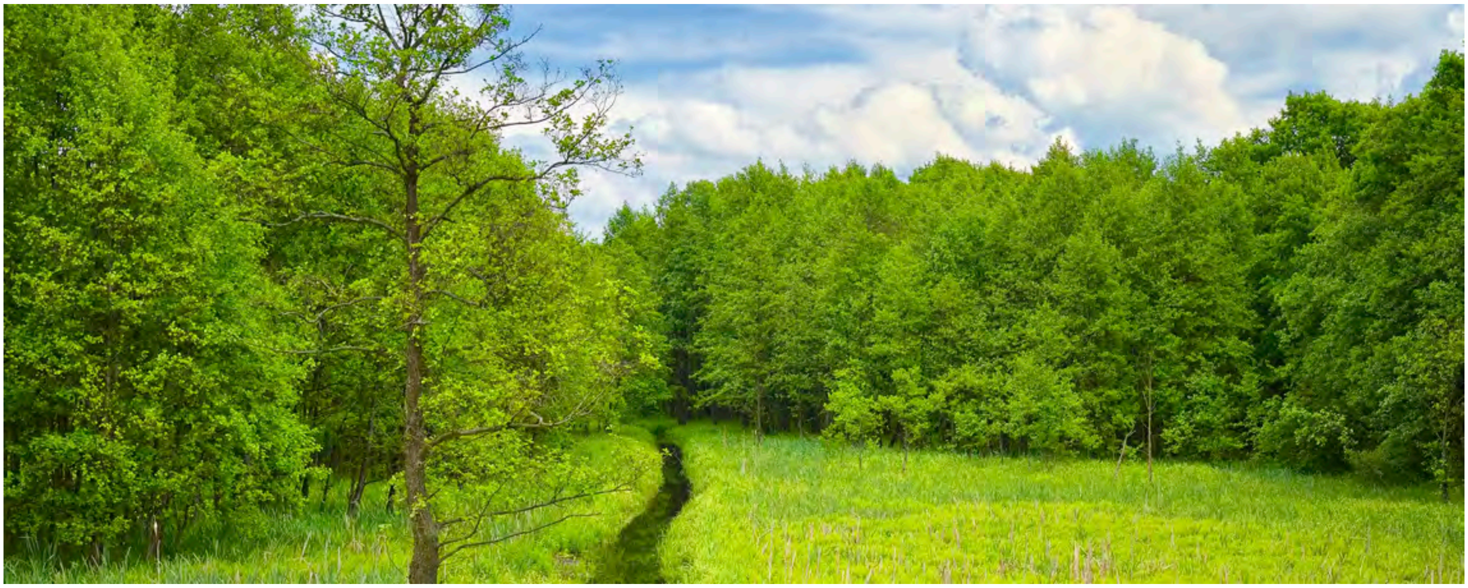
CONESTOGA-ROVERS & ASSOCIATES

www.CRAworld.com



Appendix H to Remedial Investigation Report

Ecological Risk Assessment

Former GM Wilmington Assembly Plant
Wilmington, Delaware

Prepared for: Revitalizing Auto Communities Environmental Response Trust

Conestoga-Rovers & Associates
2055 Niagara Falls Boulevard, Suite 3
Niagara Falls, New York 14304

July 2015 • 017338 • Report No. 22

Partners in Sustainability

CONESTOGA-ROVERS & ASSOCIATES

www.CRAworld.com

Appendix H to Remedial Investigation Report

Ecological Risk Assessment

Former GM Wilmington Assembly Plant
Wilmington, Delaware

Prepared for: RACER Trust

Conestoga-Rovers & Associates
2055 Niagara Falls Boulevard
Niagara Falls, New York/14304

July 2015 • 017338 • Report No. 22

Partners in Sustainability

Executive Summary

An ecological risk assessment as described in the Remedial Investigation Work Plan (August 23, 2011) and the Supplemental Remedial Investigation Work Plan for OU-6 (September 29, 2014) submitted to the Delaware Department of Natural Resources and Environmental Control (DNREC) and consisting of Steps 1, 2, and 3a of the United States Environmental Protection Agency (USEPA) process for conducting ecological risk assessment (USEPA 1997), was conducted at the Former General Motors Wilmington Assembly Plant (Site) in Wilmington, New Castle County, Delaware on behalf of the Revitalizing Automotive Communities Environmental Response (RACER) Trust. Media evaluated were soil collected from the main manufacturing area and an area of mature forest east of the Site (wooded area) and surface water and sediment of Little Mill Creek, which is located in the wooded area. Sediment collected from a stormwater ditch in the northeastern portion of the Site was also evaluated.

The screening process (Steps 1 and 2) identified constituents of potential ecological concern (COPECs) by comparing maximum concentrations to ecological screening values (ESVs). In Step 3a, the COPECs identified in the screening process were refined by considering complete exposure pathways, exposure concentrations based on 95 percent upper confidence limit (UCL) concentrations, background concentrations, and alternative ecological benchmarks. Food chain models were used to assess the potential for risks to avian and mammalian wildlife.

The screening process for soil collected from the main manufacturing area identified four volatile organic compounds (VOCs), three of the four BTEX (benzene, toluene, ethylbenzene, and xylene) constituents, two semi-volatile organic compounds (SVOCs), high molecular weight (HMW) polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), three pesticides, petroleum hydrocarbons, and 17 metals as constituents of potential ecological concern (COPECs). The Step 3a refinement process eliminated all COPECs for soil in the main manufacturing area. All soil samples in the main manufacturing area dataset were collected for areas covered by pavement or other man-made surfaces. Due to the cover, ecological receptors are not exposed to the COPECs in soil.

Screening of soil collected for the wooded area, referred to as Operable Unit-6 (OU-6), identified 2 VOCs, 1 SVOC, and 12 metals as COPECs. The Step 3a refinement process evaluated the potential for risk to soil invertebrates, terrestrial plants, avian wildlife, and mammalian wildlife. Food chain models were used to further evaluate the potential for risk to avian and mammalian wildlife that were carried forward from the refinement process. The risk characterization for Step 3a did not identify a potential for risk to any ecological receptors

exposed to any of the chemical constituents detected in the wooded area above the threshold for concern.

Screening of data for surface water collected from Little Mill Creek in 2011 identified three metals (aluminum, barium, and zinc) as COPECs. Screening of supplemental data for surface water collected in 2014 identified barium and lead as COPECs. The Step 3a refinement process for both datasets concluded that the potential for risk due to aluminum, barium, and zinc is below the threshold for concern. The single detected concentration of lead in the 2014 data set is most likely from a source other than the Site.

Screening of sediment for samples collected from Little Mill Creek and the stormwater ditch in 2011 and 2012 identified three SVOCs, low molecular weight (LMW) and HWM PAHs, petroleum hydrocarbons, and 12 metals as COPECs. The Step 3a refinement process retained SVOCs, PAHs, and five metals as COPECs. The only detected concentrations of petroleum hydrocarbons and mercury were in samples collected from the stormwater ditch, which provides limited habitat for ecological receptors.

Due to uncertainty regarding the potential source of constituents in the sediment, a supplemental dataset was collected from Little Mill Creek in 2014. The supplement sampling provided additional data for PAHs and metals. The subsequent risk characterization for sediment for the supplemental dataset did not identify a potential for risk for benthic invertebrates exposed to metals or avian piscivores exposed to metals and PAHs above the threshold for concern. The risk characterization did, however, identify a potential for risk to benthic invertebrates exposed to PAHs in the stormwater ditch and Little Mill Creek. Analysis of the relative fraction of PAHs in sediment samples, along with the absence of detected concentrations of PAHs in perimeter wells, strongly suggests that the presence of PAHs in Little Mill Creek is due to sources other than the Site.

The evaluation of potential loading to Little Mill Creek from groundwater identified iron and manganese as potentially migrating from the Site to Little Mill Creek. The low concentrations of both iron and manganese at all sampling locations in Little Mill Creek document that, although loading may be occurring, aquatic life is not impacted by migration of metals from the Site.

Table of Contents

Table of Contents

Table of Contents

List of Figures
(Following Text)

List of Tables
(Following Text)

List of Tables
(continued)

List of Tables
(continued)

List of Appendices

List of Acronyms

ACR	Acute-to-Chronic Ratio
AOI	Area of Interest
ARCS	Assessment of Remediation of Contaminated Sediment
AUF	Area Use Factor
AVS	Acid Volatile Sulfide
BCF	Bioconcentration Factor
BCOC	Bioaccumulative Constituent of Concern
BERA	Baseline Ecological Risk Assessment
bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CCME	Canadian Council of Minters of the Environment
COPEC	Contaminant of Potential Ecological Concern
CRA	Conestoga-Rovers & Associates
CSM	Conceptual Site Model
CV	Chronic Value
DNREC	Department of Natural Resources and Environmental Control
DW	Dry Weight
EC	Effect Concentration
ECO-SSL	Ecological Soil Screening Level
EPC	Exposure Point Concentration
EqP	Equilibrium Partitioning
ERA	Ecological Risk Assessment
ESB	Equilibrium Sediment Benchmark
ESBTU	Equilibrium Sediment Benchmark Toxicity Unit
ESL	Ecological Screening Level
ESV	Ecological Screening Value
FCV	Final Chronic Value
f_{oc}	Fraction of Organic Carbon
FOD	Frequency of Detection
f_{solids}	Fraction of Solids
GWSL	Groundwater Screening Level
HMW	High Molecular Weight
HQ	Hazard Quotient
IR	Ingestion Rate
K_{oc}	Octanol-Carbon Partitioning Coefficient
K_{ow}	Octanol-Water Partitioning Coefficient
KM	Kaplan Meier
LC	Lethal Concentration
LCV	Lowest Chronic Value
LMW	Low Molecular Weight
LOAEL	Lowest Observed Adverse Effect Level
NC	Negligible Concentration

List of Acronyms

ND	Not Detected
NHESP	Natural heritage and Endangered Species Program
NOAEL	No Observed Adverse Effect Level
NQ	Narcosis Quotient
OC	Organic Carbon
ORNL	Oak Ridge National Laboratory
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PEC	Probably Effect Level
RACER	Revitalizing Auto Communities Environmental Response Trust
RB	Refinement Benchmark
RI	Remedial Investigation
RQ	Refinement Quotient
SCV	Secondary Chronic Value
SD	Standard Deviation
SEM	Simultaneously Extracted Metal
SIRS	Site Investigation and Restoration Section
SQ	Screening Quotient
SQB	Sediment Quality Benchmark
SQG_E	Soil Quality Guidelines
SVOC	Semi-volatile Organic Compound
SWSL	Surface Water Screening Level
TAL	Target Analyte List
TCL	Target Compound List
TEC	Threshold Effect Concentration
TI	Toxicity Index
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TRV	Toxicity Reference Value
TU	Toxicity Unit
UCL	Upper Confidence Limit
URS	Uniform Risk-Based Standard
USEPA	United States Environmental Protection Agency
USFWS	United State Fish and Wildlife Service
UT	Upper Tier
VOC	Volatile Organic Compound
WW	Wet Weight

Section 1.0 Introduction

Conestoga-Rovers & Associates (CRA) has prepared this ecological risk assessment (ERA) as described in the Remedial Investigation Work Plan dated August 23, 2011, the Supplemental Remedial Investigation Work Plan OU-6 submitted to Delaware Department of Natural Resources and Environmental Control (DNREC) on September 29, 2014 and according to the United States Environmental Protection Agency's (USEPA) Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessment (USEPA, 1997). This ERA for the Former General Motors Wilmington Assembly Plant (Site) addresses Steps 1, 2, and 3a of the 8-step process presented in the USEPA's 1997 guidance document.

The objective of this ERA is to identify, and eliminate from further evaluation, those chemical constituents in soil and surface water and sediment of Little Mill Creek that have little potential to pose risk to ecological receptors that may be present in the assessment area for the Site. The screening process for this ERA (Steps 1 and 2) is based on conservative assumptions and estimates of exposure and toxicological effects. Screening allows subsequent steps in the risk assessment process, if required, to focus on those constituents and exposure pathways with the greatest potential to pose risk to ecological receptors (i.e., the risk drivers).

The refinement process in Step 3a incorporates numerous factors not considered at the screening level, such as more ecologically realistic exposure point concentrations (EPCs), background concentrations, alternative toxicity benchmarks, and evaluation of specific receptor groups.

This ERA is organized as follows:

Section 1.0: Introduction

Presents the purpose and objectives of this report, and its organization

Section 2.0: Step 1 - Screening-Level Problem Formulation

Presents Step 1 of the screening process: the problem formulation step. This section includes a description of the ecological setting, identification of known or suspected contaminants, a discussion of the fate and transport of contaminants, identification of potentially complete exposure pathways, selection of assessment and measurement endpoints, and an ecological effects evaluation.

Section 3.0: Step 2 - Screening-Level Exposure Estimate and Risk Calculation

Presents Step 2 of the screening process: the exposure estimate and risk calculation step.

Section 4.0: **Step 3A – Refinement of Constituents of Potential Ecological Concern (COPECs)**
Presents Step 3a of the ERA process: the refinement of constituents identified in the screening process as COPECs.

Section 5.0: **Supplement Refinement with Additional Surface Water, Sediment, and Groundwater Dataset**

Describes the collection of supplement data for soil, surface water, sediment, and groundwater in October and November 2014 and presents the results of the evaluation of these data.

Section 6.0: **Uncertainty Analysis**

Presents a discussion of the uncertainties associated with the screening and refinement processes.

Section 7.0: **Summary and Conclusions**

Presents the summary and conclusions of the ERA.

Section 8.0: **References**

Presents references cited in this ERA.

Section 2.0 Step 1: Screening-Level Problem Formulation and Ecological Effects Evaluation

2.1 Ecological Setting

The vast majority of the Site assessment area is covered with buildings, pavement, and other man-made surfaces. A few areas of maintained lawn are adjacent to some of the buildings and parking fields. A few mature trees are present in the lawn area of the main entrance on Boxwood Road. These areas of lawn and trees are small and isolated and provide minimal habitat for ecological receptors.

A large area of mature forest, 15.3 acres in size, is present east of the northeastern portion of the Site (hereafter referred to as the wooded area). Little Mill Creek enters the north central portion of the wooded area, flows in a southeasterly direction and enters into a residential area. Little Mill Creek eventually flows into the Christiana River. The wooded area and Little Mill Creek likely provide habitat for a diversity of wildlife species.

2.2 Species and Habitats of Concern

The website for the Delaware Natural Heritage and Endangered Species Program (NHESP) was consulted for the potential occurrence of species of concern in the vicinity of the Site (http://www.dnrec.delaware.gov/fw/NHESP/information/Pages/Endangered.aspx). The website identifies 24 species of birds, 6 species of reptiles, 2 species of amphibians, 1 species of mammals, 6 species of mollusks, and 9 species of insects as threatened in Delaware. The website does not provide information on documented occurrence by county. Site-specific information on species and habitats can be obtained through a written request to the NHESP. A formal request to the NHESP for the Site was done in 2005. A letter response from NHESP indicated that no endangered and/or threatened species are expected to be present at the Site. A copy of the letter is included in Appendix A.

The website for the U.S. Fish and Wildlife Service (USFWS) was consulted for the potential occurrence of federally listed species of concern (http://www.fws.gov/chesapeakebay/EndSppWeb/LISTS/DEspeciesList.pdf). The website identifies bog turtle (*Clemmys muhlenbergii*), swamp pink (*Helonius bullata*), and small-whorled pogonia (*Isotria medeoloides*) as occurring in New Castle County. Bog turtle occurs in emergent wetlands characterized by soft, mucky soil. This habitat is not present on or adjacent to the Site. Swamp pink is an obligate wetland plant that occurs in perennially saturated wetland forests. Habitat for swamp pink is also not present on or adjacent to the Site. Small-whorled pogonia occurs in a variety of hardwood forests and is commonly found on slopes near small streams. The mature forest east of the Site potentially provides habitat for small-whorled pogonia.

2.3 Known and Suspected Contaminants

The Remedial Investigation (RI) for the Site identified a number of contaminants that are present above the DNREC Site Investigation and Restoration Section (SIRS) Screening levels in Site soils and groundwater. Section 4.0 of the RI Report presents a detailed summary of the known contaminants at the Site.

Contaminants in surface soil and subsurface soil include 1,4-dichlorobenzene, ethylbenzene, xylenes (total) benzo(a)pyrene, 2-methylnaphthalene, naphthalene antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, thallium, vanadium, and zinc. Contaminants in groundwater include benzene, toluene, ethylbenzene, and xylene (BTEX) and various chlorinated volatile organics, various petroleum related semi-volatile organic compounds (SVOCs), and metals. The contaminants present at the Site are consistent with the historical operation of the Site as an automotive assembly plant.

2.4 Contaminant Fate and Transport

There are several potential mechanisms for transport of constituents from one or more source areas to habitats that potentially support ecological receptors. One such mechanism is surface flow during storm events. Constituents dissolved in stormwater or adsorbed to particles suspended in stormwater may be transported from source areas to habitats within or immediately adjacent to the assessment area. The fate of constituents in surface flow is dependent on the chemical and physical properties of the constituents and their interaction with the biological properties of the habitats. For example, VOCs transported in surface runoff will likely volatilize to the atmosphere. Hydrophobic compounds will likely leave solution and become bound to organic matter in soil or the sediments of Little Mill Creek. Other less hydrophobic compounds may remain in solution.

Wind is another potential mechanism for transport of chemical constituents from source areas to ecological receptors. Constituents transported by wind may be deposited in either terrestrial habitats or aquatic habitats, such as Little Mill Creek.

Chemical constituents may also be transported from source areas to habitats that support ecological receptors by groundwater flow. Ecological receptors would be exposed to Site-related chemicals in areas where groundwater discharges to streams or at the ground surface (i.e., wetlands).

2.5 Potentially Complete Exposure Pathways

A complete exposure pathway must have the following components:

1. An anthropogenic (human) source of a chemical constituent
2. A mechanism for transport of the constituent from the source to one or more ecological receptors
3. Exposure of ecological receptors to the constituent (exposure route)

Exposure routes include ingestion, direct contact, dermal absorption, and inhalation. In ecological risk assessment, the dermal absorption and inhalation exposure routes are typically not considered to be significant. Accordingly, this ERA does not consider dermal absorption or inhalation as complete exposure routes.

The potentially complete exposure routes for soil are:

- Direct contact of soil invertebrates and plants with soil
- Ingestion and absorption by soil invertebrates

- Uptake and absorption of constituents in soil by plants
- Incidental ingestion of soil and bioaccumulative constituents of concern (BCOCs) (as identified by the Texas Commission on Environmental Quality, 2003) by insectivores and omnivores via food web transfer
- Incidental ingestion of soil and constituents taken up and bioaccumulated in plant tissue by herbivores and omnivores via food web transfer
- Ingestion of soil and BCOCs by carnivores via food web transfer

The potentially complete exposure routes for surface water are:

- Direct contact of aquatic invertebrates and fish with surface water
- Ingestion and absorption by aquatic invertebrates and fish
- Uptake and absorption by aquatic plants
- Ingestion of surface water by insectivores, herbivores, carnivores, and piscivores
- Ingestion of BCOCs by insectivores, herbivores, omnivores, and piscivores via food web transfer

The potentially complete exposure routes for sediment are:

- Direct contact of benthic invertebrates
- Ingestion and absorption by benthic invertebrates and fish
- Uptake and adsorption by aquatic plants
- Incidental ingestion of sediment and BCOCs by insectivores, herbivores, omnivores, and piscivores via food web transfer

2.6 Conceptual Site Model

A conceptual site model (CSM) is a graphical representation of the exposure pathways within an assessment area, ecological receptors associated with each exposure pathway, and the exposure routes for each potentially exposed receptor or receptor group.

2.7 Assessment and Measurement Endpoints

Assessment endpoints are explicit expressions of environmental values or characteristics to be protected at a site. Assessment endpoints for the screening and refinement processes are presented in Table 2.1 and summarized below.

Soil

- Species richness and productivity of the terrestrial plant and soil invertebrate communities

- Relative and absolute densities of avian and mammalian insectivores, herbivores, and carnivores

Surface Water (Little Mill Creek)

- Diversity of aquatic life (aquatic invertebrates and fish) inhabiting the water column
- Relative and absolute densities of avian and mammalian insectivores and piscivores

Sediment (Little Mill Creek)

- Species richness and productivity of the benthic invertebrate community
- Relative and absolute densities of avian and mammalian insectivores and piscivores

Measurement endpoints are quantifiable responses to chemical stressors related to assessment endpoints and are intended to provide a basis for assessing the potential for risk for the assessment endpoint. They may be defined in terms of an unacceptable level of impact to ecological receptors, such as a certain relative percent decrease in survival, growth, or reproduction of ecological populations. For the screening and refinement of soil, surface water, and sediment, the measurement endpoints were ecological benchmarks protective of receptors exposed to these media.

In the refinement process, food chain models were used to evaluate the potential for risk to avian and mammalian wildlife. The measurement endpoints for avian and mammalian receptors were no observed adverse effect levels (NOAELs) and lowest observed adverse effect levels (LOAELs) for growth and reproduction.

The ecological benchmark selected as ecological screening values (ESVs) and refinement benchmarks (RBs) and NOAELs and LOAELs used in food chain models are assumed to be associated with a quantifiable level of impact relative to the selected assessment endpoints.

2.8 Ecological Screening Values

2.8.1 Overview

The objective of the screening process is to eliminate those constituents that, with a high degree of certainty, have a low probability of posing risk to one or more ecological receptors. To ensure that the potential for risk is not incorrectly dismissed, screening-level assessments are very conservative; that is, assumptions regarding exposure and toxicological effects are biased toward identifying risk. This includes selection of conservative ESVs.

Ecological screening values are conservative benchmark concentrations used to determine the potential for risk to ecological receptors. Because ESVs are conservative, it can be concluded with a high degree of certainty that constituents with maximum concentrations below their ESVs do not pose risk to ecological receptors. Alternatively, constituents with maximum concentrations that exceed their ESVs do not necessarily indicate risk or adverse impacts to ecological receptors. Rather, it only indicates that the potential for risk exists and that further assessment should be undertaken. The ESVs for soil, surface water, and sediment are taken from a variety of sources recognized by USEPA and state regulatory agencies.

The preferred source of ESVs was screening levels identified by DNREC (2014). Other sources of ESVs were searched using the Ecological Benchmark Tool developed and maintained by Oak Ridge National Laboratory (ORNL). The Ecological Benchmark Tool can be accessed through ORNL's website at: http://rais.ornl.gov/cgi-bin/eco/ECO_select. For each medium, a hierarchical approach was used in the selection of appropriate ESVs. In general, the first tier in the hierarchy considered the most recently developed ESVs, which typically have the strongest and most contemporary scientific basis. If multiple benchmarks were available within a tier, the lowest value was selected as the ESV to maintain a level of conservatism commensurate with a screening-level assessment.

