant	Specimen	Sampling Time
Xylene (CAS 1330-20-7)	1.5 g/g	Methylhippuric acids	Creatinine in urine	*
Benzene (CAS 71-43-2)	25 µg/g	S-Phenylmercapturic acid	Creatinine in urine	*
Toluene (CAS 108-88-3)	0.3 mg/g	o-Cresol, with hydrolysis	Creatinine in urine	*
	0.03 mg/l	Toluene	Urine	*
	0.02 mg/l	Toluene	Blood	*

* - For sampling details, please see the source document.

Exposure guidelines

US - California OELs: Skin designation

Benzene (CAS 71-43-2)

Can be absorbed through the skin.

Toluene (CAS 108-88-3)

Can be absorbed through the skin.

US - Minnesota Haz Subs: Skin designation applies

Toluene (CAS 108-88-3)

Skin designation applies.

US ACGIH Threshold Limit Values: Skin designation

Benzene (CAS 71-43-2)

Can be absorbed through the skin.

Appropriate engineering controls

Explosion-proof general and local exhaust ventilation. Eye wash fountain and emergency showers are recommended.

Individual protection measures, such as personal protective equipment

Eye/face protection	Chemical respirator with organic vapor cartridge and full facepiece.
Skin protection	
Hand protection	Wear appropriate chemical resistant gloves.
Other	Wear suitable protective clothing. Use of an impervious apron is recommended.
Respiratory protection	Chemical respirator with organic vapor cartridge and full facepiece.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	When using do not smoke. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties**Appearance**

Physical state	Liquid.
Form	Liquid.
Color	Colorless.
Odor	Gasoline.
Odor threshold	Not available.
pH	Not available.
Melting point/freezing point	Not available.
Initial boiling point and boiling range	100 - 435 °F (37.78 - 223.89 °C)
Flash point	-40.0 °F (-40.0 °C) Closed Cup
Evaporation rate	Not available.
Flammability (solid, gas)	Not available.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	1.5 %
Flammability limit - upper (%)	7.6 %
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	525 mm Hg at 20°C
Vapor density	Not available.
Relative density	0.75
Solubility(ies)	
Solubility (water)	Nil
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	750 °F (398.89 °C)
Decomposition temperature	Not available.
Viscosity	Not available.
Other information	
Percent volatile	100

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Avoid heat, sparks, open flames and other ignition sources. Avoid temperatures exceeding the flash point. Contact with incompatible materials.
Incompatible materials	Strong oxidizing agents.

Hazardous decomposition products No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Inhalation May cause drowsiness and dizziness. Headache. Nausea, vomiting.
Skin contact Causes skin irritation.
Eye contact Direct contact with eyes may cause temporary irritation.
Ingestion Droplets of the product aspirated into the lungs through ingestion or vomiting may cause a serious chemical pneumonia.

Symptoms related to the physical, chemical and toxicological characteristics May cause drowsiness and dizziness. Headache. Nausea, vomiting. Aspiration may cause pulmonary edema and pneumonitis. Skin irritation. May cause redness and pain.

Information on toxicological effects

Acute toxicity May be fatal if swallowed and enters airways. Narcotic effects.

Toxicological data

Constituents	Species	Test Results
Xylene (CAS 1330-20-7)		
Acute		
<i>Dermal</i>		
LD50	Rabbit	12126 mg/kg, 24 Hours
<i>Inhalation</i>		
LC50	Rat	6350 ppm, 4 Hours
<i>Oral</i>		
LD50	Rat	3523 mg/kg
Benzene (CAS 71-43-2)		
Acute		
<i>Oral</i>		
LD50	Rat	930 mg/kg
Toluene (CAS 108-88-3)		
Acute		
<i>Dermal</i>		
LD50	Rabbit	14.1 ml/kg
<i>Inhalation</i>		
LC50	Rat	49000 mg/m ³ , 4 Hours
<i>Oral</i>		
LD50	Rat	636 mg/kg

Skin corrosion/irritation Causes skin irritation.

Serious eye damage/eye irritation Direct contact with eyes may cause temporary irritation.

Respiratory or skin sensitization

Respiratory sensitization Not a respiratory sensitizer.

Skin sensitization This product is not expected to cause skin sensitization.

Germ cell mutagenicity May cause genetic defects.

Carcinogenicity May cause cancer.

IARC Monographs. Overall Evaluation of Carcinogenicity

Benzene (CAS 71-43-2) 1 Carcinogenic to humans.
Toluene (CAS 108-88-3) 3 Not classifiable as to carcinogenicity to humans.
Xylene (CAS 1330-20-7) 3 Not classifiable as to carcinogenicity to humans.

NTP Report on Carcinogens

Benzene (CAS 71-43-2) Known To Be Human Carcinogen.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Benzene (CAS 71-43-2) Cancer

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure May cause drowsiness and dizziness.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard May be fatal if swallowed and enters airways.

12. Ecological information

Ecotoxicity Very toxic to aquatic life. Toxic to aquatic life with long lasting effects.

Constituents	Species	Test Results
Toluene (CAS 108-88-3)		
Aquatic		
Crustacea	EC50	Water flea (Daphnia magna) 5.46 - 9.83 mg/l, 48 hours
Fish	LC50	Pink salmon (Oncorhynchus gorbuscha) 6.86 - 8.48 mg/l, 96 hours

Persistence and degradability No data is available on the degradability of this product.

Bioaccumulative potential Not available.

Mobility in soil Expected to be slightly to moderately mobile in soil.

Other adverse effects No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal instructions Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Dispose of contents/container in accordance with local/regional/national/international regulations.

Local disposal regulations Dispose in accordance with all applicable regulations.

Hazardous waste code The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

US RCRA Hazardous Waste U List: Reference

Benzene (CAS 71-43-2)	U019
Toluene (CAS 108-88-3)	U220
Xylene (CAS 1330-20-7)	U239

Waste from residues / unused products Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

UN number UN1268

UN proper shipping name Petroleum products, n.o.s. (naphtha, benzene)

Transport hazard class(es)

Class 3

Subsidiary risk -

Label(s) 3

Packing group II

Environmental hazards

Marine pollutant Yes

Special precautions for user Read safety instructions, SDS and emergency procedures before handling.

Special provisions 144, IB2, T7, TP1, TP8, TP28

Packaging exceptions 150

Packaging non bulk 202

Packaging bulk 242

IATA

UN number UN1268

UN proper shipping name Petroleum products, n.o.s. (naphtha, benzene)

Transport hazard class(es)

Class 3

Subsidiary risk -

Label(s) 3

Packing group II

Environmental hazards Yes

ERG Code 3H

Special precautions for user Read safety instructions, SDS and emergency procedures before handling.

IMDG

UN number UN1268

UN proper shipping name PETROLEUM PRODUCTS, N.O.S. (naphtha, benzene)

Transport hazard class(es)

Class 3

Subsidiary risk -

Label(s) 3

Packing group II

Environmental hazards

Marine pollutant Yes

EmS F-E, S-E

Special precautions for user Read safety instructions, SDS and emergency procedures before handling.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not established.

General information IMDG Regulated Marine Pollutant.

15. Regulatory information**US federal regulations**

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
All components are on the U.S. EPA TSCA Inventory List.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Benzene (CAS 71-43-2)

Cancer
Central nervous system
Blood
Aspiration
Skin
Eye
respiratory tract irritation
Flammability

CERCLA Hazardous Substance List (40 CFR 302.4)

Benzene (CAS 71-43-2)

LISTED

Toluene (CAS 108-88-3)

LISTED

Xylene (CAS 1330-20-7)

LISTED

Superfund Amendments and Reauthorization Act of 1986 (SARA)**Hazard categories**

Immediate Hazard - Yes
Delayed Hazard - Yes
Fire Hazard - Yes
Pressure Hazard - No
Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical

Yes

SARA 313 (TRI reporting)

Chemical name	CAS number	% by wt.
Benzene	71-43-2	0 - 20
Xylene	1330-20-7	0 - 10

SARA 313 (TRI reporting)

Chemical name	CAS number	% by wt.
Toluene	108-88-3	0 - 20

Other federal regulations**Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List**

Benzene (CAS 71-43-2)
Toluene (CAS 108-88-3)
Xylene (CAS 1330-20-7)

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.**Drug Enforcement Administration (DEA). List 2, Essential Chemicals (21 CFR 1310.02(b) and 1310.04(f)(2) and Chemical Code Number**

Toluene (CAS 108-88-3) 6594

Drug Enforcement Administration (DEA). List 1 & 2 Exempt Chemical Mixtures (21 CFR 1310.12(c))

Toluene (CAS 108-88-3) 35 %WV

DEA Exempt Chemical Mixtures Code Number

Toluene (CAS 108-88-3) 594

US state regulations**US. Massachusetts RTK - Substance List**

Benzene (CAS 71-43-2)
Toluene (CAS 108-88-3)
Xylene (CAS 1330-20-7)

US. New Jersey Worker and Community Right-to-Know Act

Benzene (CAS 71-43-2)
Toluene (CAS 108-88-3)
Xylene (CAS 1330-20-7)

US. Pennsylvania Worker and Community Right-to-Know Law

Benzene (CAS 71-43-2)
Toluene (CAS 108-88-3)
Xylene (CAS 1330-20-7)

US. Rhode Island RTK

Benzene (CAS 71-43-2)
Toluene (CAS 108-88-3)
Xylene (CAS 1330-20-7)

US. California Proposition 65

WARNING: This product contains a chemical known to the State of California to cause cancer and birth defects or other reproductive harm.