The ESVs for surface soil, surface water, and sediment are discussed below and presented in Table 2.2.

2.8.2 Soil

The first tier in the selection of ESVs for surface soil consisted of screening levels identified by DNREC (2014). Ecological Soil Screening Levels (ECO-SSLs) were the considered for second tier. The ECO-SSLs have a strong technical basis and have recently been developed or revised by the USEPA. If multiple ECO-SSLs were available for a constituent (avian, invertebrate, mammalian, or plant receptors), then the lowest of the ECO-SSLs was selected as the ESV. If neither a DNREC screening level nor ECO-SSL was available, the third tier in the hierarchy was ecological screening benchmarks identified by USEPA Region 4. The fourth tier was ecological screening levels (ESLs) identified by USEPA Region 5. A summary of the benchmarks is outlined below:

<u>Tier I Benchmarks</u>

- DNREC screening levels (DNREC, 2014)

<u>Tier II Benchmarks</u>

The lowest value of the following benchmarks was selected as the ESV:

- ECO-SSL for avian receptors (USEPA, 2010)
- ECO-SSL for soil invertebrates (USEPA, 2010)
- ECO-SSL for mammalian receptors (USEPA, 2010)
- ECO-SSL for plants (USEPA, 2010)

Tier III Benchmarks
- USEPA Region 4 ecological screening benchmarks (USEPA, 2001)

Tier IV Benchmarks
- USEPA Region 5 Ecological Screening Levels (ESL) (USEPA, 2003a)

2.8.3 Surface Water

The first tier in the selection of ESVs for surface water was the screening levels identified by DNREC (2014). If a DNREC screening level was not available, then the freshwater screening benchmark identified by USEPA Region 3 (2013a) was selected as the ESV. A summary of the benchmarks is outlined below:

Tier I Benchmarks
- DNREC screening levels (DNREC, 2014)

Tier II Benchmarks
- USEPA Region 3 freshwater screening benchmarks (USEPA, 2013).

2.8.4 Sediment

The first tier in the selection of ESVs for sediment was the screening levels for freshwater identified by DNREC (2014). If DNREC screening level was not available, then sediment screening benchmarks identified by USEPA Region 3 (2013a) was considered as second tier benchmarks. For the third tier, threshold effect concentrations (TECs) identified by MacDonald et al (2000) were considered. Probable effect concentrations (PECs) identified by USEPA's Assessment and Remediation of Contaminated Sediments (ARCS) program (USEPA, 1996) and ecological screening levels (ESLs) identified by USEPA Region 5 were considered as forth tier benchmarks. Fifth tier benchmarks were Netherlands negligible concentrations (NCs) identified by Crommentuijn et al (1997). A summary of the benchmarks is outlined below:

Tier I Benchmarks
- DNREC screening level (DNREC, 2014)

Tier II Benchmarks

- USEPA Region 3 Freshwater Sediment Screening Benchmarks (USEPA, 2013).

Tier III Benchmarks

- Consensus-based TECs (MacDonald et al, 2000)

Tier IV Benchmarks

- USEPA ARCS Probable Effects Concentration (PEC) (USEPA, 1996)
- USEPA Region 5 ecological screening levels (USEPA, 2003a)

Tier V Benchmarks

- Netherlands Negligible Concentration (NC) (Crommentuijn et al, 1997)

Section 3.0 STEP 2: Screening-Level Exposure Estimate and Risk Calculation Exposure Estimates

3.1 Screening Methodology

3.1.1 Soil

Surface soil is considered to be soil collected from the depth interval of 0 to 2 feet below ground surface (bgs). This depth interval represents the primary zone of biological activity. The dataset for surface soil has been divided into two areas for the purposes of evaluation in this ERA. The first set represents surface soil from the main manufacturing area which is defined in the RI to include Operable Units (OU) 3, 4, 5 and portions of OU6 which are west of the Outfall 001. The second set represents the wooded area east of the main manufacturing areas, which is a portion of OU6. The data sets are addressed separately herein because of their distinct differences from an ecological perspective. The main manufacturing consists primarily of buildings or paved areas and therefore ecological receptors are not exposed or have extremely limited exposure to chemical constituents in soil, whereas the wooded area represents a potentially robust ecological habitat.

The dataset for the main manufacturing area consists of 130 samples collected between September 13 and October 10, 2011. Figure 3.1 identifies the location of the sampling stations. Samples were analyzed for target compound list (TCL) VOCs, TCL SVOCs, polychlorinated biphenyls (PCBs), pesticides, and target analyte list (TAL) metals. Not all samples were analyzed for all chemical groups. For sample locations where duplicate samples were analyzed, the maximum concentration was selected for use in the screening process. Details on the sample locations and sample collection methods for the main manufacturing area dataset can be found in the RI Report.

The dataset for the wooded area (OU-6) consists of samples collected at 15 sampling stations on October 2 and 3, 2014. Soil was collected from a depth interval of 0 to 2 feet bgs, composited, placed in glass sampling jars, and stored on ice until picked up by TestAmerica on the day of sampling. The soil profile, including texture and color, was characterized at each sampling station. Figure 3.1 identifies the location of the sampling stations. Soil logs are provided as Appendix B. TestAmerica analyzed all soil samples for TCL VOCs and SVOCs, pesticides, PCBs, and TAL metals. The analytical data for soil, along with data validation information, are provided as Appendix C.

For the screening process, the maximum concentration of each constituent detected was divided by a conservative ESV to produce a screening quotient (SQ):

$$\mathrm{SQ} = \frac{Concentration_{Max}}{ESV} \ldots \qquad \text{Equation 1}$$

Those constituents with a SQ greater than 1.0 (i.e., maximum concentration is greater than the ESV) were identified as COPECs and carried forward for further evaluation of risk. Those constituents that were detected in one or more samples but do not have an ESV were also identified as COPECs.

3.1.2 Surface Water

Five samples of surface water were collected from Little Mill Creek on September 17, 2012. Figure 3.1 identifies the location of the sampling stations. Samples were analyzed for SVOCs and metals (total and dissolved concentrations). These five samples were considered in the screening process. As was done for soil, maximum detected concentrations in surface water were used as the exposure concentrations. The same criteria as were used for soil (i.e., SQ > 1) were also used to identify COPECs for surface water.

For metals, samples were analyzed for both total and dissolved concentrations. Metals in surface water were screened using a two-phase process. In the first phase, total concentrations, which include both the dissolved portion of the constituent and the portion adsorbed to particular matter in the water column, were screened. If the SQ for the maximum total concentration exceeded one, then the maximum dissolved concentration, which represents the bioavailable fraction, was evaluated in the second phase. A metal was identified as a COPEC if the SQ for the maximum dissolved concentration was greater than 1.0.

3.1.3 Sediment

Seven sediment samples were collected from Little Mill Creek and stormwater ditch in the northeastern portion of the Site on October 5, 2011. Five samples were collected from Little Mill Creek on September 17, 2012. Figure 3.1 identifies the location the sampling stations. Samples were analyzed for VOCs, SVOCs, PCBs, pesticides, total petroleum hydrocarbons (TPH), and metals. The seven samples collected in 2011 were collected from a depth interval of 0 to 0.5 foot. The five samples collected in 2012 were collected from an interval of 0.5 to 1.0 feet bgs. These 12 samples constituted the dataset for the ERA. Although the stormwater ditch provides limited habitat for ecological receptors, samples from the four locations within the ditch were included in the dataset.

As was done for soil and surface water, the maximum detected concentration of a constituent was compared to its ESV. A constituent was identified as a COPEC if the SQ was greater than 1.0 or the constituent was detected and an ESV was not available.

3.2 Screening Risk Characterization

3.2.1 Soil – Main Manufacturing Area

Table 3.1 summarizes the results of the screening of surface soil for the main manufacturing area. Information presented in Table 3.1 includes the number of samples, number of samples with detected concentrations, frequency of detection (FOD), maximum concentration, area of interest (AOI) and sample with the maximum concentration, ESV, SQ, identification of BCOCs, and rationale for retaining or eliminating a constituent as a COPEC.

3.2.1.1 Volatile Organic Compounds

Nine VOCs, exclusive of BTEX (benzene, toluene, ethylbenzene, and xylene), were detected. The nine VOCs are cyclohexane, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,1-dichloroethene, cis-1,2-dichloroethene, isopropylbenzene, methylcyclohexane, 1,2,4-trichlorobenzene, and trichloroethene. The SQs for 1,3-dichlorobenzene (0.0037), 1,4-dichloroethene (0.26), 1,1-dichloroethene (0.00049), 1,2,4-trichlorobenzene (0.046), and trichloroethene (0.015) are below 1.0. None of these five VOCs is a BCOC. Consequently, 1,3-dichlorobenzene, 1,4-dichloroethene, 1,1-dichloroethene, 1,2,4-trichlorobenzene, and trichloroethene are eliminated as COPECs.

The SQs for cyclohexane (11) is greater than 1.0. Ecological screening values are not available for cis-1,2-dichloroethene, isopropylbenzene, and methylcyclohexane, Cyclohexane, cis-1,2-dichloroethene, isopropylbenzene, and methylcyclohexane are identified as COPECs and are carried forward for further evaluation. None of these four VOCS is a BCOC.

3.2.1.2 BTEX

All four BTEX constituents (benzene, toluene, ethylbenzene, and xylene) were detected. The SQ for toluene (0.060) is below 1.0. Toluene is not a BCOC and is eliminated as a COPEC.

The SQs for benzene (2.9), ethylbenzene (4.3), and total xylenes (10) are greater than 1.0. These three BTEX constituents are identified as COPECs and are carried forward for further evaluation. None of these BTEX constituents is a BCOC.

3.2.1.3 Semi-Volatile Organic Compounds

Four SVOCs, exclusive of polycyclic aromatic hydrocarbons (PAHs), were detected. The four SVOCs are bis(2-ethylhexyl)phthalate, butylbenzylphthalate, di-n-butylphthalate, and 4-methylphenol. The SQs for di-n-butylphthalate (0.75) and 4-methylphenol (0.00055) are below 1.0. Neither is a BCOC. Consequently, di-n-butylphthalate and 4-methylphenol are eliminated as COPECs.

The SQs for bis(2-ethylhexyl)phthalate (2.2) and butylbenzylphthalate (3.2) are greater than 1.0. Bis(2-ethylhexyl)phthalate and butylbenzylphthalate are identified as COPECs. Neither is a BCOC.

3.2.1.4 Polycyclic Aromatic Hydrocarbons

Thirteen PAHs were detected in soil. Three low molecular weight (LMW) PAHs (2-methylnaphthalene, naphthalene, and phenanthrene) and all ten high molecular weight (HMW) PAHs analyzed for were detected (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, and pyrene). PAHs were first screened by considering total PAHs. The concentrations of all PAHs detected in a sample were summed to produce a concentration for total PAHs. The SQ for the sample with maximum concentration of total PAHs (26) is greater than 1.0. For the second step, the sums of detected LMW PAHs and HMW PAHs were compared to their respective ESVs. For LMW PAHs, the SQ (0.90) is below 1.0. Low molecular weight PAHs are not BCOCs. Consequently, all detected LMW PAHs (2-methylnaphthalene, naphthalene, and phenanthrene) are eliminated as COPECs.

For HMW PAHs, the SQ (2.1) is greater than 1.0. For the third step of screening, the SQs for the individual HMW PAHs were considered. The SQs for all ten of the HMW PAHs are below 1.0. However, the maximum concentration of all HMW PAHs was not detected in the same sample. Furthermore, the mechanism of toxicity is similar for all of the HMW PAHs. Consequently, consideration of the HWM PAHs individually may underestimate the potential for risk. Based on these factors, HMW PAHs as a group are identified as COPECs. High molecular weight PAHs are not BCOCs.

3.2.1.5 Polychlorinated Biphenyls

Polychlorinated biphenyls were detected in one of 15 samples analyzed for PCBs. Aroclor 1254 was the single Aroclor detected. The SQ for total PCBs (0.00085) is below 1.0. Because PCBs are BCOCs, total PCBs are identified as a COPEC and are carried forward for further evaluation.

3.2.1.6 Pesticides

Four pesticides were detected in soil. The four pesticides are 4,4'-DDT, endrin aldehyde, endrin ketone, and methoxychlor. The SQ for methoxychlor (0.65) is below 1.0. Methoxychlor is not a BCOC and is eliminated as a COPEC.

The SQ for 4,4'-DDT (0.28) is also below 1.0. Because it is a BCOC, 4,4'-DDT is identified as a COPEC. The SQ for endrin aldehyde (2.0) is greater than 1.0. An ESV is not available for endrin ketone. Endrin aldehyde and endrin ketone are also identified as COPECs. Neither is a BCOC.

3.2.1.7 Metals

Twenty-three metals were detected. The SQs for beryllium (0.066) and silver (0.97) are less than 1.0. Neither is a BCOC. Beryllium and silver are eliminated as COPECs.

Ecological screening values are not available for calcium, magnesium, potassium, and sodium. The four metals are essential nutrients for ecological receptors and, as such, are not identified as COPECs.

The toxicity of aluminum is based on based on pH (USEPA, 2003b). The potential for risk to ecological receptors is negligible at a soil pH greater than 5.5. Because the pH of soil in the main manufacturing area is unknown, aluminum is identified as a COPEC.

The SQs for antimony (130), arsenic (100), barium (180), cadmium (200), chromium (6,500), cobalt (5.5), copper (25), iron (470), lead (670), manganese (12), mercury (26,000), nickel (5.6), selenium (550), titanium (8.5), vanadium (38), and zinc (2,000) are greater than 1.0. These 16 metals are identified as COPECs. Of these metals, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc are BCOCs.

3.2.1.8 Wooded Area

Table 3.2 summarizes the screening for COPECs in surface soil in the wooded area. Information presented in Table 3.2 is similar to that presented in Table 3.1 for the main manufacturing area.

Volatile Organic Compounds

Three VOCs, exclusive of BTEX, were detected. The three VOCs are cyclohexane, isopropylbenzene, and methylcylcohexane. An ESV is available only for cyclohexane. The SQ for cyclohexane (0.16), which is not a BCOC, is less than 1.0. Consequently, cyclohexane is eliminated as a COPEC.

Ecological screening values are not available for isopropylbenzene and methylcylcohexane. Due to the absence of ESVs, isopropylbenzene and methylcyclohexane are retained as COPECs and are carried forward for further evaluation.

BTEX

Two of the four BTEX constituents, toluene and xylene, were detected. The SQs for both toluene (0.00012) and xylene (0.0038) are less than 1.0. Neither is a BCOC. Consequently, toluene and xylene are eliminated as COPECs.

Semi-Volatile Organic Compounds

Two SVOCs, exclusive of PAHs, were detected. The two SVOCs are butylbenzylphthalate and di-n-butylphthalate. The SQ for butylbenzylphthalate (11), which was detected in 14 of the 15 samples, is greater than 1.0. Based on a SQ greater than 1.0, butylbenzylphthalate is retained as a COPEC.

The SQ for di-n-butylphthalate (0.00032), which is not a COPEC, is less than 1.0. Di-n-butylphthalte is eliminated as a COPEC.

Polycyclic Aromatic Hydrocarbons

Eleven of the PAHs analyzed for were detected in one or more samples. As was done for the main manufacturing area, PAHs detected in the wooded area were evaluated using a tiered approach. The first tier is evaluation of total PAHs. One or more of the individual PAHs was detected in 13 of the 15 samples. The SQ for total PAHs (1.3) exceeds 1.0. Therefore, evaluation of PAHs proceeds to the second tier, which is evaluation of LMW and HMW PAHs.

Phenanthrene is the only LMW PAH detected. The SQ for LMW PAHs (0.0031) is less than 1.0. All LMW PAHs, which are not BCOCs, are eliminated as COPECs.

All 10 HMW PAHs analyzed for were detected in one or more samples. The SQ for HMW PAHs (1.1) is slightly greater than 1.0. Based on a SQ greater than 1.0 for HMW PAHs, the process proceeds to evaluation of the individual HMW PAHs. The SQs for all 10 HMW PAHs are less than 1.0. None of the 10 HMW PAHs are BCOCs. Based on a SQ only slightly greater than 1.0 for HMW PAHs and SQs less than 1.0 for all ten of the individual HMW PAHs, all ten HMW PAHs are eliminated as COPECs.

Pesticides

No pesticides were detected in surface soil collected from the wooded area.

Polychlorinated Biphenyls

No PCBs were detected in surface soil collected from the wooded area.

Metals

Twenty of the 23 metals analyzed for were detected in one or more soil samples. Silver, sodium, and thallium were not detected.

Ecological screening values are not available for calcium, magnesium, and potassium. These three metals are essential nutrients for ecological receptors and, as such, are eliminated as COPECs.

The SQs for arsenic (0.63), barium (0.99), beryllium (0.11), cadmium (0.33), cobalt (0.66), copper (0.40), and nickel (0.49) are less than 1.0. Arsenic, barium, beryllium, and cobalt are not BCOCs for soil and are eliminated as COPECs.

Cadmium, copper, and nickel are BCOCs. The ESV for nickel is the screening level of 30 mg/kg identified by DNREC (2014). This screening level is less than the ECO-SSLs identified for avian (210 mg/kg) and mammalian (130 mg/kg) identified by USEPA (2007d). Based on an ESV protective of avian and mammalian wildlife, nickel is eliminated as a COPEC.

The ESVs for cadmium and copper (50 mg/kg) are also screening levels identified by DNREC (2014). The screening level of 3.0 mg/kg for cadmium is greater than the ECO¬SSLs for both avian (0.77 mg/kg) and mammalian (0.36 mg/kg) wildlife (USEPA 2005c). Similarly, the screening level of 50 mg/kg for copper is greater than the ECO SSLs for avian (28 mg/kg) and mammalian (49 mg/kg) wildlife (USEPA, 2007a). To ensure the potential for risk to avian and mammalian is not incorrectly dismissed, cadmium and copper are retained as COPECs for further evaluation.

The SQs for antimony (2.8), chromium (96), iron (110), lead (17), manganese (2.2), mercury (260), selenium (6.5), vanadium (25), and zinc (15) are greater than 1.0. These nine metals are retained as COPECs. Chromium, lead, mercury, selenium, and zinc are BCOCs.

The ESV for aluminum is based on a soil pH less than 5.5 (standard units). Because the pH of soil in the wooded area is unknown, aluminum is retained as a COPEC. Aluminum is not a BCOC.

3.2.2 Surface Water

Table 3.3 summarizes the results of the screening of the surface water collected from Little Mill Creek in 2012. Information presented in Table 3.3 is similar to that presented in Table 3.1 and Table 3.2 for soil. Surface water was analyzed only for SVOCs (including PAHs) and metals.

3.2.2.1 Semi-Volatile Organic Compounds

No SVOCs were detected in surface water.

3.2.2.2 Polycyclic Aromatic Hydrocarbons

No PAHs were detected in surface water.

3.2.2.3 Metals

Seven metals were detected as total concentrations. The seven metals are barium, calcium, iron, magnesium, potassium, sodium, and zinc. The SQs for calcium (0.30), magnesium (0.25), potassium (0.085), and sodium (0.11) are below 1.0. None of these four metals is a BCOC. Calcium, magnesium, potassium, and sodium are essential nutrients. Calcium, magnesium, potassium, and sodium are eliminated as COPECs.

The SQs for total concentrations of barium (160), iron (1.9) and zinc (12) are greater than 1.0. Iron was not detected as dissolved concentration. Iron is eliminated as a COPEC. The SQs for dissolved concentrations of barium (57) and zinc (1.1) are greater than 1.0. Barium and zinc are identified as COPECs. Neither is a BCOC for surface water.

Aluminum was not detected as total concentration, but was detected in two samples as dissolved concentration. The SQ for dissolved concentration (2.5) is greater than 1.0. Based on a SQ greater than 1.0 for dissolved concentration, aluminum is also identified as a COPEC. Aluminum is not a BCOC.

3.2.3 Sediment

Table 3.4 summarizes the results of the screening of the sediment collected from Little Mill Creek and the stormwater ditch in 2011 and 2012. Information presented in Table 3.4 is similar to that presented in Table 3.1, Table 3.2, and Table 3.3.

3.2.3.1 Volatile Organic Compounds

No VOCs were detected in the sediment of Little Mill Creek or stormwater ditch.

3.2.3.2 BTEX

Toluene is the only BTEX constituent detected in sediment. The SQ (0.082) is less than 1.0. Toluene, which is not a BCOC, is eliminated as a COPEC.

3.2.3.3 Semi-Volatile Organic Compounds

Five SVOCs, exclusive of PAHs, were detected in sediment. The five SVOCs are bis(2-ethylhexyl)phthalate, butylbenzylphthalate, carbazole, dibenzofuran, and di-n-octylphthalate. The SQs for butylbenzylphthalate (0.89) and di-n-octylphthalate (0.067) are less than 1.0. Neither is a BCOC. Butylbenzylphthalate and di-n-octylphthalate are eliminated as COPECs.

The SQs for bis(2-ethylhexyl)phthalate (3.8) and dibenzofuran (7.5) are greater than 1.0. An ESV is not available for carbazole. Bis(2-ethylhexyl)phthalate, butylbenzylphthalate, and carbazole are identified as COPECs. None of these SVOCs is a BCOC.

3.2.3.4 Polycyclic Aromatic Hydrocarbons

Sixteen PAHs were detected in sediment. The PAHs detected are six LMW PAHs (2-methylnaphthalene, acenaphthene, anthracene, fluorene, naphthalene, and phenanthrene) ten HMW PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene and pyrene).

As was done for soil, PAHs were first screened by considering total PAHs. The SQ for the sample with maximum concentration of total PAHs (370) is greater than 1.0. For the second step, the sums of detected LMW PAHs and HMW PAHs were compared to their respective ESVs. The SQs for both LMW PAHs (1,400) and HMW PAHs (1,900) are greater than 1.0.

For the third step of screening, the SQs for the individual HMW PAHs were considered. The SQs for all six LMW PAHs and all ten HWM PAHs are greater than 1.0. Based on these results, all detected PAHs are identified as COPECs. Polycyclic aromatic hydrocarbons are not BCOCs.

3.2.3.5 Polychlorinated Biphenyls

Polychlorinated biphenyls were not detected in the sediment of Little Mill Creek or stormwater ditch.

3.2.3.6 Pesticides

Pesticides were not detected in the sediment of Little Mill Creek or stormwater ditch.

3.2.3.7 Total Petroleum Hydrocarbons

The C10-C28 fraction of TPH was detected in sediment of the stormwater ditch. An ESV for this TPH fraction is not available for sediment. Consequently, TPH, which is not a BCOC, is identified as a COPEC.