US - California Proposition 65 - Carcinogens & Reproductive Toxicity (CRT): Listed substance

Benzene (CAS 71-43-2)
Toluene (CAS 108-88-3)

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	No

Country(s) or region	Inventory name	On inventory (yes/no)*
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).

A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date	09-June-2015
Revision date	-
Version #	01
HMIS® ratings	Health: 2* Flammability: 3 Physical hazard: 0

NFPA ratings



Disclaimer

Philadelphia Energy Solutions cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

APPENDIX B RAIS Risk Calculator Output

**Cancer Risks and Non-Cancer Hazards
Schuylkill River Recreator
UDEX Feed Underground Line Release**

Site-specific Risk
Recreator for Surface Water

Key: IC = IRIS Current; IA = IRIS Archive; PC = PPRTV Current; PA = PPRTV Archive; O = OPP; AF = ATSDR Final; AD = ATSDR Draft; C = Cal EPA; XC = PPRT

Chemical	CAS Number	Category	Mutagen?	VOC?	RfD (mg/kg-day)	RfD Ref	SF ₀ (mg/kg-day) ⁻¹	SF ₀ Ref	ABS _{gl}	K _p (cm/hr)	B Ratio across viable epidermis (unitless)	t*	Tau _{event} (hr/event)	FA	EPD
Benzene	71-43-2	VOCs	No	Yes	4.00E-03	IC	5.50E-02	IC	1.00E+00	1.49E-02	5.07E-02	6.91E-01	2.88E-01	1.00E+00	1.00E+00
Toluene	108-88-3	VOCs	No	Yes	8.00E-02	IC	-	-	1.00E+00	3.11E-02	1.15E-01	8.28E-01	3.45E-01	1.00E+00	1.00E+00
<i>*Total Risk/HI</i>					-	-	-	-	-	-	-	-	-	-	-

Output generated 10JUN2025:15:15:39

**Cancer Risks and Non-Cancer Hazards
Schuylkill River Recreator
UDEX Feed Underground Line Release**

Site-specific Risk
Recreator for Surface Water

Key: IC = IRIS Current; IA =V Screening Level Current; XA = PPRTV Screening Level Archive; HC = HEAST Current; HA = HEAST Archive; D = OW; W =

Chemical	CAS Number	Carcinogenic Absorbed dose per event (ug/cm ² -event)	Noncancer-child Absorbed dose per event (ug/cm ² -event)	Noncancer-adult Absorbed dose per event (ug/cm ² -event)	Noncancer-adjusted Absorbed dose per event (ug/cm ² -event)	Surface Water Concentration (ug/L)	Child Ingestion Noncarcinogenic CDI (mg/kg-day)	Child Dermal Noncarcinogenic CDI (mg/kg-day)
Benzene	71-43-2	2.13E-08	2.13E-08	2.13E-08	2.13E-08	9.20E-04	9.07E-10	1.12E-09
Toluene	108-88-3	1.45E-12	1.45E-12	1.45E-12	1.45E-12	2.80E-08	2.76E-14	7.59E-14
<i>*Total Risk/Hi</i>		-	-	-	-	-	-	-

Output generated 10JUN2025:15:1

Cancer Risks and Non-Cancer Hazards Schuylkill River Recreator UDEX Feed Underground Line Release

Site-specific Risk

Recreator for Surface Water

Key: IC = IRIS Current; IA = EF applied; E = RPF applied; SU = Surrogate;

Chemical	CAS Number	Adult Ingestion Noncarcinogenic CDI (mg/kg-day)	Adult Dermal Noncarcinogenic CDI (mg/kg-day)	Adjusted Ingestion Noncarcinogenic CDI (mg/kg-day)	Adjusted Dermal Noncarcinogenic CDI (mg/kg-day)	Ingestion Carcinogenic CDI (mg/kg-day)	Dermal Carcinogenic CDI (mg/kg-day)
Benzene	71-43-2	1.56E-10	6.46E-10	3.30E-10	7.55E-10	1.22E-10	2.80E-10
Toluene	108-88-3	4.75E-15	4.39E-14	1.00E-14	5.13E-14	3.73E-15	1.91E-14
<i>*Total Risk/HI</i>		-	-	-	-	-	-

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Cancer Risks and Non-Cancer Hazards Schuylkill River Recreator UDEX Feed Underground Line Release

Site-specific Risk

Recreator for Surface Water

Key: IC = IRIS Current; IA =

Chemical	CAS Number	Child Ingestion HQ	Child Dermal HQ	Child Total HI	Adult Ingestion HQ	Adult Dermal HQ	Adult Total HI	Adjusted Ingestion HQ	Adjusted Dermal HQ	Adjusted Total HI	Ingestion Risk	Dermal Risk	Total Risk
Benzene	71-43-2	2.27E-07	2.79E-07	5.06E-07	3.90E-08	1.62E-07	2.01E-07	8.24E-08	1.89E-07	2.71E-07	6.73E-12	1.54E-11	2.22E-11
Toluene	108-88-3	3.45E-13	9.48E-13	1.29E-12	5.93E-14	5.49E-13	6.08E-13	1.25E-13	6.41E-13	7.67E-13	-	-	-
*Total Risk/HI		2.27E-07	2.79E-07	5.06E-07	3.90E-08	1.62E-07	2.01E-07	8.24E-08	1.89E-07	2.71E-07	6.73E-12	1.54E-11	2.22E-11

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APPENDIX C Pre-Existing Conditions Acknowledgement – UDEX Release Area



Evergreen Resources Management
2 Righter Parkway, Suite 120
Wilmington, DE 19803

January 30, 2026

Matthew Sabetta, PG
Pennsylvania Department of Environmental Protection
Southeast Regional Office
2 East Main Street
Norristown, PA 19401

**Subject: Pre-Existing conditions acknowledgment - UDEX Release Area
Point Breeze South Yard – Former PES Refinery
3144 West Passyunk Avenue
City of Philadelphia, Philadelphia County**

Dear Matt:

This letter is to acknowledge that Evergreen Resources Management Operations (Evergreen) has reviewed Stantec Consulting Services Inc.'s (Stantec) Remedial Investigation (RI), Human Health Risk Assessment (HHRA), and Screening Level Ecological Risk Assessment (SLERA) reports for the UDEX Release, completed on behalf of Bellwether District Holdings, LLC (BDH). In accordance with the 2012 Consent Order & Agreement (CO&A) and the 2020 CO&A Amendment, Evergreen is responsible for addressing Pre-Existing Contamination at the facility, and BDH is responsible for addressing Post-September 2012 Contamination. Pre-Existing Contamination is the result of historic petroleum releases that occurred at the facility during the period of Evergreen responsibility and were previously characterized by Evergreen through approved Act 2 reporting.

Evergreen acknowledges Pre-Existing Contamination was identified and characterized in the area of the UDEX release as reported in Evergreen's past Act 2 Area of Interest 3 (AOI 3) and Sitewide Fate & Transport Remedial Investigation Reports (RIRs). The Pre-Existing Contamination is managed via pathway elimination as documented in the Human Health Risk Assessments and Cleanup Plan. Evergreen will continue to manage sitewide Pre-Existing Contamination through the One Cleanup Program under Facility ID No. 780190. Please contact me if you have any questions or concerns regarding this letter.

Regards,

Evergreen Resources Management Operations

Tiffani L. Doerr, PG

cc: Julianna Connolly (HRP Group)
Joe Jeray (HRP Group)

APPENDIX D Report Notices

The Philadelphia Inquirer

100 S. INDEPENDENCE MALL W, STE 600, PHILADELPHIA, PA 19106

Affidavit of Publication

On Behalf of:
STANTEC
1060 Andrew Drive
WEST CHESTER, PA 19380

STATE OF PENNSYLVANIA COUNTY OF PHILADELPHIA:

Before the undersigned authority personally appeared the undersigned who, on oath represented a and say: that I am an employee of The Philadelphia Inquirer, LLC, and am authorized to make this affidavit of publication, and being duly sworn, I depose and say:

1. The Philadelphia Inquirer, LLC is the publisher of the Philadelphia Daily News, with its headquarters at 100 S. Independence Mall West, Suite 600, Philadelphia, PA 19106.
2. The Philadelphia Daily News is an edition of The Philadelphia Inquirer. The Philadelphia Daily News is continuously published and distributed Sunday-Friday in the City of Philadelphia, count and state aforesaid.
3. The printed notice or publication attached hereto set forth on attached hereto was published in all regular print editions of the Philadelphia Daily News on

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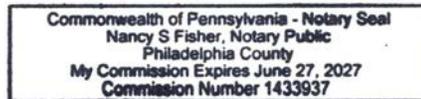
2/10/2026

4. Under oath, I state that the following is true and correct, and that neither I nor The Philadelphia Inquirer, LLC have any is interest in the subject matter of the aforesaid notice or advertisement.