3.2.3.8 Metals

Twenty metals were detected in sediment. The SQs for aluminum (0.17), arsenic (0.68), beryllium (0.76), and cobalt (0.26) are less than 1.0. Ecological screening values are not available for calcium, magnesium, potassium, and sodium. As essential nutrients, these four metals are not expected to pose risk to ecological receptors. None of the metals identified above are BCOCs. Aluminum, arsenic, beryllium, calcium, cobalt, magnesium, potassium, and sodium are eliminated as COPECs.

The SQs for antimony (5.3), barium (1.2), cadmium (4.1), chromium (2.7), copper (120), iron (2.4), lead (15), manganese (1.2), mercury (4.5), nickel (1.9), vanadium (1.3), and zinc (20) are greater than 1.0. An ESV is not available for iron. These 12 metals are identified as COPECs. Cadmium, copper, mercury, nickel, and zinc are BCOCs for sediment.

3.3 Summary of the Screening Risk Characterization

Table 3.5 summarizes the results of the screening process. Information presented in Table 3.5 identifies those constituents retained as COPECs in soil for the main manufacturing area and wooded area and the surface water and sediment of Little Mill Creek and stormwater ditch for samples collected in 2011 and 2012. Table 3.5 also identifies the rationale for retaining each constituent. The screening process identified 32 individual or groups of chemicals as COPECs.

3.3.1 Soil - Main Manufacturing Area

Constituents identified as COPECs for soil of the main manufacturing area are four VOCs (cyclohexane, cis-1,2-dichloroethene, isopropylbenzene, and methylcyclohexane), three BTEX constituents (benzene, ethylbenzene, and xylenes), two SVOCs (bis(2-ethylhexyl)phthalate and butylbenzylphthalate), HMW PAHs, total PCBs, three pesticides (4,4'-DDT, endrin aldehyde, and endrin ketone), and 17 metals (aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, titanium, vanadium, and zinc) were identified as COPECs.

3.3.2 Wooded Area

Screening of surface soil collected from the wooded area identified two VOCs (isopropylbenzene and methylcyclohexane), one SVOC (butylbenzylphthalate), and 12 metals (aluminum, antimony, cadmium, chromium, copper, iron, lead, manganese mercury, selenium, vanadium, and zinc) as COPECs. Isopropylbenzene and methylcylcohexane were retained as COPECs due the lack of ESVs. Aluminum was retained because pH of the soil, which is the basis of the ESV, is uncertain. The maximum concentration of cadmium was below its ESV. However, cadmium was retained as a COPEC because it is a BCOC and could potentially pose risk to upper trophic level wildlife.

3.3 Surface Water of Little Mill Creek

The screening of surface water collected from Little Mill Creek in 2012 identified three metals (aluminum, barium, and zinc) as COPECs.

3.4 Sediment of Little Mill Creek and Stormwater Ditch

The screening of sediment collected from Little Mill Creek and stormwater ditch collected in 2011 and 2012 identified three SVOCs (bis(2-ethylhexyl)phthalate, carbazole, and dibenzofuran), LMW PAHs, HMW PAHs, C10-C28 fraction of TPH, and 12 metals (antimony, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, vanadium, and zinc) were identified as COPECs.

Section 4.0 Step 3a: Refinement of Constituents of Potential Ecological Concern

4.1 Refinement Methodology

4.1.1 Overview

This section presents the results of Step 3a of the 8-step process for conducting ecological risk assessment under the USEPA guidance (USEPA, 1997). This step, which is the first phase of the problem formulation step for the baseline ecological risk assessment (BERA), refines the list of constituents identified in the screening process as COPECs. In order to minimize the probably of incorrectly dismissing the potential for risk, the ESVs used in the screening process are generally the lowest ecological benchmarks available. Moreover, maximum concentrations were conservatively used as the EPCs. In Step 3a, constituents identified as COPECs are refined by considering complete exposure pathways, EPCs based on 95 percent upper confidence limit (UCL) concentrations, background concentrations, alternative ecological benchmarks, and specific receptor groups..

4.1.2 Soil

4.1.2.1 Overview

The refinement process evaluated the potential for risk to soil invertebrates, terrestrial plants, avian wildlife, and mammalian wildlife. Refinement benchmarks were identified for these four receptor groups, if available. Sources for RBs were ECO-SSLs (all receptor groups), soil quality guidelines (SQG_E) identified by the Canadian Council of Minister of the Environment (CCME, 2007) (all receptor groups), ESLs identified by USEPA Region 5 (2003a) (mammalian wildlife), and Oak Ridge Natural Laboratory (ORNL) for soil invertebrates (Efroymson et al. 1997a) and terrestrial plants (Efroymson et al., 1997b).

Background concentrations were also considered in the selection of RBs. The *Statewide Soil Background Study: Report of Findings* (DNREC 2012) was the source for background concentrations. In particular, the mean concentrations for the analytical data for Site 1 and Site 2 were identified as representative background for the Site. Site 1 and Site 2 are in Brandywine State Park in New Castle County. The soil descriptions for Site 1 and Site 2 are similar to those observed in the wooded area during the October 2014 soil sampling event (see Appendix B).

Benchmarks lower than the mean concentrations identified by DNREC (2012) were eliminated from consideration as RBs. If available, and above background concentrations, ECO-SSLs were selected as RBs. Otherwise, the lowest benchmark above background was selected as the RB for a specific receptor group. If no benchmarks were available for a specific receptor group, then the lowest of the mean background concentrations for Site 1 and Site 2 was conservatively selected as the RB for that receptor group.

4.1.2.2 Soil Invertebrates

The RBs for soil invertebrates were selected using a tiered approach. If available, the ECO-SSL identified by USEPA was selected as the RB. If an ECO-SSL was not available, the lower of the benchmarks identified by ORNL (Efroymson et al. 1997a) and CCME (2007) was selected.

In general, soil invertebrates are sessile or have relatively limited ranges of movement. Consequently, statistics of central tendency, such as UCLs, have limited value in evaluating risk to soil invertebrates. In the refinement process, the number and percent of samples with concentrations that exceed the RB are considered. Exceedence of an RB in a single sample is unlikely to have a significant impact on populations of avian and mammalian wildlife that forage on soil invertebrates. A constituent was retained as a COPEC if more than 20 percent of the samples exceeded the RB for soil invertebrates. The value of 20 percent was selected as a threshold based on a 20 percent loss of ecological function, which is typically used to identify ecological benchmarks.

Table 4.1 identifies RBs for soil invertebrates. Information presented in Table 4.1 includes the mean background concentrations for Site 1 and Site 2 (DNREC 2012), benchmark concentrations identified in the available sources, and the value selected as the RB.

4.1.2.3 Terrestrial Plants

The RBs for terrestrial plants were selected using a tiered approach. If available, the ECO-SSL identified by USEPA was selected as the RB. If an ECO-SSL was not available, the lower of the benchmarks identified by ORNL and CCME was selected.

Terrestrial plants are sessile. As is the case with soil invertebrates, statistics of central tendency have limited value in evaluating risk to terrestrial plants. In the refinement process, the number and percent of samples with concentrations that exceed the RB are considered.

Exceedence of an RB in a single sample is unlikely to have a significant impact on the terrestrial plant community or herbivores that forage on plants. A constituent was retained as a COPEC if more than 20 percent of the samples exceeded the RB for terrestrial plants. As was done for soil invertebrates, the value of 20 percent was selected as a threshold based on a 20 percent loss of ecological function, which is typically used to identify ecological benchmarks.

Table 4.2 identifies RBs for terrestrial plants. Information presented in Table 4.2 is similar to that presented that in Table 4.1 for soil invertebrates.

4.1.2.4 Avian and Mammalian Wildlife

If available, ECO-SSLs were selected as the RBs. If an ECO-SSL specific to avian or mammalian wildlife was not available, then either the CCME SQG_E or lower of the ESL (USEPA, 2003a) and SQG_E was selected as the RB, provided the benchmark concentration is greater than the mean background for New Castle County. For these situations, the lowest benchmark greater than ambient background was selected as the RB. If all available benchmarks were less than the background, then the lower of the mean background concentrations for Site 1 and Site 2 was used as the RB.

The refinement process for evaluating the potential risk to avian and mammalian wildlife was conducted using a two-phase process. In the first phase, UCL concentrations calculated using ProUCL Version 5 (USEPA, 2014) were divided by the selected RBs to produce a refinement quotient (RQ_{UCL}):

$$RQ_{UCL} = \frac{Concentration_{UCL}}{RB} \ldots \quad \text{Equation 2}$$

If the RQ_{UCL} was greater than 1.0 (i.e., UCL is greater than the RB) or an RB was not available, then risk to avian and mammalian wildlife was further evaluated in a second phase using food chain models, as discussed in the following section.

Tables 4.3 and Table 4.4 identify the RBs for avian and mammalian wildlife, respectively. Information presented in these tables is similar to that presented in Table 4.1 for soil invertebrates and Table 4.2 for terrestrial plants.

4.1.2.5 Food Chain Models

Food chain models were used to evaluate the potential for risk to avian and mammalian wildlife birds exposed to COPECs carried forward from the first phase of the refinement process. The trophic groups evaluated are the avian and mammalian insectivores, avian and mammalian herbivores, and avian and mammalian carnivores. The indicator species used to represent these trophic groups are the same as those used by the USEPA to develop ECO-SSLs (USEPA, 2010). American woodcock (*Scolopax minor*) and short-tailed shrew (*Blarina brevicauda*) are the indicator species for avian and mammalian insectivores, respectively. Mourning dove (*Zenaida macroura*) and meadow vole (*Microtus pennsylvanicus*) are the indicator species for avian and mammalian herbivores, respectively. Red-tailed hawk (*Buteo jamaicensis*) and long-tailed weasel (*Mustela frenata*) are the indicator species for avian and mammalian top carnivores, respectively. These species were selected because they are representative of feeding guilds in the assessment area and because exposure parameters for these species have been established by USEPA (2010).

Ingestion of COPECs by avian and mammalian wildlife was calculated using the general equation:

$$IR_{total} = ((IR_{foodWW} * Conc_{food}) + (IR_{water} * Conc_{water}) + (IR_{foodDW} * Conc_{soil} * P_{soil})) * AUF \qquad \text{Equation 3}$$

where:

IR_{total} = total ingestion rate of a COPEC (milligram (mg) of COPEC per kg body weight per day)
IR_{foodWW} = ingestion rate of food (kg wet weight of food per kg body weight per day)
$Conc_{food}$ = concentration of a COPEC in food (mg of COPEC per kg wet weight)
IR_{water} = ingestion rate of drinking water (liter per kg body weight per day)
$Conc_{water}$ = concentration of a COPEC in drinking water (mg of COPEC per liter)
IR_{foodDW} = ingestion rate of food (kg dry weight of food per kg body weight per day)
$Conc_{soil}$ = concentration of a COPEC in soil (mg of COPEC per kg dry weight)
P_{soil} = proportion of incidental ingestion of soil or sediment
AUF = area use factor (fraction of diet obtained from the assessment area)

The potential for risk to the indicator species was calculated by dividing IR_{total} by a toxicity reference value (TRV) to produce a hazard quotient (HQ):

$$HQ = \frac{IR_{total}}{TRV} \qquad \text{Equation 4}$$

Toxicity reference values (TRVs) are benchmarks, expressed as milligrams of a chemical constituent per kilogram of body weight per day (mg/kg day), that are used to evaluate the potential for risk to wildlife. To provide bracket the potential for risk, two TRVs were considered: NOAELs and LOAELs. A NOAEL is a dose that does not produce adverse effects in test subjects whereas a LOAEL is the lowest dose that adversely affects test subjects.

Exposure point concentrations for avian and mammalian wildlife were calculated using soil-to-biota uptake equations identified in various guidance documents. For organics in soil, EPCs for soil invertebrates were calculated using Equations 5 through 9, which are from USEPA (2010).

$C_i = K_{ww} * C_w$ Equation 5

Where:

C_i = concentration of constituent in invertebrates (mg/kg WW)
K_{ww} = biota to soil water partitioning coefficient (L soil pore water/kg WW tissue)
C_w concentration in soil pore water (mg/L)

$\log(K_{ww}) = 0.87 * \log(K_{ow}) – 2.0$ Equation 6

Where:

K_{ww} = biota to soil water partitioning coefficient (L soil pore water/kg WW tissue)
K_{ow} = octanol-water partitioning coefficient (unitless)

$C_w = C_s/K_d$ Equation 7

Where:

C_s = concentration in soil (mg/kg)
K_d = soil to water partitioning coefficient (L soil pore water/kg DW soil)

$K_d = f_{oc} * K_{oc}$ Equation 8

Where:

f_{oc} = fraction of organic carbon in soil (kg organic carbon/kg soil)

K_{oc} = soil organic carbon to water partitioning coefficient (L soil pore water/kg organic carbon).

The f_{oc} in soil was conservatively assumed to be 0.01 (1 percent).

Exposure point concentrations of organics in terrestrial plants were calculated using Equation 9, which is from USEPA (1999b).

$$Log(BCF) = 1.558 – (0.578*Log(K_{ow})) \qquad \text{Equation 9}$$

Where:

BCF = Bioconcentration Factor
K_{ow} = octanol-water partitioning coefficient.

Exposure point concentrations for surface water are the UCLs calculated using ProUCL, Version 5 (USEPA 2014). If data sufficient to calculate an UCL were not available (low number of detected concentrations) or the UCL was greater than the maximum concentration, the maximum concentration was conservatively used as the EPC. For surface water, the EPCs for those constituents that were not detected were assumed to be zero.

Section 4.2.2.5 provides additional detail on the calculation of EPCs and selection of TRVs.

4.1.3 Surface Water

The screening process identified aluminum, barium, and zinc as COPEC for the surface water of Little Mill Creek. Screening considered only maximum concentrations. For the refinement of aluminum, barium, and zinc, EPCs are 95 percent UCLs calculated using ProUCL, Version 5 (USEPA, 2014).

In addition to using the 95 percent UCLs as the EPCs, the ESVs used in the screening process were reviewed and replaced with more realistic ecological benchmarks, if appropriate. Alternative benchmarks were used if the ESV was below background concentrations identified by DNREC (1999).

The ESV for barium is 4.0 micrograms per liter (μg/L). This value is also the default background standard identified by DNREC (1999). The ESV is a Tier II value based on data for daphnia, gammarids, and gastropods (Suter and Tsao, 1996). Tier II benchmarks are developed for those constituents with limited data on toxicity. Inspection of the basis for this ESV indicates that the data for daphnia were the only real chronic data considered in development of the benchmark; the other two data points were extrapolated from the LC50s (lethal concentration effects on 50 percent of test organisms). The LC50 for the three test species (daphnia, gammarids, and gastropods) was divided by the acute to chronic ratio for daphnia to derive the Tier II value. The daphnid data were from a 21-day test and the EC16 endpoint (effective concentration for effects on 16 percent of test organisms) was 5,800 µg/L. Therefore, the 3.9 µg/L Tier II value used in the screening process is unrealistically conservative.

For the refinement process, the USEPA Region 5 ESL of 220 µg/L was selected as the refinement benchmark for barium. The ESVs for aluminum and zinc are also used as RBs.

4.1.4 Sediment

4.1.4.1 Overview

The screening of chemical constituents in sediment was based on ecological benchmarks for bulk sediment. Over the past few years, USEPA has recognized that toxicity to benthic invertebrates is through exposure to pore water and that methods that consider the mechanisms of toxicity and bioavailability of contaminants are much better predictors of toxicity (DiToro et al, 2000, USEPA, 2003c, 2005f, 2008b). The refinement of the organic compounds identified as COPECs for sediment considers these factors. The data for samples collected in 2011 and 2012 do not allow similar consideration for metals.

4.1.4.2 Benthic Invertebrates

BTEX and SVOCs

For the refinement process, risk to benthic invertebrates posed by those BTEX and SVOCs detected in sediment (no VOCs were detected) was based on equilibrium partitioning (EqP) and the narcosis mode of toxicity (DiToro et al, 2000, USEPA, 2003c, 2008b). Narcosis is characterized as the alteration of the function of cell membranes by xenobiotics (chemicals found in an organism, but not produced in the organism).

The first step in this approach is calculation of final chronic values for water (FCVs – based on larger sets of data on narcotic effects) or secondary chromic values (SCVs - based on smaller sets of data) for narcotic organic compounds based on the acute critical lipid concentration, an acute-to-chronic ratio (ACR) which converts an assumed acute toxic toxicity to chronic toxicity, and the octanol-water partitioning coefficient (Kow). The following equation is used to calculate FCVs and SCVs:

$$\log(\text{FCV or SCV}) = \log (C^*_L/ACR) + \Delta_{Cl} - 0.945 \log K_{ow} \qquad \text{(Equation 10)}$$

where

C^*_L is the acute critical lipid concentration

Δ_{Cl} is a correction factor for constituent class to be applied when general organic fraction ACRs are used

K_{ow} is the octanol-water partitioning coefficient

The acute critical lipid concentration is derived from data demonstrating threshold concentrations for toxicity to occur to different species for a given constituent. The identification of threshold concentrations may require extrapolation from the short term acute toxicity tests (such as lethal concentration 50 percent mortality - LC50 responses). The acute values are then averaged over various studies for the constituent on the same species or genus of organism. The USEPA (2003c, 2008b) used a value of 35.3 µmol per gram octanol to develop FCVs and SCVs. Acute-to-chronic ratio values are published in a number of source documents and may be for general organic compounds or specific to class, such as halogenated aliphatics, aromatics, PAHs, etc. Throughout the remainder of this document, the term chronic value (CV) will be used to reference FCVs and SCVs.

The second step in the process is calculation of equilibrium sediment benchmarks (ESBs) by converting the CVs described above to sediment equivalent values for bulk sediment using the equation:

$$ESB = CV\ [(f_{oc}*K_{oc}) + ((1 - f_{solids})/f_{solids})] \qquad \text{(Equation 11)}$$

Where

ESB = the equilibrium sediment benchmark (milligrams per kilogram [mg/kg] dry weight)

CV = the chronic value for water (µg/L)

f_{oc} = the fraction of organic carbon (unit less)

K_{oc} = the octanol-carbon partitioning coefficient (unit less)

f_{solids} = the fraction of solids in sediment

Incorporation of f_{oc} and f_{solid} represents the modification developed by Fuchsman (2003). Site-specific data for f_{oc} are not available for data collected in 2011 and 2012. However, data are available for samples collected from Little Mill Creek and the stormwater ditch in 2014. Values for samples collected from the same general area (Little Mill Creek, culvert under the rail yard, and stormwater ditch) were assigned to samples collected in 2011 and 2012. Values for f_{solids} are available for all samples. Because f_{solids} vary among samples, ESBs were calculated for each sample.

The concentration of toluene and each SVOC detected in a sample is divided by the ESB specific to each organic constituent to produce a narcosis quotient (NQ). The NQs are then summed to produce a toxicity index (TI) for that sample. A TI greater than 1.0 indicates a potential for risk.

Section 4.4.4.1 provides additional details on the calculation of CVs, ESBs, and NQs.

Polycyclic Aromatic Hydrocarbons

For the refinement of PAHs in sediment, EqP and equilibrium sediment benchmark toxicity units (ESBTUs) developed by USEPA (2003c) were employed. This method is based on EqP of PAHs between sediment and porewater and the additive narcosis mode of toxicity. The concentration for each PAH detected within a sample (with the exception of 2-methylnaphthalene, which is not considered in the method) was normalized for organic carbon based on data collected in 2014. The carbon normalized value is then divided by a final chronic value ($C_{oc,\ PAHi,FCVi}$) to produce an ESBTU for each of the 34 PAHs.

$$\text{Total ESBTUs} = \sum_{i}^{34} \frac{Conc_{sediment}}{f_{oc}} \div C_{oc,PAH_i,FCV_i}, \qquad \text{Equation 12}$$

A value for total ESBTUs greater than 1.0 identifies a potential for risk to benthic invertebrates.

Section 4.4.4.1 provides additional details on the calculation of the EqP benchmarks and TUs for PAHs.

Petroleum Hydrocarbons

The C10-C28 fraction of petroleum hydrocarbons was identified as a COPEC because an ESV for sediment specific to this fraction is not available. Due to the absence of an ESV or any other ecological benchmark, the potential for risk to benthic invertebrates cannot be evaluated.

Metals

The ESVs for metals in bulk sediment used in the screening process are intentionally conservative. This is done to minimize incorrectly dismissing the potential for risk. For bulk sediment, two tiers of sediment quality benchmarks (SQBs) for metals are available. Lower-tier benchmarks are intended to represent concentrations below which risk or impact to benthic communities is not expected to occur. The ESVs used in the screening process are lower-tier benchmarks. Upper-tier benchmarks are concentrations above which risk or impact is expected.

For the refinement of metals, both lower-tier and upper-tier benchmarks are considered. As sediment benchmarks have been developed for benthic organisms, which have limited motility, concentrations in individual samples were compared to the RBs.

4.1.4.3 Avian and Mammalian Wildlife

Potential risk to avian and mammalian wildlife that may forage on benthic invertebrates and fish in Little Mill Creek and stormwater ditch was evaluated using food chain models. Constituents evaluated for potential risk to avian and mammalian wildlife are those identified as COPECs in the screening assessment, with the exception of iron. The rationale for not evaluating iron is that is among the most commonly occurring metals in the environment and as a result, little data are available on the toxicological effects of iron on ecological receptors.

Tree swallow (*Tachycineta bicolor*) and little brown bat (*Myotis lucifugus*) are the indicator species for avian and mammalian insectivores, respectively, that feed on invertebrates that spend their early life stages in sediment and are terrestrial as adults. Belted kingfisher (*Megaceryle alcyon*) and mink (*Mustela vison*) are the indicator species for avian and mammalian piscivores, respectively. Ingestion of COPECs in sediment by these indicator species was calculated using Equation 3.

Data on concentrations of the COPECs in benthic invertebrates and fish consumed in Little Mill Creek and stormwater ditch potentially consumed by avian and mammalian wildlife are not available. In the absence of site-specific data, generic equations that calculate sediment-to-invertebrate and sediment-to-fish were used.

Section 4.4.2 provides additional details on the calculation EPCs and selection of TRVs.

4.2 Refined Risk Characterization

4.2.1 Soil Main Manufacturing Area

The screening process for soil within the main manufacturing areas evaluated samples from the 0 to 2 foot bgs depth interval without consideration of land cover or habitat value of the sample locations. For the refinement process, the locations of all soil samples were evaluated to determine if complete exposure pathway is present. As discussed in Section 2.5, all of the following criteria must be met in order to have a complete exposure pathway:

1. An anthropogenic (human) source of a chemical constituent
2. A mechanism for transport of the constituent from the source to one or more ecological receptors

3. Exposure of ecological receptors to the constituent (exposure route)

The first two criteria are met within the assessment area. However, all samples in the dataset for the main manufacturing area were collected from areas that are covered by buildings or pavement. Therefore, ecological receptors are not exposed, or have extremely limited exposure, to chemical constituents identified in Table 3.1 as COPECs. Based on the absence of a complete exposure pathway, additional evaluation of risk to terrestrial receptors is not undertaken.