Notary Public

My Commission Expires:



Ad No: 201440
Customer No: 103409

COPY OF ADVERTISEMENT

Bellwether District – UDEX Release Risk Assessment Reports

Pursuant to the Land Recycling and Environmental Remediation Standards Act, the act of May 19, 1995, P.L. 4, No. 1995-2., notice is hereby given that Bellwether District Holdings, LLC (BDH) is submitting Human Health Risk Assessment and Screening Level Ecological Risk Assessment Reports to the Pennsylvania Department of Environmental Protection (PADEP) Southeast Regional Office for the UDEX release site at the former Philadelphia Energy Solutions Refinery located at 3144 West Passyunk Avenue, Philadelphia, Philadelphia County, Pennsylvania on February 11, 2026. The reports are being submitted in accordance with site-specific remediation standards.



Stantec Consulting Services Inc.
1060 Andrew Drive, Suite 140
West Chester PA 19380-5602

February 9, 2026

Leigh Anne Rainford, MPH
Philadelphia Department of Public Health
Environmental Health Services
321 University Avenue - 2nd Floor
Philadelphia, PA 19104

Dear Ms. Rainford,

**Reference: Submission of Risk Assessment Reports
UDEX Release Area – Point Breeze South Yard
Former PES Refinery
3144 West Passyunk Avenue
Philadelphia, PA 19153**

This letter is to provide notice to the City of Philadelphia that Bellwether District Holdings, LLC (BDH) is submitting Human Health Risk Assessment (HHRA) and Screening Level Ecological Risk Assessment (SLERA) reports to the Pennsylvania Department of Environmental Protection (PADEP) Southeast Regional Office on February 11, 2026, for the UDEX Release located in the Point Breeze South Yard area of the former Philadelphia Energy Solutions Refinery at 3144 West Passyunk Avenue in Philadelphia, Pennsylvania (Site). The HHRA and SLERA provide information for the Site under Pennsylvania's Land Recycling and Environmental Remediation Standards Act, the Act of May 19, 1995, P.L. #4, No. 2 (Act 2) in accordance with the site-specific remediation standards.

Please call me at (610) 850-1420 if you have any questions concerning the report submissions.

Sincerely,

Stantec Consulting Services Inc.

Andrew Klingbeil PG
Associate Geologist
Phone: (610) 840-2525
Mobile: (610) 850-1420
andrew.klingbeil@stantec.com

cc: C. David Brown, PADEP (via email)
Joseph Jeray, HRP Group (via email)

Dear Customer,

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Recipient:

MS. Leigh Ane Rainford, Dept. of Public Health
7801 Essington Avenue
PHILADELPHIA, PA, US, 19153

Shipper:

ANDREW KLINGBEIL, STANTEC CONSULTING SVCS INC.
1060 Andrew Dr Ste 140
WEST CHESTER, PA, US, 19380



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Stantec Consulting Services Inc.
1060 Andrew Drive, Suite 140
West Chester PA 19380-5602

June 4, 2025

Leigh Anne Rainford, MPH
Philadelphia Department of Public Health
Environmental Health Services
321 University Avenue - 2nd Floor
Philadelphia, PA 19104

Dear Ms. Rainford,

**Reference: Revised Notice of Intent to Remediate
UDEX Release Area – Point Breeze South Yard
Former PES Refinery
3144 West Passyunk Avenue
Philadelphia, PA 19153**

The Land Recycling and Environmental Remediation Standards Act (Act 2) requires that a Notice of Intent to Remediate (NIR) a site be provided to the municipality in which the site is located. On behalf of Bellwether District Holdings, LLC (BDH), this notification is to inform the City of Philadelphia of the submission of a revision to the previously submitted NIR for this project. The purpose of the revised NIR is to change the selected remediation standard from the Statewide Health Standard to the Site-Specific Standard for the UDEX Release area. A copy of the revised NIR (enclosed) will be sent to the Pennsylvania Department of Environmental Protection (PADEP) and published in the Pennsylvania Bulletin.

Please call me at (610) 850-1420 if you have any questions concerning the proposed remediation.

Sincerely,

Stantec Consulting Services Inc.

Andrew Klingbeil PG
Associate Geologist
Phone: (610) 840-2525
Mobile: (610) 850-1420
andrew.klingbeil@stantec.com

cc: C. David Brown, PADEP
Joseph Jeray, HRP Group

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