4.2.2 Soil Wooded Area

4.2.2.1 Soil Invertebrates

Table 4.5 summarizes the evaluation of risk to soil invertebrates. Information presented in Table 4.5 includes the RB, number of samples, number of samples with detected concentrations, maximum concentration, number and percent of samples with concentrations that exceed the RB, and rationale for retaining or eliminating a constituent as a COPEC. A constituent was retained as a COPEC if concentrations in greater than 20 percent of the samples exceeded the RB.

The maximum concentrations of aluminum, antimony, cadmium, chromium, copper, iron, lead, manganese, selenium, and vanadium are below their RBs. These ten metals are eliminated as COPECs. Concentrations of mercury in two samples (13 percent) exceed its RB. The concentration of zinc in one sample (6.7 percent) exceeds its RB. Based on concentrations in less than 20 percent that exceed their RBs, mercury and zinc are also eliminated as COPECs.

Refinement benchmarks specific to soil invertebrates are not available for isopropylbenzene, methylcyclohexane, and butylbenzylphthalate. Isopropylbenzene was detected in only one sample of 15 samples. The location of this single detection (Station 007) is the closest location to the Norfolk Southern Tracks. Isopropylbenzene was detected in one of the perimeter wells (MW-28) in October 2012 at an estimated (J-qualified) concentration of 0.097 µg/L, which is well below the DNREC standard of 39 µg/L for groundwater. Association of isopropylbenzene with past Site activities is uncertain. Isopropylbenzene can reasonably be eliminated as a COPEC based on a single detection (6.7 percent).

Methylcyclohexane was detected in five of the 15 samples (33 percent). Four of the five locations with detected concentrations are adjacent to Little Mill Creek (Stations 007, 011, 014, and 015). The fifth location with a detected concentration is in the approximate center of the wooded area (Station 006). As a VOC, methylcyclohexane is expected to dissipate relatively quickly in surface soil, which is suggestive of a more recent source. The pattern of detected concentrations suggests that the source of methylcylcohexane may be overflow from Little Mill Creek during high flows. Methylcyclohexane has not been detected in groundwater in the perimeter wells, which suggests sources other than the Site. Based on the above lines of evidence, methylcyclohexane can reasonably be eliminated as a COPEC for soil invertebrates.

Butylbenzylphthalate was detected in 14 of the 15 soil samples. This SVOC was not detected at Station 005, which is adjacent to the former parking lot. The source of butylbenzylphthalate in surface soil is uncertain. Butylbenzylphthalate has not been detected in any of the perimeter groundwater wells, which suggests sources other than the Site. As a plasticizer, the analytical laboratory could potentially be a source of the detected concentrations of butylbenzylphthalate. The widespread detection of butylbenzylphthalate suggests that this may be the case. Due to the questionable association with past Site activities, butylbenzylphthalate is eliminated as a COPEC for soil invertebrates.

4.2.2.2 Terrestrial Plants

Table 4.6 summaries the evaluation of risk to terrestrial plants. Information presented in Table 4.6 is similar to that presented in Table 4.5 for soil invertebrates.

The maximum concentrations of aluminum, cadmium, chromium, copper, iron, manganese, mercury, vanadium, and zinc are below their RBs. These nine metals are eliminated as COPECs. Concentrations of antimony and lead in one sample each (6.7 percent) exceed their RBs. Concentrations of selenium in two samples (13 percent) exceed its RB. Based on concentrations in less than 20 percent of samples that exceed their RBs, antimony, lead, and selenium are also eliminated as COPECs.

Refinement benchmarks specific to terrestrial plants are not available for isopropylbenzene, methylcyclohexane, and butylbenzylphthalate. The association of these three organic compounds with past Site activities is uncertain. All three were eliminated as COPECs for soil invertebrates based on lines on evidence that they may attributable to sources other than the Site. Those same lines of evidence apply to the evaluation for terrestrial plants. One additional line of evidence for plants is the absence of any indicator of chemically stressed vegetation at the locations where surface soil was sampled. As was done for soil invertebrates, isopropylbenzene, methylcyclohexane, and butylbenzylphthalate are also eliminated as COPECs for terrestrial plants.

4.2.2.3 Avian Wildlife

Table 4.7 summarizes the first step in the evaluation of risk to avian wildlife. Information presented in Table 4.7 includes the RB, number of samples, number of samples with detected concentrations, UCL, RQ_{UCL}, and rationale for retaining or eliminating a constituent as a COPEC. A constituent was retained as a COPEC if the RQ_{UCL} was greater than 1.0 (i.e., the UCL is greater than the RB). Constituents with a RQ_{UCL} greater than 1.0 were retained as COPECs and carried forward for additional evaluation using food chain models.

Refinement benchmarks are not available for isopropylbenzene, methylcyclohexane, and butylbenzylphthalate. These three organic compounds are retained as COPECs.

The RQ_{UCL}s for aluminum (0.66), cadmium (1.0), chromium (0.80), copper (0.047), iron (0.58), manganese (0.069), vanadium (0.60), and zinc (0.094) are less than 1.0. These eight metals are eliminated as COPECs for avian wildlife.

The RQ_{UCL}s for lead (4.1), mercury (1.7), and selenium (1.1) are greater than 1.0. These three metals are retained as a COPECs and are carried forward for further evaluation using food chain models. Antimony is also retained as a COPEC due to the lack of an available RB.

4.2.2.4 Mammalian Wildlife

Table 4.8 summarizes the first step in the evaluation of risk to mammalian wildlife. Information presented in Table 5.4 is similar to that presented in Table 5.3 for avian wildlife.

Refinement benchmarks are not available for isopropylbenzene, methylcyclohexane, and butylbenzylphthalate. These three organic compounds are retained as COPECs.

The RQ_{UCL}s for aluminum (0.66), chromium (0.80), copper (0.047), iron (0.58), manganese (0.075), vanadium (0.15), and zinc (0.094) are less than 1.0. These seven metals are eliminated as COPECs for avian wildlife.

The RQ_{UCL}s for antimony (21), cadmium (2.2), lead (5.2), mercury (1.7), and selenium (2.1) are greater than1.0. These five metals are retained as a COPECs and are carried forward for further evaluation using food chain models.

4.2.2.5 Food Chain Models

Overview

Food chain models were used to further evaluation the potential for risk to avian and/or mammalian wildlife exposed to methylcyclohexane, methylcyclohexane, butylbenzylphthalate, antimony, cadmium, lead, mercury, and/or selenium. Section 4.1.2.5 describes the general methodology for use of food chain models. This section provides further discussion based on the constituents retained as COPECs.

Exposure Parameters

Table 4.9 and Table 4.10 identify the exposure parameters for each indicator species for avian wildlife and mammalian wildlife, respectively. Information presented Table 5.5 includes body weight, rates of ingestion for food (on a dry weight and wet weight basis), soil, and water, area use, and diet. The foraging area provided for the wooded area is 15.3 acres. Although the diets of the indicator species include a number of food items, it is assumed that American woodcock and short-tailed shrew consume only soil invertebrates, mourning dove and meadow vole consume only terrestrial plants, and red-tailed hawk and long-tailed weasel consume only small mammals.

Toxicity Reference Values

Table 4.11 identifies the NOAELs and LOAELs for the constituents evaluated using food chain models. Neither a NOAEL nor a LOAEL is available for isopropylbenzene, methylcylcohexane, and butylbenzylphthalate for avian wildlife.

For mammalian wildlife, the NOAELs and LOAELs for isopropylbenzene are from Wolf et al. (1956) and are based on sub-lethal effects on growth in rats. For methylcyclohexane, the NOAEL is from Kim et al. (2011) and is based on reproductive effects in rats. A LOAEL was not identified for methylcyclohexane. The NOAEL for butylbenzylphthalate is based on a two generation study of reproductive effects on rats as reported by the U.S. Consumer Product Safety Commission (Tyl et al., 2004).

The NOAELs and LOAELs for HMW PAHs, antimony, cadmium, lead, and selenium are from the source documents for ECO-SSLs (USEPA 2005a, c;d 2007e,f). The NOAELs are the geometric means of NOAELs for growth and reproduction whereas the LOAELs are the geometric means of bounded LOAELs (i.e., a NOAEL was also reported) for growth and reproduction. For antimony, neither a NOAEL nor a LOAEL are available for avian wildlife. Data sufficient to calculate a LOAEL for antimony is not available for mammalian wildlife.

The NOAELs and LOAELs for inorganic mercury (the form expected to be present in soil) are from Sample et al. (1996). A LOAEL for mammalian receptors is not identified in Sample et al. (1996).

Due to the absence of NOAELs and/or LOAELs for isopropylbenzene, methylcyclohexane, butylbenzylphthalate, and antimony for avian wildlife, the potential for risk to avian wildlife will be based on mammalian wildlife.

Table 4.12 identifies uptake equations soil invertebrates, terrestrial plants, and small mammals. Table 4.13 identifies the EPCs. Appendix D and Appendix E provide the calculations for the uptake of organic compounds for soil-to-invertebrate and soil-to-plant, respectively.

Avian Wildlife

Table 4.14 through Table 4.16 summarize the food chain models for avian wildlife. Information presented in these tables include ingestion of COPECs via diet, soil, and surface water, total ingestion adjusted for area use (IR_{total} from Equation 3), NOAELs and LOAEL, HQs for the NOAEL (HQ_{NOAEL}) and LOAEL (HQ_{LOAEL}). Appendix F provides detailed calculations for the food chain models.

American Woodcock

Table 4.14 summarizes the food chain model for American woodcock, the indicator species for avian insectivores. Neither a NOAEL nor a LOAEL is available for isopropylbenzene, methylcyclohexane, butylbenzylphthalate, or antimony.

For mercury, lead, and selenium, the HQ_{NOAEL}s are less than 1.0. The HQ_{NOAEL}s are 0.46 for lead, 0.0033 for mercury, and 0.099 for selenium. Based on these results, it can be concluded that the potential for risk to avian insectivores exposed to lead, mercury, and selenium in the wooded area is below the threshold for concern.

Mourning Dove

Table 4.15 summarizes the food chain for mourning dove, the indicator species for avian herbivores. Neither a NOAEL nor a LOAEL is available for isopropylbenzene, methylcyclohexane, butylbenzylphthalate, or antimony.

For lead, mercury, and selenium, the HQ_{NOAEL}s are less than 1.0. The HQ_{NOAEL}s are 0.0027 for lead, 0.000022 for mercury, and 0.00092 for selenium. Based on these results, it can be concluded that the potential for risk to avian herbivores exposed to lead, mercury, and selenium in the wooded area is below the threshold for concern.

Red-Tailed Hawk
Table 4.16 summarizes the food chain for red-tailed hawk, the indicator species for avian carnivores. Neither a NOAEL nor a LOAEL is available for isopropylbenzene, methylcyclohexane, butylbenzylphthalate, or antimony.

For lead, mercury, and selenium, the HQ_{NOAEL}s and HQ_{LOAEL}s are less than 1.0. The HQ_{NOAEL}s are 0.0008 for lead, 0.0000069 for mercury, and 0.00067 for selenium. Based on these results, it can be concluded that the potential for risk to avian carnivores exposed to lead, mercury, and selenium in the wooded area is below the threshold for concern.

Mammalian Wildlife

Tables 4.17 through Table 4.19 summarize the food chain model for mammalian wildlife. Information presented in these tables is similar that provided in Table 4.14 through 4.16 for avian wildlife. Appendix F provides detailed calculations for the food chain models.

Short-Tailed Shrew
Table 4.17 summarizes the food chain model for short-tailed shrew, the indicator species for mammalian insectivores.

For all eight COPECs, the HQ_{NOAEL}s are less than 1.0. The HQ_{NOAEL}s are 0.000022 for isopropylbenzene, 0.00039 for methylcyclohexane, 0.13 for butylbenzylphthalate, 0.057 for antimony, 0.48 for cadmium, 0.28 for lead, 0.0033 for mercury, 0.000022 for lead, and 0.00092 for selenium. Based on these results, it can be concluded that the potential for risk to mammalian insectivores exposed to isopropylbenzene, methylcyclohexane, butylbenzylphthalate, antimony, cadmium, lead, mercury, and selenium in the wooded area is below the threshold for concern.

Meadow Vole
Table 4.18 summarizes the food chain model for meadow vole, the indicator species for mammalian herbivores.

For all eight COPECs, the HQ_{NOAEL}s are less than 1.0. The HQ_{NOAEL}s are 0.0000016 for isopropylbenzene, 0.000031 for methylcyclohexane, 0.00016 for butylbenzylphthalate, 0.0043 for antimony, 0.058 for cadmium, 0.062 for lead, 0.001 for mercury, and 0.33 for selenium. Based on these results, it can be concluded that the potential for risk to mammalian herbivores exposed to isopropylbenzene, methylcyclohexane, butylbenzylphthalate, antimony, cadmium, lead, mercury, and selenium in the wooded area is below the threshold for concern.

Long-Tailed Weasel

Table 4.19 summarizes the food chain model for long-tailed weasel, the indicator species for mammalian carnivores.

For all eight COPECs, the HQ_{NOAEL}s are less than 1.0. The HQ_{NOAEL}s are 0.000011 for isopropylbenzene, 0.0002 for methylcyclohexane, 0.063 for butylbenzylphthalate, 0.0037 for antimony, 0.020 for cadmium, 0.082 for lead, 0.0011 for mercury, and 0.24 for selenium. Based on these results, it can be concluded that the potential for risk to mammalian carnivores exposed to isopropylbenzene, methylcyclohexane, butylbenzylphthalate, antimony, cadmium, lead, mercury, and selenium in the wooded area is below the threshold for concern.

4.3.3 Surface Water

The screening process identified aluminum, barium, and zinc as COPECs for surface water. Table 4.20 summarizes the refinement of these three metals. Information presented in Table 4.20 includes the ESVs, default background standard identified by DNREC (1999), RB, maximum concentration, 95 percent UCL, and rationale for retaining or eliminating the each constituent as a COPEC.

For aluminum, the ESV (87 µg/L) is lower than the default background standard (200 µg/L). The 95 percent UCL of 183 µg/L is below the default background standard. Based on a 95 percent UCL concentration below background, aluminum is eliminated as a COPEC.

As discussed in Section 2.8.1, the ESV of 4.0 µg/L is unrealistically low. The RB is the ESL of 220 µg/L identified by USEPA Region 5 (2003a). The 95 percent UCL concentration of 192 µg/L is below the RB. Based on a 95 percent UCL concentration below the RB, barium is eliminated as a COPEC.

The ESV of 120 µg/L for zinc is also the refinement benchmark. The 95 percent UCL for zinc (101 µg/L) is below the ESV. Based on a 95 percent UCL concentration below the ESV, zinc is eliminated as a COPEC.

4.4.4 Sediment

4.4.4.1 Benthic Invertebrates

BTEX and SVOCs

The screening process identified one three SVOCs (bis(2-ethylhexyl)phthalate, carbazole, and dibenzofuran) as COPECs. As discussed in Section 4.1.4.2BTEX and SVOCs are refined using ESBs

(DiToro, 2000, USEPA, 2003c, 2008). This approach considers all BTEX constituents and SVOCs detected in a sample, not only those identified as COPECs based on bulk sediment. Therefore, refinement includes toluene, butylbenzylphthalate and di-n-octylphthaltate, which were detected in sediment, but eliminated as COPECs. Refinement also includes 2-methylnaphthalene as a SVOC. Although this SVOC is a PAH, it is not included in the calculation of TUs for PAHs (USEPA, 2003c).

The first step in the refinement process is calculation of CVs, which is based on K_{ow} and molecular weight of the individual organic compounds (see Equation 6). Table 4.21 identifies the CVs for the toluene and SVOCs (including 2-methylnaphthalene) detected in sediment.

The second step is calculation of ESBs for the individual organic compounds. As ESBs are a function of f_{oc} and f_{solids}, ESBs were calculated for each sediment sample. Table 4.21 also identifies the ESBs for toluene each detected SVOC and each sediment sample.

Table 4.22 summarizes the results of the refinement of BTEX and SVOCs in sediment. Information presented in Table 4.22 includes the NQ for each compound (detected concentration divided by the ESB) and TI for each sediment sample. The TI for SED 4-11 (1.17) is slightly greater than 1.0. This sample is from the stormwater ditch, which provides limited habitat for benthic invertebrates. The TIs for the other 11 sediment samples are less than 1.0.

<u>Polycyclic Aromatic Hydrocarbons</u>

The screening process identified both LMW PAHs, and HMW PAHs as COPECs. As discussed in Section 4.1.2.1, PAHs in sediment were refined using EqP and calculation of TUs (USEPA, 2003c). Similar to the approach for BTEX and SVOCs, the refinement method for PAHs considers all PAHs detected.

Table 4.23 summarizes the results of the refinement. Information presented in Table 4.23 includes the FCV for each PAH (USEPA, 2003c), the TUs for each PAH in each sample, and sum of the TUs for each sample. The sum of the TUs for SED 1-11 (1.94), SED 2-11 (23.7), SED 3-11 (30.3), SED 4-11 (59.5), SED 7-11 (2.32), and SED 12 (7.2)are greater than 1.0, indicating a potential for risk to benthic invertebrates at these six sample locations. Samples SED 1-11 through SED 4-11 are from the stormwater ditch, which provides limited habitat for benthic invertebrates. Sample SED 7-11 was collected from Little Mill Creek at a depth of 0-0.5 feet. and SED 12was collected from Little Mill Creek at a depth of 0.5-1.0 feet, a depth at which benthic invertebrates are not expected to be present.

<u>Total Petroleum Hydrocarbons</u>

The C10-C28 fraction of TPH was detected in four of the sediment samples collected in 2011 and 2012. Neither an ESV nor a RB is available for this TPH fraction. The four samples with detected concentrations were all collected from the stormwater ditch, which provides limited habitat for benthic invertebrates. Based on a limited potential to support ecological receptors, the potential to pose risk is considered to be negligible.

Metals

The screening process identified antimony, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, vanadium, and zinc as COPECs for sediment of Little Mill Creek and stormwater ditch. For the refinement process, both lower-tier and upper-tier SQBs are considered.

Table 4.25 summarizes the results of the refinement of metals in sediment. Information presented in Table 4.5 includes the ESV used in the screening process, values for the lower-tier and upper-tier SQBs, source of the SQBs, number of samples and number of samples with detected concentrations, minimum and maximum detected concentrations, and number of samples with concentrations greater than the lower-tier and upper-tier SQBs.

For manganese, all detected concentrations are below both the lower-tier and upper-tier SQBs. For antimony, barium, cadmium, iron, mercury, nickel, and vanadium, concentrations in all samples are below their upper-tier benchmarks. Based on these results, antimony, barium, cadmium, iron, manganese, mercury, nickel, and vanadium are eliminated as COPECs.

For chromium, copper, lead, and zinc, concentrations in one or more samples exceed their upper-tier SQBs. All exceedances are in samples SED 2-11 (copper, lead, and zinc), SED 3-11 (chromium, copper, lead, and zinc), and SED 4-11 (zinc). These three samples are from the stormwater ditch, which provides limited habitat for benthic invertebrates.

4.4.4.2 Food Chain Models

Overview

Food chain models were used to further evaluate the potential for risk to avian and/or mammalian wildlife exposed to bis(2-ethylhexyl)phthalate, carbazole, dibenzofuran, LMW PAHs, HMW PAHs, TPH, antimony, barium, cadmium, chromium, copper, lead, manganese, mercury, nickel, vanadium, and zinc. Section 4.1.2.5describes the general methodology for use of food chain models. This section provides further discussion based on the constituents retained as COPECs.

Exposure Parameters

Table 4.9 identifies the exposure parameters for tree swallow (avian insectivore) and belted kingfisher (avian piscivores). Table 4.10 Identifies the exposure parameters for little brown bat (mammalian insectivore) and mink (mammalian piscivores). The available foraging area in Little Mill Creek was conservatively assumed to be 500 feet in length and 10 feet in width (0.11 acre). The proportion of diet obtained from the assessment area, or AUF, is based on this assumption. Bioavailability of COPECs was conservatively assumed to be 100 percent.

Toxicity Reference Values

Table 4.11 identifies the NOAELs and LOAELs for avian and mammalian wildlife. Toxicity reference values for LMW PAHs, HMW PAHs, antimony barium, cadmium, chromium, copper, lead, manganese, nickel vanadium, and zinc were derived using data presented in the source documents for the ECO-SSLs for these constituents. The TRVs for the above constituents are the geometric means of the NOAELs and LOAELs.

TRVs for bis(2-ethylhexyl)phthalate, and ,methyl mercury (the form associated with aquatic habitats) are from Sample et al (1996). The TRV for petroleum hydrocarbons for mammalian receptors is from American Petroleum Institute (2004) and is based on beef cattle.

Toxicity reference values have not been identified for carbazole and dibenzofuran. A search of the USEPA ECOTOX and IRIS and National Institute of Health databases identified a number studies that reported endpoints relative to development of TRVs for mammalian wildlife. Based on the studies reported in the ECOTOX database, TRVs were developed for carbazole and dibenzofuran for mammalian receptors using the methodology used by USEPA (2010) to develop TRVs for ECO-SSLs.

Toxicity reference values were not identified or developed for carbazole, dibenzofuran, total petroleum hydrocarbons, antimony, and barium for avian wildlife. A LOAEL was not identified for petroleum hydrocarbons for mammalian wildlife.

Exposure Point Concentrations

Table 4.25 identifies the uptake equations and bioaccumulation factors used calculate concentrations of the COPECs in benthic invertebrates and fish. Equations identified by USEPA, Region 2 (undated tables) were the primary source. Equations identified by USEPA (1999b) for combustion facilities were used if an equation was not identified by Region 2. If an equation was not identified by Region 2 or USEPA (1999b), a bioaccumulation factor of 1.0 (i.e., the concentration in invertebrates and/or fish is equal to the concentration in sediment) was assumed. Table 5.22 identifies the source for the equations used for the refinement process.

Table 4.26 identifies the exposure concentrations for benthic invertebrates, fish, sediment and surface water. Concentrations for sediment and surface water are 95 percent UCL concentrations as calculated using ProUCL, Version 5 (USEPA, 2014). Concentrations for benthic invertebrates and fish were calculated using the 95 percent UCL concentrations and equations identified in Table 4.25.

Avian Wildlife

Tree Swallow

Table 4.27 summarizes the results of the food chain for tree swallow, the indicator species for avian insectivores. The HQ_{NOAEL}s are below 1.0 for all 12 COPECs for which NOAELs are available. The HQ_{LOAEL}s are 0.054 for bis(2-ethylhexyl)phthalate, 0.000043 for LMW PAHs, 0.10 for HMW PAHs, 0.0084 for cadmium, 0.015 for chromium, 0.13 for copper, 0.041 for lead, 0.022 for manganese, 0.38 for mercury, 0.0018 for nickel, 0.32 for vanadium, and 0.48 for zinc. Based on HQ_{NOAEL}s below 1.0, it can be concluded that these 12 constituents do not pose a potential for risk to avian insectivores above the threshold for concern.

Toxicity reference values are not available for carbazole, dibenzofuran, TPH, antimony, and barium. They are, however, available for mammalian receptors. Determination of risk to insectivores is based on the results for mammalian insectivores.

Belted Kingfisher

Table 4.28 summarizes the results of the food chain for belted kingfisher, the indicator species for avian piscivores. The HQ_{NOAEL}s are equal to or below 1.0 for bis(2-ethylhexyl)phthalate (0.69), LMW PAHs (0.0042), cadmium (0.012), chromium (0.14), copper (0.33), lead (0.30(, manganese (0.28), and nickel (0.16). Based on these results, it can concluded that bis(2-ethylhexyl)phthalate, LMW PAHs, cadmium, chromium, copper, lead, manganese, and nickel do not pose a potential for risk to avian piscivores above the threshold for concern.

For HMW PAHs, mercury, vanadium, and zinc, both the HQ_{NOAEL} and HQ_{LOAEL} are greater than 1.0. For HMW PAHs, the HQ_{NOAEL} and HQ_{LOAEL} are 21 and 2.1, respectively. For mercury, the HQ_{NOAEL} and HQ_{LOAEL} are 12 and 1.2, respectively. For vanadium, the HQ_{NOAEL} and HQ_{LOAEL} are 4.1 and 2.9, respectively. For zinc, the HQ_{NOAEL} and HQ_{LOAEL} are 3.0 and 1.3, respectively. Based on HQ_{LOAEL}s greater than 1.0, HMW PAHs, mercury, vanadium, and zinc are retained as COPECs for avian piscivores.

Toxicity reference values are not available for carbazole, dibenzofuran, TPH, antimony, and barium. They are, however, available for mammalian receptors. Consequently, the determination of risk to piscivores is based on the results for mammalian piscivores.

Mammalian Wildlife

Little Brown Bat

Table 4.29 summarizes the results of the food chain for little brown bat, the indicator species for mammalian insectivores. The HQ_{NOAEL}s are below 1.0 for bis(2-ethylhexyl)phthalate (0.035), carbazole (0.13), dibenzofuran (0.064), LMW PAHs (0.004), HWM PAHs (0.12) antimony (0.038), barium (0.29), cadmium (0.071), chromium (0.16), lead (0.17), manganese (0.81), nickel (0.015), and vanadium (0.62) are below 1.0. For copper, mercury, and zinc, the HQ_{NOAEL}s are greater than 1.0, whereas the HQ_{LOAEL}s are equal to or below 1.0. For copper, HQ_{NOAEL} and HQ_{LOAEL} are 1.5 and 0.24, respectively. For mercury, the HQ_{NOAEL} and HQ_{LOAEL} are 1.7 and 1.0, respectively. For zinc, the HQ_{NOAEL} and HQ_{LOAEL} are 4.5 and 0.38, respectively. Based on these results, it can reasonably be concluded that these 17 constituents do not pose a potential for risk to mammalian insectivores above the threshold for concern.

For TPH, the HQ_{NOAEL} is greater than 1.0 (3.6). A LOAEL is not available for mammalian receptors. Based on this result, TPH is identified as potentially posing risk to mammalian insectivores. However, TPH was detected only in the stormwater ditch, which is not expected to support an ecologically significant invertebrate community. Furthermore, in the absence of available uptake factors for sediment-to-benthic invertebrates, an uptake was conservative assumed. This assumption overestimates the potential for risk. Based on limited exposure and conservative assumption regarding uptake, it can reasonably be concluded that TPH does not pose a potential for risk to mammalian insectivores above the potential for concern.

Mink

Table 4.30 summarizes the results of the food chain for mink, the indicator species for mammalian piscivores. The HQ_{NOAEL}s for all COPECs are below 1.0. The HQ_{NOAEL}s are 0.0044 for bis(2-ethylhexyl)phthalate, 0.016 for carbazole, 0.0082 for dibenzofuran, 0.0043 for LMW PAHs, 0.25 for HWM PAHs, 0.45 for TPH, 0.0049 for antimony, 0.037 for barium, 0.023 for cadmium, 0.064 for chromium, 0.047 for copper, 0.042 for lead, 0.10 for manganese, 0.54 for mercury, 0.018 for nickel, 0.079 for vanadium, and 0.32 for zinc (0.90). Based on these results, it can be concluded that all 17 constituents do not pose a potential for risk to mammalian piscivores above the threshold for concern.

Section 5.0 Supplemental Refinement with Additional Surface Water, Sediment, and Groundwater Dataset

5.1 Overview

Following completion of the refined risk characterization and subsequent discussions between representatives of DNREC and CRA and RACER, CRA prepared and implemented a Work Plan, which was approved by DNREC, to provide additional data to supplement the refined risk characterizations for surface water and sediment. Specifically, the additional data, collected in October and November 2014, are:

- Collection of surface water samples from Outfall 001, stormwater outfall, and five stations in Little Mill Creek and analysis for dissolved metals
- Collection of sediment samples from the stormwater ditch and five stations in Little Mill Creek and analysis for acid volatile sulfides and simultaneously extracted metals (AVS/SEM), mercury, PAHs for 34 parent and alkylated homologs, total organic carbon (TOC), black carbon, and grain size

This section of the ERA presents the results of the 2014 sampling program and incorporates those data into the evaluation of risk to ecological receptors that are potentially present in Little Mill Creek.

5.2 Supplemental Surface Water Dataset

5.2.1 Sample Collection and Analysis

Samples of surface water were collected from the base of Outfall 001, the stormwater outfall upstream of Outfall 001, and five stations within Little Mill Creek on November 12, 2014. Samples were collected using dedicated balers, field filtered, transferred to jars provided by TestAmerica, and stored on ice until picked up by TestAmerica on the day of sampling.

TestAmerica analyzed all surface water samples for dissolved TAL metals. The analytical data for surface water are provided as Appendix C.

5.2.2 Evaluation of Surface Water Data

Concentrations of dissolved metals in each sample were compared ecological surface water screening levels for fresh water (DNREC, 2014). Distribution of dissolved metals in Little Mill Creek relative to the stormwater outfall and Outfall 001 were also evaluated.

In addition to comparison to DNREC screening levels, data for surface water were evaluated in conjunction with data for groundwater concurrently collected from perimeter wells in order to assess the potential for loading of Site-related metals to Little Mill Creek. Section 5.4 discusses the assessment of loading in more detail.

Table 5.1 summarizes the evaluation of risk to aquatic life exposed to metals detected in the surface water collected from the stormwater outfall, Outfall 001, and Little Mill Creek. Information presented in Table 5.1 includes screening levels for barium, iron, lead, manganese, and zinc (DNREC 2014); concentrations for the stormwater outfall and Outfall 001; maximum, mean, and UCL concentrations for Little Mill Creek; and comparison to the DNREC screening levels.

Calcium, magnesium, potassium, and sodium were detected in all surface water samples. Screening levels or other ESVs are not available for these four metals, which are all essential nutrients. Because they are essential nutrients, they are not considered to be COPECs.

All detected concentrations of iron and zinc are below their DNREC screening levels. Consequently, it can be concluded that these two metals do not pose risk to aquatic life.

The concentrations of barium in samples from the stormwater outfall and Outfall 001 and all samples from Little Mill Creek exceed the DNREC screening level of 4.0 µg/L. As discussed in Section 4.3.3, this value is a Tier II value, which includes a number of safety factors due to lack of robust dataset. Therefore, it is a conservative value that can be used for screening for potential risk but should not be used as a benchmark for impact to aquatic life. The USEPA Region 5 identifies an ESL of 220 µg/L for barium. Concentrations in all samples from the two outfalls and Little Mill Creek are below the Region 5 ESL.

Data collected in 2014 suggest that the concentrations of barium in Little Mill Creek are not entirely attributable to the Site. Concentrations in the stormwater outfall and Outfall 001 are lower than those in Little Mill Creek. Moreover, concentrations of barium in Little Mill Creek are very consistent from upstream the sample at the culvert under the Norfolk Southern tracks (SED 100-07) to the most downstream sample (SED 100-01). Concentrations in Little Mill Creek range from a minimum of 119 µg/L to 123 µg/L. Based on these data, it can reasonably be concluded that the concentrations of barium in Little Mill Creek are due to natural sources and do not pose risk to aquatic life.

Lead was not detected in samples collected from the stormwater outfall and Outfall 001 and was detected at an estimated (J-qualified) concentration of 6.5 µg/L in one sample collected from Little Mill Creek. The absence of a detected concentration in Outfall 001 suggests that the detected concentration of lead in Little Mill Creek may be due to sources other than the Site.

The screening level of 2.5 µg/L is conservative and should not be used as a benchmark for impact to aquatic life. Suter and Tsao (1996) identify a number of benchmarks substantially higher than the single detected concentration of 6.5 µg/L. These benchmarks include an EC_{20} (effect concentration for 20 percent of test organisms) for fish (22 µg/L), EC_{25} for bass (71 µg/L), lowest chronic value (LCV) for daphnids (12.3 µg/L), LCV for non-daphnids (25.5 µg/L), and LCV for fish (18.9 µg/L). Based on a single detected concentration below numerous benchmarks aquatic invertebrates and fish, it can reasonably be concluded that concentrations of lead in Little Mill Creek do not pose risk to aquatic life.

5.3 Supplemental Sediment Dataset

5.3.1 Sample Collection and Analysis

Samples of sediment were collected from the stormwater ditch upgradient of Outfall 001 and five stations in Little Mill Creek on November 12, 2014. Samples were collected from the top 3 inches of the substrate using dedicated hand trowels, transferred to jars provided by TestAmerica, and stored on ice until picked up by TestAmerica on the day of sampling.

TestAmerica analyzed all sediment samples for AVS, SEM (cadmium, copper, lead, nickel, silver, and zinc), mercury, PAHs for 34 parent and alkylated homologs, grain size, TOC, and black carbon. The analytical data for sediment are provided as Appendix C.

5.3.2 Evaluation of Sediment Data

5.3.2.1 Sediment Quality Benchmarks

Concentrations of metals and the 17 parent PAHs in bulk sediment in each sample were compared to the SQBs identified for the screening process (see Table 2.2). The distribution of metals and PAHs in Little Mill Creek relative to the stormwater ditch upgradient of Outfall 001 was also evaluated.

5.3.2.2 Acid Volatile Sulfides/Simultaneously Extracted Metals

Sediment samples were analyzed for AVS. Because concentrations of AVS in all samples were below detect limits, the ratio of SEM to AVS, which is an indicator of bioavailability, could not be calculated.

5.3.2.3 Equilibrium Partitioning Sediment Benchmarks For Polycyclic Aromatic Hydrocarbons

Analysis of sediment for the 34 parent and alkylated homologs allows for evaluation of risk to benthic invertebrates with consideration of bioavailability and the relative toxicity of the individual PAHs (USEPA 2003c). This method is the same as that used for the refinement of sediment data for 2011 and 2012. Whereas the refinement of the data for 2011 and 2011 was conducted using only the parent PAHs, the supplemental data include all 34 parent and alkylated homologs identified by USEPA (2003c). Section 4.1.4.2 provides a discussion of this method.

5.3.2.4 Food Chain Models

Based on data collected in 2011 and 2012, a potential for risk was identified for belted kingfisher, the indicator species for avian piscivores, due to HMW PAHs, mercury, vanadium, and zinc in the sediment. The dataset for 2011 and 20122 was biased by inclusion of samples collected from the stormwater ditch in the calculation of EPCs. Consequently, the EPCs calculated for 2011 and 2012 are not representative of Little Mill Creek or current conditions. The potential for risk to belted kingfisher was re-evaluated using sediment data for HMW PAHs and zinc collected from Little Mill Creek in 2014. Mercury and vanadium are not evaluated. Mercury was not detected in the samples collected in 2014. Vanadium was not an analyte for the 2014 samples. Vanadium was not an analyte for sediment collected in 2014. However, the highest concentrations of vanadium for the 2011-2012 dataset are from the stormwater ditch, which overestimated the EPCs.

Ingestion of HMW PAHs and zinc by belted kingfisher was calculated using Equation 3. Concentrations in fish were calculated using equations identified in Table 4.25.
Section 5.5.2.3.3 provides additional details on the food chain model for belted kingfisher.

5.3.3 Supplemental Sediment Dataset Evaluation

5.3.3.1 Polycyclic Aromatic Hydrocarbons

Sediment Quality Benchmarks

Table 5.2 summarizes the evaluation of risk to benthic invertebrates exposed to PAHs based on comparison of detected concentrations to SQBs. Information presented in Table 5.2 includes ESVs for total PAHs, LMW PAHs, HMW PAHs and the 17 individual parent PAHs, concentrations in the sample collected from the stormwater ditch; maximum and minimum concentrations detected in Little Mill Creek and comparison to SQBs

For the stormwater ditch, concentrations of total PAHs, LMW PAHs, and HMW PAHs are greater than their SQBs. For the individual PAHs, 2-methylnaphthalene and acenaphthene were not detected. Benzo(b)fluoranthene was detected at a concentration less than its SQB. For the other 14 individual PAHs, concentrations exceed their SQBs.

For samples collected from Little Mill Creek, the maximum concentration of total PAHs (28 mg/kg) exceeds the SQB of 1.61 mg/kg in one sample (SW/SED 100-02). Concentrations of LMW PAHs exceed the SQB in four samples and concentrations of HMW PAHs exceed the SQB in all five samples. All of the 17 individual parent PAHs were detected in at least one sample from Little Mill Creek. Concentrations of acenaphthylene and benzo(b)concentrations in all samples are below their SQBs. Concentrations of all other individual PAHs exceed their SQB in at least one sample, ranging from a single exceedance for 2-methylnaphthale, anthracene, fluorene, benzo(g,h,i)perylene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene to exceedances in all five samples for benzo(a)anthracene, dibenz(a,h)anthracene, and fluoranthene.

A discussion of the source of PAHs and potential risk to benthic invertebrates is provided below.

<u>Equilibrium Partitioning Sediment Benchmarks</u>

Table 5.3 summarizes the evaluation of risk to benthic invertebrates based on ESBs. As discussed in Section 4.1.4.2, ESBs are based on equilibrium partitioning of PAHs between sediment and porewater. Equilibrium partitioning benchmarks also account for the relative toxicity of the 34 individual parent and alkylated PAHs. Information presented in Table 5.3 includes values for TOC, black carbon, and total ESBTUs in each sample collected from the stormwater ditch and Little Mill Creek. Appendix G provides details for the calculation of ESBTUs for each sample.

As identified in Table 5.3, TOC is below the detection limit of 1,000 mg/kg (f_{oc} of 0.001) for four of the six samples. Total organic carbon is present above the detection limit only for the stormwater ditch (f_{oc} of 0.0122) and SED 100-07 (f_{oc} of 0.015), which is the upstream sample at the culvert for the Norfolk Southern rail yard. Concentrations of black carbon are below the detection limit of 1,000 mg/kg for all six samples, including the stormwater ditch. The low concentrations of carbon in the sediment indicates that adsorption of PAHs to carbon in sediment is limited.

Whereas all of the parent PAHs were detected in at least one sample, several of the alkylated PAHs were not detected in any of the samples (e.g., C2-naphthalenes, C3-fluorenes). Those individual PAHs that were not detected in any sample were not included in the calculation of total ESBTUs. For those PAHs that were detected in at least one but not in a specific sample, a value equal to one-half the detection limit was included in the calculation of total ESBTUs.

The values for total ESBTUs are greater than 1.0 for all six samples. The value for total ESBTUs for the stormwater ditch is 14 (unitless). The values for total ESBTUs for Little Mill Creek range from 1.5 (SED 100-01 and SED 100-03), which are downstream of the stormwater ditch and Outfall 001, to 43 for SED 100-02.

A discussion of the source of PAHs and potential risk to benthic invertebrates is provided below.

Summary for Polycyclic Aromatic Hydrocarbons

Based on both SQBs and ESBs, concentrations of PAHs in the sediment of the stormwater ditch and Little Mill Creek potentially pose risk to benthic invertebrates. Due to the small size and poor habitat quality of the stormwater ditch, an ecologically significant benthic community is not expected to be present. In contrast, Little Mill Creek has the potential to support a diversity of ecological receptors.

The primary area of potential risk in Little Mill Creek is the vicinity of SED 100-02. This is the only sampling location where the concentration of total PAHs exceeds the upper-tier PEC of 22.8 mg/kg (MacDonald et al. 2000). Similarly, the sum of the ESBTUs of 43 for SED 100-02 is substantially higher than other sampling locations. The ESBTUs for the other sampling locations range from 1.5 to 3.7. These values are indicative of a potential for risk to sensitive benthic species but are within the range of a limited potential for risk to common benthic species (USEPA 2003c).

Several lines of evidence suggest that the Site is not the primary source of PAHs. One line of evidence is groundwater. Samples were collected in five perimeter wells in 2014 and analyzed for the parent PAHs. None of the individual parent PAHs were detected in any of the perimeter wells.

Another line of evidence is the distribution of PAHs in the sediment of Little Mill Creek. Table 5.3 presents the ESBTUs for all samples from upstream (culvert under the Norfolk Southern rail yard) to downstream (SED 100-01). The ESBTU for the sample immediately downstream of Outfall 001 is lowest for the five samples, along with SED 100-01, which is the sampling station furthest downstream of Outfall 001. The highest ESBTU is further downstream of Outfall 011 at SED 100-02. This distribution suggests that the vicinity of SED 100-02 is a depositional area where PAHs accumulate.

A third line of evidence is composition of the individual PAHs in the five samples from Little Mill Creek. The parent PAHs with the highest concentrations in the samples from Little Mill Creek are phenanthrene, benzo(b)fluoranthene, benzo(a)pyrene, chrysene, fluoranthene, and pyrene. Figure 5.1 presents the relative fraction of these six PAHs in each of the samples, including the stormwater ditch. As can be seen from Figure 5.1, the relative fractions of each of the six PAHs are very consistent among samples. Fluoranthene, an indicator of pyrogenic origin, is the largest fraction in all samples. This consistency of among fractions from upstream of inflows from the Site to downstream suggests a common source of PAHs in Little Mill Creek that is not associated with the Site.

Data for PAHs in the sediment suggest a potential for risk to benthic invertebrates at some locations in Little Mill Creek. However, the Site does not appear to be the likely source of PAHs at these locations.

5.3.3.2 Metals

Sediment Quality Benchmarks

Table 5.4 summarizes the evaluation of risk to benthic invertebrates exposed to metals based on comparison of detected concentrations to SQBs. Information presented in Table 5.4 is similar to that presented in Table 5.3 for PAHs.

For the stormwater ditch, concentrations of lead (78.8 mg/kg) and zinc (273 mg/kg) exceed their SQBs, which are screening levels identified in DNREC (2014). These screening levels are TECs identified by MacDonald et al. (2000), which are lower-tier no effect concentrations. MacDonald et al. (2000) also identify PECs, which are upper-tier lowest effect concentrations. The PECs are 128 mg/kg and 459 mg/kg for lead and zinc, respectively. The concentrations of lead and zinc in the stormwater ditch are below their respective PECs. Risk to benthic invertebrates exposed to lead and zinc in the stormwater ditch is expected to be minimal and ecologically insignificant. Concentrations of copper, mercury, and nickel are below TECs

For samples collected from Little Mill Creek, copper, lead and zinc were detected in all five samples and nickel was detected in four samples. Mercury was not detected. Concentrations of lead, nickel, and zinc in all samples are below their SQBs. The concentration of copper in one sample exceeds its SQB. The sample with the exceedence was collected at SED 100-07, which is the upstream sample collected at the culvert for the Norfolk Southern rail yard. Concentrations of 3.4 mg/kg and 47.1 mg/kg (both J-qualified) were reported for duplicate samples collected from this location. Only the higher concentration of 47.1 mg/kg exceeds the SQB. As is the case for lead and zinc, the SQB is based on the TEC identified by MacDonald et al. (2000). The

PEC for copper is 149 mg/kg. The maximum concentration of 47.1 mg/kg is an order of magnitude lower than the PEC.

Based on comparison to SQBs and PECs, concentrations of copper, lead, mercury, nickel, and zinc in both the stormwater ditch and Little Mill Creek do not pose risk to benthic invertebrates.

Acid Volatile Sulfides/Simultaneously Extracted Metals

Concentrations of AVS were not detected in any of the samples collected from the stormwater ditch and Little Mill Creek. Consequently, the ratio of AVS to SEM could not be calculated. The ratio of AVS to SEM provides an estimate of the bioavailability of divalent metals that is not for in SQBs for bulk sediment. Because comparison of concentrations of the metals in bulk sediment to SQBs did not identify a potential for risk, it is expected that, if AVS had been detected, the conclusion of no risk would be similar.

5.3.3.3 Food Chain Models

Overview

Data collected from Little Mill Creek and the stormwater ditch in 2011 and 2012 were used to evaluate the potential for risk to avian and mammalian insectivores and piscivores that forage in Little Mill Creek. Only belted kingfisher, the indicator species for avian piscivores, was identified as having a potential for risk. High molecular weight PAHs, mercury, vanadium, and zinc were identified as the constituents potentially posing risk.

Table 5.5 summarizes the results of the food chain models based on data collected in 2011 and 2012. High molecular weight PAHs, copper, lead, mercury, nickel, and zinc were analyzed for and detected in samples collected in 2014. As demonstrated in Table 5.5, concentrations for all six constituents are lower for the 2014 samples than the samples collected in 2011 and 2012, which were biased toward higher concentrations in the stormwater ditch. Consequently, the samples collected in 2014 are more representative of exposure by ecological receptors.

The potential for risk to avian piscivores due to HMW PAHs and zinc is re-evaluated below. Because a potential for risk was not identified at the higher concentrations for the samples collected in 2011 and 2012, risk due to copper, lead, and nickel is not re-evaluated. Mercury was previously identified as posing risk, but was not detected in 2014.

Vanadium was not an analyte for the sediment samples collected in 2014. Consequently, vanadium is not re-evaluated for the supplemental 2014 data. The highest concentrations for the samples collected in 2011 and 2012 are from the stormwater ditch. Concentrations of vanadium in the sediment of Little Mill Creek, where fish are expected to be present, are not expected to pose a significant potential for risk to avian piscivores.

Exposure Parameters

Table 4.9 identifies the exposure parameters for belted kingfisher.

Toxicity Reference Values

Table 4.11 identifies the NOAELs and LOAELs for HMW PAHs and zinc.

Exposure Point Concentrations

Table 4.25 identifies the sediment-to-fish uptake equations for HMW PAHs and zinc. The uptake equation for zinc is from USEPA Region 2 (undated). An uptake equation is not available for HMW is not available. An uptake factor of 1.0 was conservatively assumed. Concentrations of HMW PAHs and zinc in sediment are UCLs calculated using ProUCL Version 5 (USEPA 2014).

Table 5.6 identifies the EPCs for HMW PAHs and zinc in sediment, fish, and surface water for the supplemental data.

Belted Kingfish

Table 5.7 summarizes the food chain model for belted kingfish exposed to HMW PAHs and zinc in sediment of Little Mill Creek. Information presented in Table 5.7 is similar to that presented in the tables for the food chain models for the 2011 and 2012 dataset.

For HMW PAHs, the HQ_{NOAEL} (6.1) is greater than 1.0 whereas the HQ_{LOAEL} (0.61) is less than 1.0. The food chain for belted kingfisher conservatively assumes a sediment-to-fish uptake factor of 1.0. Polycyclic aromatic hydrocarbons are not expected to significantly bioconcentrate in vertebrates as they are rapidly metabolized in vertebrates. For example, the ECO-SSL for carnivores is based on a soil-to-small mammal uptake factor of zero. Based on a HQ_{LOAEL} less than 1.0 and a conservative sediment-to-fish uptake factor of 1.0, it can reasonably be concluded that the concentrations of HMW PAHs in the sediment of Little Mill Creek do not pose a potential for risk to avian piscivores above the threshold for concern.

For zinc, the HQ_{NOAEL} (0.017)f is less than 1.0. Therefore, it can be concluded that concentrations of zinc in the sediment of Little Mill Creek do not pose a potential for risk to avian piscivores above the threshold for concern.

5.4 Mass Loading to Little Mill Creek Evaluation

5.4.1 Groundwater Sample Collection and Analysis

Samples of groundwater were collected from five perimeter wells on November 12, 2014. Samples were collected using dedicated balers, field filtered, transferred to jars provided by TestAmerica, and stored on ice until picked up by TestAmerica on the day of sampling.

TestAmerica analyzed all groundwater samples for dissolved TAL metals. The analytical data for groundwater are provided in Appendix C.

5.4.2 Evaluation of Groundwater Data

Concentrations of dissolved metals in groundwater were evaluated in conjunction with data for surface water in order to assess the potential for loading of Site-related metals to Little Mill Creek.

5.4.3 Mass Loading Calculation

Concentrations of dissolved metals in groundwater collected from perimeter wells and surface water provide data regarding the potential for migration of chemical constituents from the Site to Little Mill Creek. Based on discussions with representatives of DNREC, these data are qualitatively evaluated at this time rather through development of a groundwater flow model to estimate loadings to Little Mill Creek. Data collected from Little Mill Creek provide a more direct method for quantifying concentrations of chemical constituents in Little Mill Creek and evaluating potential impacts to aquatic life.

The qualitative evaluation of mass loading included comparison of concentrations of dissolved metals in groundwater and Little Mill Creek (i.e., are concentrations higher, lower, or similar between media), concentrations in samples collected at Outfall 001 and stormwater outfall, and distribution of concentrations in Little Mill Creek relative to DNREC screening levels.

5.4.4 Mass Loading Evaluation

Table 5.8 summarizes the data for groundwater and surface water. Information presented in Table 5.8 includes the minimum and maximum concentrations in groundwater and surface and the number of exceedences of screening values for groundwater and surface water.

Aluminum, arsenic, cobalt, nickel and silver were detected in groundwater but not the surface water of Little Mill Creek. Of these five metals, aluminum and silver do not have any exceedences of DNREC screening levels in groundwater. Arsenic has one exceedence (Well-28), cobalt has three exceedences (MW-27, MW-28, and MW-48), and nickel has one exceedence (MW-27). Based on these data, it can be concluded that aluminum, arsenic, nickel, and silver are not likely adding loads to Little Mill Creek.

Calcium, magnesium, potassium, and sodium are naturally occurring essential nutrients. As such, they are infrequently associated with industrial activities. DNREC has not identified screening levels for these four essential nutrients for either groundwater or surface water. The range of concentrations for all four nutrients are similar for both groundwater and surface water. These data suggest that calcium, magnesium, potassium, and sodium in groundwater and surface water are naturally occurring concentrations.

Barium was detected in all groundwater and surface water samples. Barium exceeds the DNREC screening level in one groundwater sample (MW-28) and all five surface water samples. The concentrations of barium in surface water samples are very similar for all five samples, suggesting natural sources. As discussed in Section 5.2.2, concentrations of barium in Little Mill Creek do not pose a potential for risk to aquatic life.

Concentrations of iron in groundwater are substantially higher than in surface water. Iron was detected in only two perimeter wells with concentrations of 32,500 µg/L and 3,610 µg/L in MW-28 and MW-28, respectively. Iron was detected in the downstream stations with concentrations of 64.1 µg/L and 61 µg/L at SW 100-01 and SW 100-02, respectively. This differential in concentrations in groundwater and surface water suggests loading of iron into Little Mill Creek. However, the two detected concentrations in Little Mill Creek are an order of magnitude lower than the DNREC screening level of 300 µg/L. These data suggest that, although loading may be occurring, loading is not impacting the aquatic life in Little Mill Creek.

Lead was not detected in any of the perimeter wells and was detected at only one station in Little Mill Creek. Lead was not detected in samples collected from the stormwater outfall and Outfall 001. These data suggest that the presence of lead in the surface water of Little Mill Creek is from sources other than the Site.

Manganese was detected in four of the five groundwater samples with concentrations in three of the samples exceeding the DNREC screening value for groundwater (MW-27, MW-28, and MW-48). These exceedences are two orders of magnitude higher than the concentrations detected in the surface water of Little Mill Creek, suggesting manganese is loading into Little Mill Creek. Even if loading is occurring, manganese is not impacting the aquatic life of Little Mill

Creek as concentrations in surface water are well below the surface water screening level of 120 µg/L.

Zinc was detected at similar concentrations in groundwater and surface water. None of the concentrations in groundwater or surface water exceed the DNREC screening levels. These data suggest that concentrations of zinc in both groundwater and surface water are due to natural sources.

Data for 2014 suggest that iron and manganese are the only metals in groundwater that are potentially loading into Little Mill Creek. For both metals, the detected concentrations in surface water are well below concentrations that are expected to impact the aquatic life of Little Mill Creek.

Section 6.0 Analysis of Uncertainties

Evaluation of risk to ecological receptors is typically associated with numerous sources of uncertainty. In the absence of data, assumptions must be made regarding EPCs and responses of ecological receptors to COPECs. To avoid incorrectly dismissing the potential for risk, exposure concentrations and other assumptions are intentionally biased toward identifying risk. As a result of this bias, it can be concluded with a high level of certainty that constituents with SQs and HQs below 1.0 do not pose an unacceptable potential for risk to ecological receptors. However, a SQ or HQ greater than one does not necessarily demonstrate that the risk actually exists. Uncertainty associated with the ERA presented in this document is discussed below.

6.1 Ecological Considerations

6.1.1 Area Use

American woodcock, mourning dove, red-tailed hawk, short-tailed shrew, meadow vole, long-tailed weasel, tree swallow, belted kingfisher, little brown bat and mink were selected as indicator species for avian and mammalian wildlife. The food chain models for these indicator species included an AUF. The degree of utilization of the wooded area and Little Mill Creek by these indicator species, or ecological equivalents, is uncertain.

6.1.2 Assessment and Measurement Endpoints

The assessment endpoints for both the screening and refinement processes were protection of ecological populations and communities. In the absence of data that quantify these assessment endpoints, ecological benchmarks and TRVs were used as measurement endpoints. The actual relationships between the assessment endpoints and measurement are uncertain.

6.1.3 Exposure Parameters and Exposure Concentrations

The food chain models required a number of assumptions regarding uptake, bioaccumulation, ingestion rates, and EPCs. To account for uncertainty, assumptions were biased conservative, that is, the assumptions tend to exaggerate risks. For example, COPECs were assumed to be 100% bioavailable.

In the absence of concentrations of the COPECs in tissue, uptake equations and bioaccumulation factors from a variety of guidance documents were used to estimate the concentrations of COPECs in soil invertebrates, terrestrial plants, small mammals, benthic invertebrates, and fish. For soil invertebrates, bioaccumulation of organic compounds was estimated based on log K_{ow}, K_{oc}, and f_{oc}. For plants, bioaccumulation of organic compound was estimated based on log K_{ow}. For constituents without available uptake equations, concentrations in dietary items were assumed to the same as in soil or sediment. The actual concentrations of COPECs in dietary items is uncertain.

6.1.4 Ecotoxicity

The actual toxicity of the COPECs to avian and mammalian wildlife is uncertain. The ranges of NOAELs and LOAELs upon which the geometric means are based are relatively broad, some by several orders of magnitude. This is due to differences in test organisms, forms of a COPEC tested, exposure duration, age and sex of test organism, to name a few. The application of geometric mean values, which buffer the contribution to higher outlier values, to Site specific conditions is uncertain.

6.2 Wooded Area

One of the uncertainties in the risk characterization for the wooded area is the ecotoxicological effects of isopropylbenzene, methylcyclohexane, and butylbenzylphthalate on soil invertebrates, terrestrial plants, and avian wildlife. Ecological screening values, RBs, and TRVs are not available for any of these organic compounds for these receptor groups. However, the HQ_{NOAEL}s for mammalian wildlife are substantially below 1.0, which suggests that the potential for risk to avian wildlife is also below the threshold for concern. The absence of indicators of stressed vegetation suggests that risk to terrestrial plants is low.

The potential for risk to avian wildlife exposed to antimony is also uncertain. Neither a NOAEL nor a LOAEL is available. The HQ_{NOAEL} for mammalian wildlife is substantially below 1.0, which suggests that the potential for risk to avian wildlife is also below the threshold for concern.

6.3 Surface Water

Concentrations of barium and lead in the surface water of Little Mill Creek exceed their DNREC screening levels. These metals are naturally occurring and are expected to be detected in surface water, independent of association with the Site. The source of barium and lead in Little Mill Creek is uncertain. The high degree of similarity in concentrations of barium at all stations in Little Mill Creek suggests that barium is from natural sources. Lead was not detected in any of the perimeter wells or at Outfall 001 or stormwater outfall. The absence of detected concentrations at these locations suggests that lead in Little Mill Creek is likely attributable to natural and/or other anthropogenic sources, such as the Norfolk Southern rail yard.

6.4 Sediment

The ESBs for VOCs and PAHs include normalization of bulk sediment concentrations for organic carbon. Data for f_{oc} are not available for samples collected in 2011 and 2012. For samples collected in 2014, detectable concentrations of TOC were present only in the stormwater ditch and SED 100-07, which is upstream at the culvert under the Norfolk Southern rail yard. Black carbon was not detected in any of the sediment samples. The very low values for organic carbon are likely due to the very low percentage of fine sediment in Little Mill Creek. For the calculation of ESBs, a value for f_{oc} equal to the detection limit was assumed. The actual values for f_{oc} at stations with non-detectable values are uncertain.

The source of the high concentration of total PAHs and ESBTUs at SED 100-02 is uncertain. These values are the highest in Little Mill Creek, including the station immediately downstream of Outfall 001. This station appears to be a depositional area where PAHs from multiple sources within the watershed of Little Mill Creek may accumulate. Analysis of the relative concentrations of the predominant parent PAHs in Little Mill Creek identified a consistent pattern for all stations, including the stations upstream of Outfall 001. This pattern, along with the absence of detectable concentrations of PAHs in groundwater in the perimeter wells, suggest that the Site is not the source of the elevated concentrations at SED 100-02.

Data were collected for calculation of the ratio of SEM to AVS. However, concentrations of AVS were below the detection limit for all samples. Concentrations of metals in bulk sediment, which do not account for bioavailability, are below those expected to impact benthic invertebrates.

6.5 Sources of COPECs

The refinement process for data collected in 2011 and 2012 retained SVOCs, LMW and HMW PAHs, TPH, chromium, copper, lead, mercury, vanadium, and zinc as COPECs for sediment. The highest concentrations of each of these constituents are from samples SED 1-11, SED 2-11, SED 3-11, and SED 4-11. These samples are located in Outfall 001 and not in the creek itself. These samples are nearest to the Norfolk Southern rail yard that forms the northern boundary of the assessment area.

For the supplemental data collected in 2014, PAHs were identified as potentially posing risk to benthic invertebrates. Analysis of the relative fractions of the predominant parent PAHs (phenanthrene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, and pyrene) in samples from Little Mill Creek identified a consistent pattern for all samples. Moreover, phenanthrene, a pyrogenic PAH characteristic of burning of diesel fuel, is the predominant PAH in all samples. Consequently, source of PAHs, as well as other COPECs, from samples near the tracks may be attributable to operation of the rail yard rather than from the Site.

6.6 Mass Loading

The evaluation of mass loading to Little Mill Creek is based on concentrations of dissolved metals in groundwater and surface water in samples collected at the same point in time. As the time required for groundwater to migrate from the perimeter wells to Little Mill Creek is uncertain, the correlation of concentrations in the perimeters and Little Mill Creek is likewise uncertain.

Section 7.0 Summary and Conclusions

7.1 Main Manufacturing Area

Based on maximum detected concentrations detected in soil of the main manufacturing area, the screening process identified four VOCs (cyclohexane, cis-1,2-dichloroethene, isopropylbenzene, and methylcyclohexane), three BTEX constituents (benzene, ethylbenzene, and total xylenes), two SVOCs (bis(2-ethylhexyl)phthalate, butylbenzylphthalate and carbazole), HMW PAHs, total PCBs, three pesticides (4,4'-DDT, endrin aldehyde, and endrin ketone), and

17 metals (aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, titanium, vanadium, and zinc) as COPECs.

The Step 3a refinement process eliminated all COPECs for soil in the main manufacturing area. All samples in the dataset were collected for areas covered by pavement or other man-made surfaces. Due to the cover, ecological receptors are not exposed to the COPECs in soil.

7.1.1 Ecological Risk assessment

An ERA, consisting of Steps 1, 2, and 3a of the USEPA process for conducting ecological risk assessment (USEPA 1997), was conducted for Site. Media evaluated were soil and surface water and sediment of Little Mill Creek, which is located in an area of mature forest east of the Site.

The screening process (Steps 1 and 2) identified constituents of COPECs by comparing maximum concentrations to ESVs. In Step 3a, the COPECs identified in the screening process were refined by considering complete exposure pathways, exposure concentrations based on 95 percent UCL concentrations, background concentrations, and alternative ecological benchmarks. Food chain models were used to assess the potential for risk avian and mammalian wildlife.

The ERA process for soil collected from the main manufacturing area eliminated all COPECs for soil in the main manufacturing area. All soil samples in the main manufacturing area dataset were collected for areas covered by pavement or other man made surfaces. Due to the cover, ecological receptors are not exposed to the COPECs in soil.

The ERA process for soil collected for the wooded area in OU-6 did not identify a potential for risk to any ecological receptors exposed to any of the chemical constituents detected in the wooded area above the threshold for concern.

The ERA process for surface water collected from Little Mill Creek in 2011 concluded that the potential for risk due to aluminum, barium, and zinc is below the threshold for concern. The single detected concentration of lead in the 2014 data set is most likely from source other than the Site.

The ERA process for sediment collected from Little Mill Creek and stormwater ditch in 2011 and 2012 retained SVOCs, PAHs, and five metals as COPECs. The only detected concentrations of petroleum hydrocarbons and mercury were in samples collected from the stormwater ditch, which provides limited habitat for ecological receptors.

Due to uncertainty regarding the potential source of constituents in the sediment, a supplemental dataset was collected from Little Mill Creek in 2014. The supplement sampling provided additional data for PAHs and metals. The subsequent risk characterization for sediment for the supplemental dataset did not identify a potential for risk for benthic invertebrates exposed to metals or avian piscivores exposed to metals and PAHs above the threshold for concern. The risk characterization did, however, identify a potential for risk to benthic invertebrates exposed to PAHs in the stormwater ditch and Little Mill Creek.

Several lines of evidence suggest that the elevated concentrations of PAHs in the sediment of Little Mill Creek are not from sources migrating from Site-related sources upstream of the stormwater ditch. One line of evidence is the presence of numerous sources of PAHs in the watershed of Little Mill Creek, including the urban land use upstream of the Site (oil, incomplete combustion products from car and truck traffic) and the Norfolk Southern rail yard (diesel fuel, lubricating oils, creosote, and incomplete combustion products). A second line of evidence is the consistency in the composition of the predominant PAHs in samples collected in the stormwater ditch, upstream, and adjacent to the Site. A third line of evidence is the absence of detected concentrations of PAHs in perimeter wells on the Site.

The evaluation of potential loading to Little Mill Creek from groundwater identified iron and manganese as potentially migrating from the Site to Little Mill Creek. The low concentrations of both iron and manganese at all sampling locations in Little Mill Creek document that, although loading may be occurring, aquatic life is not impacted by migration of metals from the Site.

7.2 Wooded Area

Screening of surface soil collected from the wooded area identified two VOCs (isopropylbenzene and methylcyclohexane), one SVOC (butylbenzylphthalate), and 12 metals (aluminum, antimony, cadmium, chromium, copper, iron, lead, manganese mercury, selenium, vanadium, and zinc) as COPECs. Isopropylbenzene and methylcylcohexane were retained as COPECs due the lack of ESVs. Aluminum was retained because pH of the soil, which is the basis of the ESV, is uncertain. The maximum concentration of cadmium was below its ESV. However, cadmium was retained as a COPEC because it is a BCOC and could potentially pose risk to upper trophic level wildlife.

The 14 constituents retained as COPECs for the wooded area were refined by evaluating the potential for risk to soil invertebrates, terrestrial plants, avian wildlife, and mammalian wildlife. Selection of RBs for the four receptor groups considered background concentrations in New Castle County. Due to the absence of RBs and background concentrations, potential risk to soil invertebrates and terrestrial plants could not be evaluated for isopropylbenzene, methylcyclohexane, and butylbenzylphthalate. However, based on several lines of evidence, including the absence of indicators of stressed vegetation in the wooded area, these three organic compounds are not expected to pose a significant potential for risk to soil invertebrates or terrestrial plants. None of the 12 metals carried forward for refinement were identified as posing risk to soil invertebrates and terrestrial plants.

The refinement for avian and mammalian wildlife identified isopropylbenzene, methylcylcohexane, butylbenzylphthalate, antimony, cadmium, lead, mercury, and selenium as potentially posing risk. These eight constituents were further evaluated using food chain models. Food chain models did not identify a potential for risk to avian and mammalian wildlife for any of the eight constituents.

7.3 Surface Water of Little Mill Creek

The screening of data collected in 2012 identified aluminum, barium, and zinc as COPECs for the surface water of Little Mill Creek. The refinement process eliminated all three of these metals as COPECs. For the supplemental data collected in 2014, concentrations of barium in surface water collected from Outfall 001 and the stormwater outfall and manganese in the surface water from the stormwater outfall exceed the DNREC surface water screening levels. These two areas provide limited habitat for aquatic life. Consequently, the potential for risk to aquatic life at Outfall 001 and stormwater outfall is limited due to an incomplete exposure pathway.

Concentrations of barium in all samples collected from Little Mill Creek and lead in one sample exceed their DNREC screening levels. Concentrations of barium are very similar for all samples, which suggests that concentrations above the screening level are due to natural sources. The screening level for barium is a Tier II value, which includes safety factors. All concentrations in Little Mill Creek are below the ESL identified by USEPA Region 5. Consequently, it can reasonably be concluded that concentrations of barium in Little Mill Creek do not pose risk to aquatic life above the threshold for concern.

The single detected concentration of lead in Little Mill Creek is below numerous ecological benchmarks for aquatic life. Furthermore, the absence of detected concentrations of lead in either outfall or perimeter groundwater wells suggests lead may be attributable to sources other the Site.

7.4 Sediment

The screening process for sediment collected in 2011 and 2012 identified bis(2-ethylhexyl)phthalate, butylbenzylphthalate, carbazole, and dibenzofuran, LMW PAHs, HMW PAHs, LMW PAHs, TPH, and 12 metals (antimony, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, vanadium, and zinc) as COPECs for sediment. The refinement process identified a potential for risk to benthic invertebrates exposed to organic compounds (toluene and SVOCs), PAHs, chromium, copper, lead, and zinc in the sediment. Food chain models identified a potential for risk to avian and mammalian wildlife exposed to HMW PAHs (avian piscivores), TPH (mammalian insectivores), mercury (avian piscivores), vanadium (avian piscivores), and zinc (avian piscivores).

As a result of the initial screening, supplemental data for sediment were collected in 2014 and analyzed for PAHs and metals. Concentrations of total PAHs in bulk sediment exceed both the lower-tier no effect and upper-tier lowest effect SQBs in the stormwater ditch and one station in Little Mill Creek (SED 100-02). Consideration of ESBs, which take into account bioavailability and relative toxicity of the individual PAHs, also identified a potential for risk to benthic invertebrates for the stormwater ditch and all stations in Little Mill Creek, with the highest potential at SED 100-02.

PAHs are ubiquitous in the environment due to the large number and diversity of sources that potentially release PAHs into the environment (Boehm, 2006; Neff et al., 2005). Several lines of evidence suggest that the elevated concentrations of PAHs in the stormwater ditch and Little Mill Creek are due to sources other than Site. The Norfolk Southern rail yard, which forms the northern boundary of the Site, is potentially a significant source of PAHs. Sources of PAHs in the rail yard include diesel fuel, lubricating oils, creosote in ties, and incomplete combustion products from burning of diesel fuel. Another potential source of PAHs is the urban watershed of Little Mill Creek upstream of the Site. Sources of PAHs in the urban watershed include oil and incomplete combustion products from car and truck traffic.

If Site-related sources upstream of the stormwater ditch are the primary source of PAHs in the sediment of Little Mill Creek, then the relative composition of PAHs is be expected to be different upstream of the Site and adjacent and downstream of the Site. This is not the case. Analysis of the relative concentrations of the six predominate parent PAHs in sediment identified a consistent pattern for samples collected from the stormwater ditch, upstream of surface inputs from the Site (i.e., outfalls), and adjacent to the Site. This consistency strongly suggests that PAHs are most likely attributable to sources other than Site-related activities. Groundwater provides another line of evidence for determining if the Site is a source of PAHs in Little Mill Creek. If PAHs are migrating from the Site, then the PAHs detected in Little Mill Creek at elevated concentrations would also be expected to be present in groundwater. The absence of detected concentrations of any of the PAHs in all perimeter wells provides an additional line of evidence for non Site sources of PAHs.

Concentrations of PAHs and metals in the sediment of Little Mill Creek were lower for the 2014 samples than those collected in 2011 and 2012, which are less representative of EPCs for current conditions in Little Mill Creek. The food chain model for belted kingfisher was re-evaluated for HMW PAHs and zinc. Based on EPCs for the 2014 data, the potential for risk to belted kingfisher exposed to HMW PAHs and zinc is below the threshold for concern.

Semi-volatile organic compounds, TPH, mercury, and vanadium were retained as COPECs for sediment based on data collected in 2011 and 2012. For this dataset, all detected concentrations of TPH and mercury were in samples collected from the stormwater ditch, which provides limited habitat for aquatic receptors. The absence of detected concentrations of mercury in Little Mill Creek was confirmed with the supplemental data collected in 2014. The only sample with concentrations of SVOCs with a potential for risk to benthic invertebrates was collected in the stormwater ditch. Vanadium was detected in both the stormwater ditch and Little Mill Creek, with the samples with the highest concentrations collected from the stormwater ditch. Based on these data, it can reasonably be concluded that SVOCs, TPH, mercury, and vanadium do not pose a potential for risk to the aquatic life of Little Mill Creek.

7.5 Mass Loading

Comparison of concentrations of dissolved metals in groundwater in the perimeter wells and surface water of Little Mill Creek identified iron and manganese as potential indicators of loading to Little Mill Creek. However, concentrations of both iron and manganese in Little Mill Creek are substantially below their DNREC screening levels, suggesting no impact to aquatic life.

Section 8.0 References

American Petroleum Institute. 2004. TPH TRV.

Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 0-1. Seattle, WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages.

Canadian Council of Ministers of the Environment (CCME). 2007. Environmental Quality Guidelines, Canadian Soil Quality Guidelines for the Protection of Human and Environmental Health. Update 7.1, December 2007.

Crommentuijn, T., M.D. Polder, and E.J. van de Plassche. 1997. Maximum Permissible Concentrations and Negligible Concentrations for Metals, Taking Background Concentrations into Account. National Institute of Public Health and the Environment, Bilthoven, The Netherlands. Report No. 601501 001.

Delaware Department of Natural Resources and Environmental Control. 1999. Remediation Standards Guidance Under the Delaware Hazardous Substance Cleanup Act. Revised December 1999.

Delaware Department of Natural Resources and Environmental Control. 2012. Statewide Soil Background Study: Report of Findings.

Delaware Department of Natural Resources and Environmental Control. 2014. Screening Level Table, January 1, 2013. Division of Waste and Hazardous Substances, Site Investigation and Restoration Section. Last Updated October 2014.

DiToro, D.M., J.A. McGrath, and D. J. Hansen. 2000. Technical Basis for Narcotic Chemicals and Polycyclic Aromatic Hydrocarbon Criteria. I. Water and Tissue. Environ. Tox. and Chem. 19:1951-1970.

Efroymson, R.A., Will, M.E. and Suter II, G.W. 1997a. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. Oak Ridge National Laboratory. ES/ER/TM-126/R2.

Efroymson, R.A., Will, M.E., Suter II, G.W., and Wooten, A.C. 1997b. Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Oak Ridge National Laboratory. ES/ER/TM-85/R3.

Fuchsman, P.C. 2003. Modification of the equilibrium partitioning approach for volatile organic compounds in sediment. Environ. Toxicol. Chem. 22:1532-1534.

Jager, T. 1998. Mechanistic *Chem*. 17approach for estimating bioconcentration of organic chemicals in earthworms. Environ. Toxicol.: 2080-2090.

Kim, H., Kang, M., Kim, T., and Kang, C. 2011. Toxicity of Methylcyclohexane and Its Effect on the Reproductive System in SD Rats. Saf. Health Work. Sep. 2(3):290-300.

MacDonald, D. D., Ingersoll, C.G., and Berger, T.A. 2000. Development and of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

Sample, B.E., Opresko, D.M. and Suter II, G.W. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3.

Sample, B.E., Beauchamp, J.J., Efroymson, R.A., and Suter II, G.W. 1998. Development and Validation of Bioaccumulation Models for Small Mammals. ES/ER/TM-219.

Suter II, G.W. and Tsao, C.L. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota. 1996 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-96/R2.

Texas Natural Resource Conservation Commission. 2006. Update to Guidance for Conducting Ecological Risk Assessments at Re mediation Sites in Texas. Toxicological and Risk Assessment Section. RG-263 (Revised). January 2006 Version.

Tyl, R.W., Myers, C.B., Marr, M.C., Fail, P.A., Seely, J.C., and Brine, D.R. 2004. Reproductive toxicity evaluation of dietary butyl benzyl phthalate (BBP) in rats. Reproductive Toxicology 18:241-264.

U.S. Environmental Protection Agency. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. EPA 905/R96/008. Great Lakes National Program Office, Chicago, IL

U.S. Environmental Protection Agency. 1997. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessment*, USEPA/540/R-97/006, June 1997

U.S. Environmental Protection Agency. 1999a. Data Collection for the Hazardous Waste Identification Rule. Section 12.0. Ecological Exposure Factors. Office of Solid Waste. October 1999.

U.S. Environmental Protection Agency. 1999b. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. Office of Solid Waste and Emergency Response. EPA530-D-99-001A.

U.S. Environmental Protection Agency. 2001. Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment. Originally published November 1995. Website version last updated November 30, 2001. Accessed on April 9, 2014. Available at: http://www.epa.gov/region4/superfund/programs/riskassess/ecolbul.html.

U.S. Environmental Protection Agency. 2003a. RCRA, Ecological Screening Levels, August 22, 2003.

U.S. Environmental Protection Agency. 2003b. Ecological Soil Screening Levels for Aluminum. Interim Final. OSWER Directive 9285.7-60. Office of Solid Waste and Emergency Response. November 2001.

U.S. Environmental Protection Agency. 2003c Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures. EPA 600 R 02 013. Office of Research and Development, Washington, DC 20460.

U.S. Environmental Protection Agency. 2005a. Ecological Soil Screening Levels for Antimony. Interim Final. OSWER Directive 9285.7-61. Office of Solid Waste and Emergency Response. February 2005.

U.S. Environmental Protection Agency. 2005b. Ecological Soil Screening Levels for Barium. Interim Final. OSWER Directive 9285.7-63. Office of Solid Waste and Emergency Response. February 2005.

U.S. Environmental Protection Agency. 2005c. Ecological Soil Screening Levels for Cadmium. Interim Final. OSWER Directive 9285.7-65. Office of Solid Waste and Emergency Response. March 2005.

U.S. Environmental Protection Agency. 2005d. Ecological Soil Screening Levels for Lead. Interim Final. OSWER Directive 9285.7-70. Office of Solid Waste and Emergency Response. March 2005.

U.S. Environmental Protection Agency. 2005e. Ecological Soil Screening Levels for Vanadium. Interim Final. OSWER Directive 9285.7-75. Office of Solid Waste and Emergency Response. April 2005.

U.S. Environmental Protection Agency. 2005f. Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for Protection of Benthic Organisms: Metal Mixtures (Cadmium, Copper, Lead, Nickel, Silver, and Zinc). EPA-600-R-02-011. January 2005.

U.S. Environmental Protection Agency. 2007a. Ecological Soil Screening Levels for Copper. July 2006. Revised February 2007. OSWER Directive 9285.7-68.

U.S. Environmental Protection Agency. 2007b. Ecological Soil Screening Levels for DDT and Metabolites April 2007. OSWER Directive 9285.7-57.

U.S. Environmental Protection Agency. 2007c. Ecological Soil Screening Levels for Manganese. Interim Final. March 2005, Revised April 2007. OSWER Directive 9285.7-71.

U.S. Environmental Protection Agency. 2007d Ecological Soil Screening Levels for Nickel. Interim Final. March 2007. OSWER Directive 9285.7-76.

U.S. Environmental Protection Agency. 2007e. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs). Interim Final. June 2007b. OSWER Directive 9285.7-78.

U.S. Environmental Protection Agency. 2007f. Ecological Soil Screening Levels for Selenium. Interim Final. OSWER Directive 9285.7-72. Office of Solid Waste and Emergency Response. July 2007.

U.S. Environmental Protection Agency. 2007g. Ecological Soil Screening Levels for Zinc. Interim Final. OSWER Directive 9285.7-73. Office of Solid Waste and Emergency Response. July 2007.

U.S. Environmental Protection Agency. 2008a. Ecological Soil Screening Levels for Chromium. Interim Final. OSWER Directive 9285.7-66. Office of Solid Waste and Emergency Response. March 2005. Revised April 2008.

U.S. Environmental Protection Agency. 2008b. Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Compendium of Tier 2 Values for Nonionic Organics. EPA-600-R-02-016. Office of Research and Development. Washington, DC 20460.

U.S. Environmental Protection Agency. 2010. Ecological Soil Screening Levels, OSWER Directive. Website version last updated October 20, 2010. Accessed on April 9, 2014. Available at: http://www.epa.gov/ecotox/ecossl/

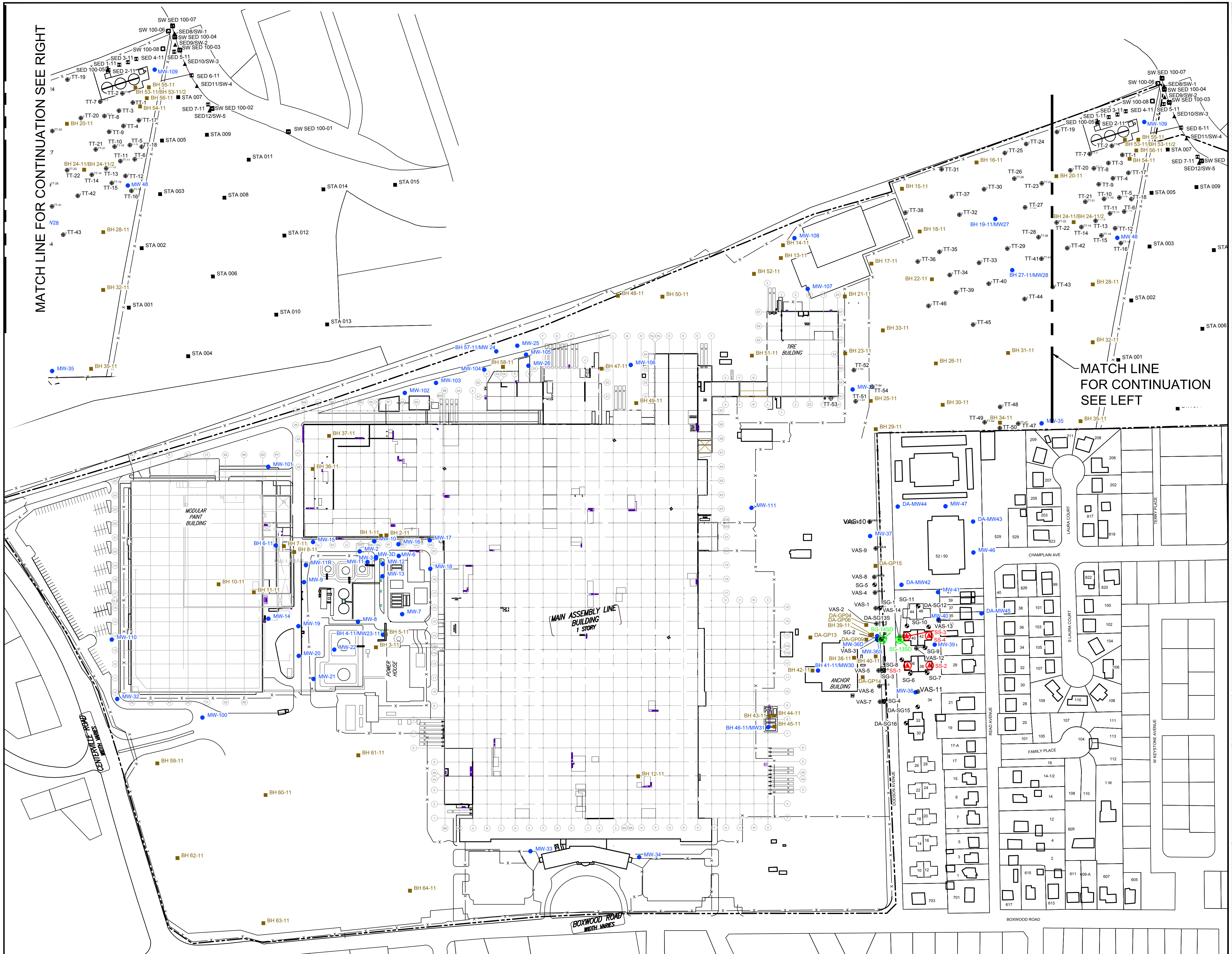
U.S. Environmental Protection Agency. 2013a. Freshwater Screening Benchmarks and Freshwater Sediment Screening Benchmarks. Available at http://www.epa.gov/reg3hwmd/risk/eco/index.htm. Last updated January 23, 2013.

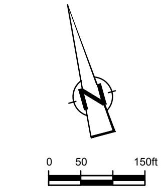
U.S. Environmental Protection Agency. 2013b. Environmental Protection Agency. 2013. EPA Region 4 Wildlife Exposure Parameters Table, Version 3 – Last Revised May 20, 2013.

U.S. Environmental Protection Agency. 2014. Statistical Software ProUCL Version 5 for Environmental Applications for Data Sets with and without Nondetect Observations. http://www.epa.gov/OSP/hstl/tsc/software.htm.

Wolf, M.A., Rowe, V.K, McCollister, D.D., and Hollingsworth, R.L. 1956. Toxicological Studies of Certain Alkylated Benzenes and Benzenes. Arch. Ind. Health 14:387-398.

FIGURES





LEGEND

- APPROXIMATE FACILITY BOUNDARY
- FENCELINE
- RAILWAY
- MW 24-11 MONITORING WELL
- SG-5 SOIL GAS SAMPLE LOCATION
- BH 54-11 BOREHOLE
- INDOOR AIR AND SUB SLAB SAMPLE LOCATION
- NESTED SOIL GAS SAMPLE LOCATION (ONE AT 6' DEEP & ONE ABOVE WATER TABLE)
- SEDIMENT SAMPLE LOCATION
- SEDIMENT/SURFACE WATER SAMPLE LOCATIONS
- SURFACE WATER SAMPLE LOCATION
- TEST TRACK METALS DELINEATION SAMPLE

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

FORMER WILMINGTON ASSEMBLY PLANT

ECOLOGICAL RISK ASSESSMENT

ECOLOGICAL ASSESSMENT SAMPLE LOCATIONS

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:

Project Manager:	Reviewed By:	Date:	
G. CARLI	REVIEWED_BY	JULY 2013	
Scale:	Project Nº:	Report Nº:	Drawing Nº:
HORZ_SC	17338-T04	022	3.1

17338-T04(022)GN-SC001 MAR 12/2015

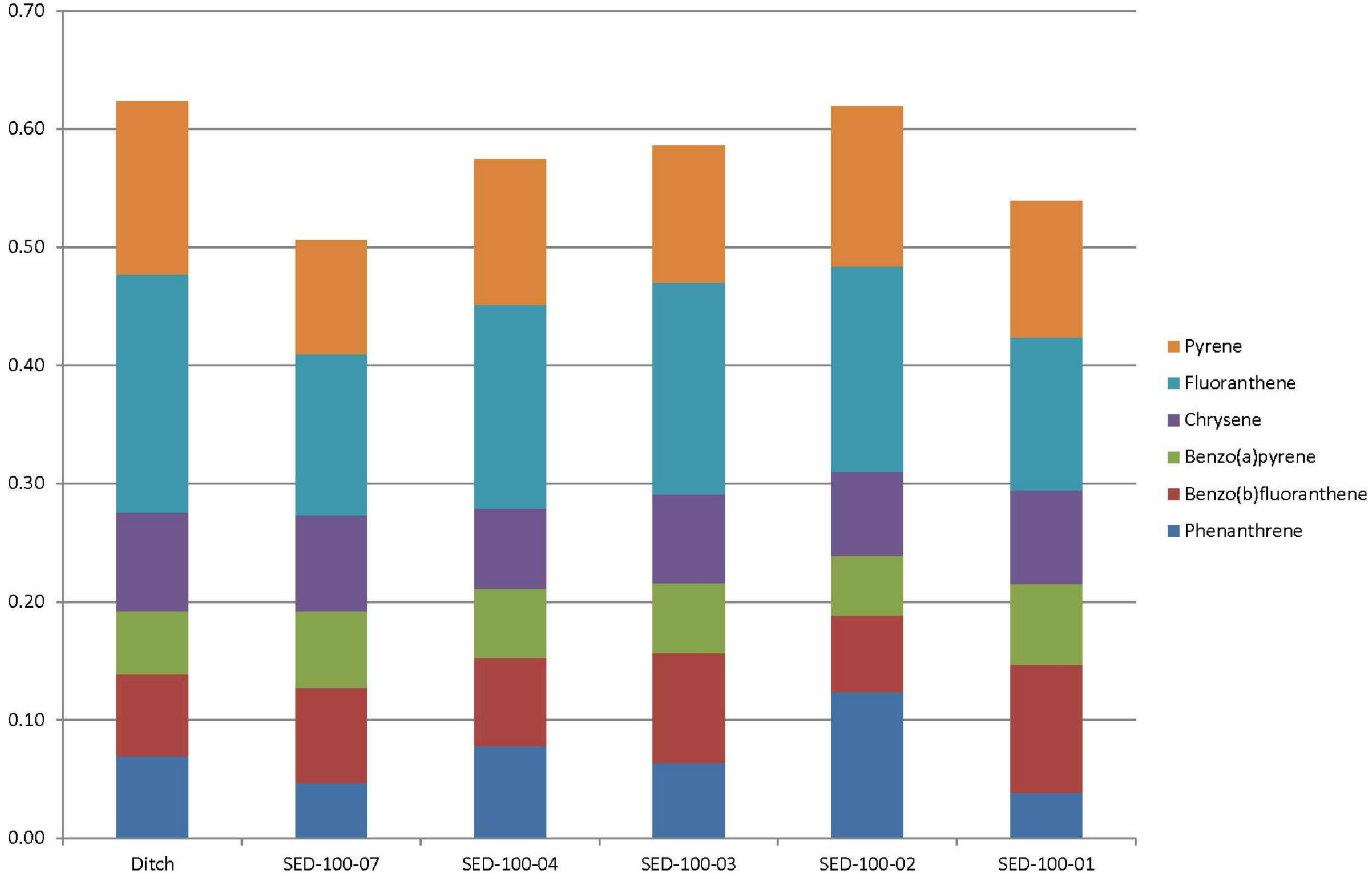


figure 5.1

RELATIVE PROPORTIONS OF PREDOMINANT PARENT PAHs
ECOLOGICAL RISK ASSESSMENT
Former Wilmington Assembly Plant

CRA

17338-T04(022)GN-SC002 MAR 12/2015

TABLES

TABLE 2.1
ASSESSMENT AND MEASUREMENT ENDPOINTS
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Media	*Assessment Endpoint*	*Measurement Endpoint*
Soil	Species richness and productivity of the terrestrial plant and soil invertebrate communities	Comparison of concentrations detected in surface soil to ecological benchmarks protective of terrestrial plants and soil invertebrates
	Relative and absolute densities of avian and mammalian insectivores, herbivores, and carnivores	Comparison of concentrations detected in surface soil to ecological benchmarks protective avian and mammalian wildlife Comparison of calculated rates of ingestion of COPECs to toxicity reference values protective of avian and mammalian wildlife
Surface Water	Diversity of aquatic life (aquatic invertebrates and fish) inhabiting the water column	Comparison of concentrations detected in surface water to ecological benchmarks protective of aquatic life
	Relative and absolute densities of avian and mammalian insectivores and piscivores	Comparison of calculated rates of ingestion of COPECs to toxicity reference values protective of avian and mammalian wildlife
Sediment	Species richness and productivity of the benthic invertebrate communities	Comparison of concentrations detected in sediment to ecological benchmarks protective of benthic invertebrates
	Relative and absolute densities of avian and mammalian insectivores and piscivores	Comparison of calculated rates of ingestion of COPECs to toxicity reference values protective of avian and mammalian receptors

Notes:
ft - feet
bgs - Below ground surface
COPEC - Constituent of potential ecological concern

TABLE 2.2
ECOLOGICAL SCREENING VALUES
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Constituent	*Soil*		*Surface Water*		*Sediment*	
	ESV (mg/kg)	*Source*	*ESV (µg/L)*	*Source*	*ESV (mg/kg)*	*Source*
Volatile Organic Compounds						
Cyclohexane	0.1	USEPA Region 4	NA	---	ND	---
1,3-Dichlorobenzene	37.7	USEPA Region 5	NA	---	ND	---
1,4-Dichlorobenzene	20	DNREC	NA	---	ND	---
1,1-Dichloroethene	20.1	USEPA Region 5	NA	---	ND	---
cis-1,2-Dichloroethene	n/a	---	NA	---	ND	---
Isopropylbenzene	n/a	---	NA	---	ND	---
Methylcyclohexane	n/a	---	NA	---	ND	---
1,2,4-Trichlorobenzene	20	DNREC	NA	---	ND	---
Trichloroethene	12.4	USEPA Region 5	NA	---	ND	---
BTEX						
Benzene	0.255	USEPA Region 5	NA	---	ND	---
Ethylbenzene	5.1	USEPA Region 5	NA	---	ND	---
Toluene	200	DNREC	NA	---	1.22	USEPA Region 5
Xylenes (total)	10	USEPA Region 5	NA	---	ND	---
Semi-Volatile Organic Compounds						
bis(2-ethylhexyl)phthalate	0.925	USEPA Region 5	ND	---	0.18	DNREC
Butylbenzylphthalate	0.239	USEPA Region 5	ND	---	10.9	DNREC
Carbazole	ND	---	ND	---	n/a	---
Dibenzofuran	ND	---	ND	---	0.415	DNREC
Di-n-butylphthalate	200	DNREC	ND	---	ND	
Di-n-octyl phthalate	ND	---	ND	---	40.6	USEPA Region 5
4-Methylphenol	163	USEPA Region 5	ND	---	ND	---
Polycyclic Aromatic Hydrocarbons (PAHs)						
Total PAHs	1.0	USEPA Region 4	ND	---	1.6	Consensus TEC
Low Molecular Weight PAHs	29	ECO-SSL - Invertebrates [a]	ND	---	0.076	USEPA Region 3
2-Methylnaphthalene	n/a	---	ND	---	0.0202	DNREC
Acenaphthene	ND	---	ND	---	0.0067	DNREC
Anthracene	ND	---	ND	---	0.0572	DNREC
Fluorene	ND	---	ND	---	0.0774	DNREC
Naphthalene	n/a	---	ND	---	0.176	DNREC
Phenanthrene	n/a	---	ND	---	0.204	DNREC
High Molecular Weight PAHs	1.1	ECO-SSL - Mammals [a]	ND	---	0.19	USEPA Region 3
Benzo(a)anthracene	5.21	USEPA Region 5	ND	---	0.108	DNREC
Benzo(a)pyrene	1.52	USEPA Region 5	ND	---	0.15	DNREC
Benzo(b)fluoranthene	59.8	USEPA Region 5	ND	---	10.4	USEPA Region 5
Benzo(g,h,i)perylene	119	USEPA Region 5	ND	---	0.17	USEPA Region 3
Benzo(k)fluoranthene	148	USEPA Region 5	ND	---	0.24	DNREC
Chrysene	4.73	USEPA Region 5	ND	---	0.166	DNREC
Dibenz(a,h)anthracene	18.4	USEPA Region 5	ND	---	0.033	DNREC
Fluoranthene	122	USEPA Region 5	ND	---	0.423	DNREC
Indeno(1,2,3-cd)pyrene	109	USEPA Region 5	ND	---	0.017	DNREC
Pyrene	78.5	USEPA Region 5	ND	---	0.195	DNREC
Polychlorinated Biphenyls (PCBs)						
Total PCBs	40	DNREC	NA	---	ND	---

TABLE 2.2
ECOLOGICAL SCREENING VALUES
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Constituent	*Soil*		*Surface Water*		*Sediment*	
	ESV (mg/kg)	*Source*	*ESV (μg/L)*	*Source*	*ESV (mg/kg)*	*Source*
Pesticides						
4,4'-DDT	0.021	ECO-SSL - Mammals [b]	NA	---	ND	---
Endrin Aldehyde	0.0105	USEPA Region 5	NA	---	ND	---
Endrin Ketone	n/a	---	NA	---	ND	---
Methoxychlor	0.0199	USEPA Region 5	NA	---	ND	---
Petroleum Hydrocarbons						
TPH (C10-C28)	NA	---	NA	---	n/a	---
Metals						
Aluminum	pH < 5	ECO-SSL [c]	87	DNREC	58,000	ARCS PEC
Antimony	5.0	DNREC	ND	---	2.0	DNREC
Arsenic	10	DNREC	ND	---	9.8	DNREC
Barium	283	DNREC	4.0	DNREC		DNREC
Beryllium	10	DNREC	ND	---	1.1	Dutch NC
Cadmium	3.0	DNREC	ND	---	0.99	DNREC
Calcium	n/a	---	116,000	USEPA Region 3	n/a	---
Chromium	0.40	DNREC	ND	---	43.4	DNREC
Cobalt	20	DNREC	ND	---	50	DNREC
Copper	50	DNREC	ND	---	31.6	DNREC
Iron	200	USEPA Region 4	300	DNREC	20,000	DNREC
Metals (continued)						
Lead	41	DNREC	ND	---	35.8	DNREC
Magnesium	n/a	---	82,000	USEPA Region 3	n/a	---
Manganese	220	ECO-SSL - Plants [d]	ND	---	460	DNREC
Mercury	0.0005	DNREC	ND	---	0.18	DNREC
Nickel	30	DNREC	ND	---	22.7	DNREC
Potassium	n/a	---	53,000	USEPA Region 3	n/a	---
Selenium	0.20	DNREC	ND	---	2.0	DNREC
Silver	2.0	DNREC	ND	---	1.0	DNREC
Sodium	n/a	---	680,000	USEPA Region 3	n/a	---
Titanium	1,000	USEPA Region 4	ND	---	NA	---
Vanadium	2.0	DNREC	ND	---	42	Dutch NC
Zinc	8.5	DNREC	120	DNREC	121	DNREC

Notes:
- n/a - Ecological Screening Value (ESV) not available
- NA - Constituent not analyzed in medium
- ND - Constituent not detected in medium
- ARCS - Assessment and Remediation of Contaminated Sediments
- DNREC - Delaware Department of Natural Resources and Environmental Control
- NC - Negligible Concentration
- PEC _ Probable Effect Concentration
- TEC - Threshold Effect Concentration
- TPH - Total Petroleum Hydrocarbons

Source:
- ARCS PEC (USEPA 1996)
- Consensus TEC (MacDonald et al. 2000)
- DNREC (2014)
- Dutch NC (Crommentuijn et al. 1997)
- ECO-SSL
  - a - USEPA 2007e
  - b - USEPA 2007b
  - c - USEPA 2003b
  - d - USEPA 2007c
- USEPA Region 3 (2013)
- USEPA Region 4 (2001)
- USEPA Region 5 (2003)

TABLE 3.1
SCREENING FOR CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN - SURFACE SOIL MAIN MANUFACTURING AREA
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Constituent	*No. Samples*	*No. Detects*	*FOD*	*Maximum Concentration AOI*	*Sample*	*Value*	*ESV*	*SQ*	*BCOC*	*COPEC*	*Rationale*
Volatile Organic Compounds (VOCs) mg/kg											
Cyclohexane	**13**	**2**	**15%**	**AOI-12**	**MW29-11**	**1.10E+00**	**1.00E-01**	**1.1E+01**	**No**	**Yes**	**SQ > 1**
1,3-Dichlorobenzene	13	1	7.7%	AOI-12	MW29-11	1.40E-01	3.77E+01	3.7E-03	No	No	SQ < 1
1,4-Dichlorobenzene	13	1	7.7%	AOI-12	MW29-11	5.10E+00	2.00E+01	2.6E-01	No	No	SQ < 1
1,1-Dichloroethene	13	1	7.7%	AOI-10	MW26-11	9.80E-03	2.01E+01	4.9E-04	No	No	SQ < 1
cis-1,2-Dichloroethene	**13**	**1**	**7.7%**	**AOI-12**	**BH27/MW028-11**	**6.50E-02**	**n/a**	**---**	**No**	**Yes**	**No ESV**
Isopropylbenzene	**13**	**2**	**15%**	**AOI-12**	**MW29-11**	**3.10E+00**	**n/a**	**---**	**No**	**Yes**	**No ESV**
Methylcyclohexane	**13**	**4**	**31%**	**AOI-12**	**MW29-11**	**1.30E+01**	**n/a**	**---**	**No**	**Yes**	**No ESV**
1,2,4-Trichlorobenzene	13	1	**7.7%**	AOI-12	MW29-11	9.20E-01	2.00E+01	4.6E-02	No	No	SQ < 1
Trichloroethene	13	1	**7.7%**	**AOI-12**	**BH27/MW028-11**	1.80E-01	1.24E+01	1.5E-02	No	No	SQ < 1
BTEX mg/kg											
Benzene	**13**	**2**	**15%**	**AOI-12**	**MW29-11**	**7.50E-01**	**2.55E-01**	**2.9E+00**	**No**	**Yes**	**SQ > 1**
Ethylbenzene	**13**	**2**	**15%**	**AOI-12**	**MW29-11**	**2.20E+01**	**5.10E+00**	**4.3E+00**	**No**	**Yes**	**SQ > 1**
Toluene	13	4	31%	AOI-12	MW29-11	1.20E+01	2.00E+02	6.0E-02	No	No	SQ < 1
Xylenes (total)	**13**	**3**	**23%**	**AOI-12**	**MW29-11**	**1.00E+02**	**1.00E+01**	**1.0E+01**	**No**	**Yes**	**SQ > 1**
Semi-Volatile Organic Compounds (SVOCs) mg/kg											
bis(2-ethylhexyl)phthalate	**14**	**2**	**14%**	**AOI-12**	**BH27/MW028-11**	**2.00E+00**	**9.25E-01**	**2.2E+00**	**No**	**Yes**	**SQ > 1**
Butylbenzylphthalate	**14**	**3**	**21%**	**AOI-12**	**BH27/MW028-11**	**7.60E-01**	**2.39E-01**	**3.2E+00**	**No**	**Yes**	**SQ > 1**
Di-n-butylphthalate	14	1	7.1%	AOI-12	MW29-11	1.50E+02	2.00E+02	7.5E-01	No	No	SQ < 1
4-Methylphenol	14	1	7.1%	AOI-12	BH27/MW028-11	8.90E-02	1.63E+02	5.5E-04	No	No	SQ < 1
Polycyclic Aromatic Hydrocarbons (PAHs) mg/kg											
Total PAHs	**14**	**7**	**50%**	**AOI-12**	**MW29-11**	**2.62E+01**	**1.00E+00**	**2.6E+01**	**No**	**Yes**	**SQ > 1**
Low Molecular Weight (LMW) PAHs	14	3	21%	AOI-12	MW29-11	2.62E+01	2.90E+01	9.0E-01	No	No	SQ < 1
High Molecular Weight (HMW) PAHs	**14**	**6**	**43%**	**AOI-12**	**BH27/MW028-11**	**2.30E+00**	**1.10E+00**	**2.1E+00**	**No**	**Yes**	**SQ > 1**
Benzo(a)anthracene	14	2	14%	AOI-12	BH19/MW27-11	1.90E-01	5.21E+00	3.6E-02	No	No	SQ < 1
Benzo(a)pyrene	14	6	43%	AOI-10	MW26-11	4.30E-01	1.52E+00	2.8E-01	No	No	SQ < 1
Benzo(b)fluoranthene	14	6	43%	AOI-10	MW26-11	4.20E-01	5.98E+01	7.0E-03	No	No	SQ < 1
Benzo(g,h,i)perylene	14	3	21%	AOI-10	MW26-11	2.70E-01	1.19E+02	2.3E-03	No	No	SQ < 1
Benzo(k)fluoranthene	14	2	14%	AOI-12	MW29-11	1.90E-01	1.48E+02	1.3E-03	No	No	SQ < 1
Chrysene	14	4	29%	AOI-12	BH19/MW27-11	2.40E-01	4.73E+00	5.1E-02	No	No	SQ < 1
Dibenz(a,h)anthracene	14	4	29%	AOI-10	MW26-11	5.50E-02	1.84E+01	3.0E-03	No	No	SQ < 1
Fluoranthene	14	4	29%	AOI-12	BH19/MW27-11	3.20E-01	1.22E+02	2.6E-03	No	No	SQ < 1
Indeno(1,2,3-cd)pyrene	14	6	43%	AOI-10	MW26-11	3.30E-01	1.09E+02	3.0E-03	No	No	SQ < 1
Pyrene	14	4	29%	AOI-12	BH19/MW27-11	3.30E-01	7.85E+01	4.2E-03	No	No	SQ < 1
Polychlorinated Biphenyls (PCBs) mg/kg											
Total PCBs	**15**	**1**	**6.7%**	**AOI-21**	**BH52-11**	**3.40E-02**	**4.00E+01**	**8.5E-04**	**Yes**	**Yes**	**BCOC**

TABLE 3.1
SCREENING FOR CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN - SURFACE SOIL MAIN MANUFACTURING AREA
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Constituent	*No. Samples*	*No. Detects*	*FOD*	*Maximum Concentration*			*ESV*	*SQ*	*BCOC*	*COPEC*	*Rationale*
				AOI	*Sample*	*Value*					
Pesticides mg/kg											
4,4'-DDT	**11**	**2**	**18%**	**AOI-12**	**BH14-11**	**5.90E-03**	**2.10E-02**	**2.8E-01**	**Yes**	**Yes**	**BCOC**
Endrin Aldehyde	**11**	**2**	**18%**	AOI-12	**BH23-11**	**2.10E-02**	**1.05E-02**	**2.0E+00**	**No**	**Yes**	**SQ > 1**
Endrin Ketone	**11**	**1**	**9.1%**	AOI-12	**BH27/MW28-11**	**2.90E-02**	**n/a**	**---**	**No**	**Yes**	**No ESV**
Methoxychlor	11	1	9.1%	AOI-12	BH27/MW28-11	1.30E-02	1.99E-02	6.5E-01	No	No	SQ < 1
Metals mg/kg											
Aluminum	**20**	**20**	**100%**	**AOI-5**	**BH5-11**	**1.99E+04**	**pH < 5**	**---**	**No**	**No**	**pH Unknown**
Antimony	**73**	**34**	**47%**	**AOI-12**	**BH27/MW28-11**	**6.56E+02**	**5.00E+00**	**1.3E+02**	**No**	**Yes**	**SQ > 1**
Arsenic	**130**	**129**	**99%**	**AOI-12**	**TT-12**	**1.05E+03**	**1.00E+01**	**1.0E+02**	**No**	**Yes**	**SQ > 1**
Barium	**128**	**128**	**100%**	**AOI-12**	**TT-10**	**5.18E+04**	**2.83E+02**	**1.8E+02**	**No**	**Yes**	**SQ > 1**
Beryllium	20	19	95%	AOI-12	BH20-11	6.60E-01	1.00E+01	6.6E-02	No	No	SQ < 1
Cadmium	**128**	**97**	**76%**	**AOI-12**	**BH27/MW28-11**	**5.86E+02**	**3.00E+00**	**2.0E+02**	**Yes**	**Yes**	**SQ > 1**
Calcium	73	73	100%	AOI-6	BH6-11	1.07E+05	n/a	---	No	No	Ess. Nutr.
Chromium	**128**	**127**	**99%**	**AOI-12**	**TT-5**	**2.60E+03**	**4.00E-01**	**6.5E+03**	**Yes**	**Yes**	**SQ > 1**
Cobalt	**73**	**67**	**92%**	**AOI-12**	**BH17-11**	**1.10E+02**	**2.00E+01**	**5.5E+00**	**No**	**Yes**	**SQ > 1**
Copper	**128**	**126**	**98%**	**AOI-12**	**TT-5**	**1.23E+03**	**5.00E+01**	**2.5E+01**	**Yes**	**Yes**	**SQ > 1**
Iron	**128**	**128**	**100%**	**AOI-12**	**TT-11**	**9.39E+04**	**2.00E+02**	**4.7E+02**	**No**	**Yes**	**SQ > 1**
Lead	**128**	**128**	**100%**	**AOI-12**	**TT-12**	**2.75E+04**	**4.10E+01**	**6.7E+02**	**Yes**	**Yes**	**SQ > 1**
Magnesium	20	20	100%	AOI-12	BH20-11	1.40E+04	n/a	---	No	No	Ess. Nutr.
Manganese	**128**	**128**	**100%**	**AOI-6**	**BH8-11**	**2.57E+03**	**2.20E+02**	**1.2E+01**	**No**	**Yes**	**SQ > 1**
Mercury	**126**	**116**	**92%**	**AOI-12**	**TT-35**	**1.30E+01**	**5.00E-04**	**2.6E+04**	**Yes**	**Yes**	**SQ > 1**
Nickel	**73**	**73**	**100%**	**AOI-7**	**BH57/MW24-11**	**1.67E+02**	**3.00E+01**	**5.6E+00**	**Yes**	**Yes**	**SQ > 1**
Potassium	20	20	100%	AOI-6	BH7-11	2.86E+03	n /a	---	No	No	Ess. Nutr.
Selenium	**73**	**35**	**48%**	**AOI-12**	**BH27/MW28-11**	**1.10E+02**	**2.00E-01**	**5.5E+02**	**Yes**	**Yes**	**SQ > 1**
Silver	73	30	41%	Parking Lot	BH59-11	1.94E+00	2.00E+00	9.7E-01	No	No	SQ ≤ 1
Sodium	20	12	60%	AOI-12	MW29-11	9.32E+02	n/a	---	No	No	Ess. Nutr.
Titanium	**53**	**53**	**100%**	**AOI-12**	**BH30-11**	**8.46E+03**	**1.00E+03**	**8.5E+00**	**No**	**Yes**	**SQ > 1**
Vanadium	**73**	**66**	**90%**	**AOI-12**	**BH13-11**	**7.60E+01**	**2.00E+00**	**3.8E+01**	**No**	**Yes**	**SQ > 1**
Zinc	**128**	**128**	**100%**	**AOI-12**	**BH27/MW28-11**	**1.69E+04**	**8.50E+00**	**2.0E+03**	**Yes**	**Yes**	**SQ > 1**

Notes:
- **Bold Font** identifies Constituent of Potential Ecological Concern (COPEC)
- AOI - Area of Interest
- BCOC - Bioaccumulative Chemical of Concern
- Ess. Nutr. - Essential Nutrient
- ESV - Ecological Screening Value
- FOD - Frequency of Detection
- J - Estimated Concentration
- n/a - Ecological Screening Value Not Available
- SQ - Screening Quotient

TABLE 3.2
SCREENING FOR CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN - SURFACE SOIL WOODED AREA
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Constituent	*No. Samples*	*No. Detects*	*FOD*	*Maximum Concentration*			*ESV*	*SQ*	*BCOC*	*COPEC*	*Rationale*
				OU	*Sample*	*Value*					
Volatile Organic Compounds (VOCs) mg/kg											
Cyclohexane	15	1	6.7%	OU-6	Station-007	1.60E-02	1.00E-01	1.6E-01	No	No	SQ < 1
Isopropylbenzene	**15**	**1**	**6.7%**	**OU-6**	**Station-007**	**4.00E-03**	**n/a**	**---**	**No**	**YES**	**No ESV**
Methylcyclohexane	**15**	**5**	**33%**	**OU-6**	**Station-015**	**4.70E-02**	**n/a**	**---**	**No**	**YES**	**No ESV**
BTEX mg/kg											
Toluene	15	2	13%	OU-6	Station-007	2.30E-02	2.00E+02	1.2E-04	No	No	SQ < 1
Xylenes (total)	15	2	13%	OU-6	Station-007	3.80E-02	1.00E+01	3.8E-03	No	No	SQ < 1
Semi-Volatile Organic Compounds (SVOCs) mg/kg											
Butylbenzylphthalate	**15**	**14**	**93%**	**OU-6**	**Station-015**	**2.70E+00**	**2.39E-01**	**1.1E+01**	**No**	**YES**	**SQ > 1**
Di-n-butylphthalate	15	1	6.7%	OU-6	Station-002	6.40E-02	2.00E+02	3.2E-04	No	No	SQ < 1
Polycyclic Aromatic Hydrocarbons (PAHs) mg/kg											
Total PAHs	**15**	**13**	**87%**	**OU-6**	**Station-001**	**1.31E+00**	**1.00E+00**	**1.3E+00**	**No**	**YES**	**SQ > 1**
Low Molecular Weight (LMW) PAHs	15	1	6.7%	OU-6	Station-001	9.10E-02	2.90E+01	3.1E-03	No	No	SQ < 1
Phenanthrene	15	1	6.7%	OU-6	Station-001	9.10E-02	n/a	---	No	No	SQ_{LMW} < 1
High Molecular Weight (HMW) PAHs	**15**	**13**	**87%**	**OU-6**	**Station-001**	**1.21E+00**	**1.10E+00**	**1.1E+00**	**No**	**YES**	**SQ > 1**
Benzo(a)anthracene	15	9	60%	OU-6	Station-001	7.90E-02	5.21E+00	1.5E-02	No	No	SQ < 1
Benzo(a)pyrene	15	11	73%	OU-6	Station-001	1.00E-01	1.52E+00	6.6E-02	No	No	SQ < 1
Benzo(b)fluoranthene	15	12	80%	OU-6	Station-001	2.00E-01	5.98E+01	3.3E-03	No	No	SQ < 1
Benzo(g,h,i)perylene	15	3	20%	OU-6	Station-001	8.80E-02	1.19E+02	7.4E-04	No	No	SQ < 1
Benzo(k)fluoranthene	15	8	53%	OU-6	Station-001	5.40E-02	1.48E+02	3.6E-04	No	No	SQ < 1
Chrysene	15	4	27%	OU-6	Station-001	1.40E-01	4.73E+00	3.0E-02	No	No	SQ < 1
Dibenz(a,h)anthracene	15	1	7%	OU-6	Station-001	2.20E-02	1.84E+01	1.2E-03	No	No	SQ < 1
Fluoranthene	15	4	27%	OU-6	Station-001	2.50E-01	1.22E+02	2.0E-03	No	No	SQ < 1
Indeno(1,2,3-cd)pyrene	15	8	53%	OU-6	Station-001	9.10E-02	1.09E+02	8.3E-04	No	No	SQ < 1
Pyrene	15	3	20%	OU-6	Station-001	1.90E-01	7.85E+01	2.4E-03	No	No	SQ < 1
Metals mg/kg											
Aluminum	**15**	**15**	**100%**	**OU-6**	**Station-010**	**1.38E+04**	**pH < 5.5**	**---**	**No**	**YES**	**pH Unknown**
Antimony	**15**	**6**	**40%**	**OU-6**	**Station-009**	**3.25E+00**	**5.00E+00**	**2.8E+00**	**No**	**YES**	**SQ > 1**
Arsenic	15	15	100%	OU-6	Station-004	4.10E+00	1.00E+01	6.3E-01	No	No	SQ < 1
Barium	15	15	100%	OU-6	Station-006	1.87E+02	2.83E+02	9.9E-01	No	No	SQ ≤ 1
Beryllium	15	15	100%	OU-6	Station-004	6.63E-01	1.00E+01	1.1E-01	No	No	SQ < 1
Cadmium	**15**	**2**	**13%**	**OU-6**	**Station-002**	**5.36E-01**	**3.00E+00**	**3.3E-01**	**YES**	**YES**	**BCOC**
Calcium	15	15	100%	OU-6	Station-002	4.28E+02	---	---	No	No	Ess. Nutr.
Chromium	**15**	**15**	**100%**	**OU-6**	**Station-012**	**2.92E+01**	**4.00E-01**	**9.6E+01**	**YES**	**YES**	**SQ > 1**
Cobalt	15	15	100%	OU-6	Station-006	7.20E+00	2.00E+01	6.6E-01	No	No	SQ < 1
Copper	**15**	**15**	**100%**	**OU-6**	**Station-011**	**1.21E+01**	**5.00E+01**	**4.0E-01**	**YES**	**YES**	**BCOC**
Iron	**15**	**15**	**100%**	**OU-6**	**Station-012**	**1.57E+04**	**2.00E+02**	**1.1E+02**	**No**	**YES**	**SQ > 1**
Lead	**15**	**15**	**100%**	**OU-6**	**Station-009**	**9.55E+01**	**4.10E+01**	**1.7E+01**	**YES**	**YES**	**SQ > 1**
Magnesium	15	15	100%	OU-6	Station-011	1.37E+03	---	---	No	No	Ess. Nutr.

TABLE 3.2
SCREENING FOR CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN - SURFACE SOIL WOODED AREA
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Constituent	No. Samples	No. Detects	FOD	Maximum Concentration			ESV	SQ	BCOC	COPEC	Rationale
				OU	Sample	Value					
Metals mg/kg (Continued)											
Manganese	**15**	**15**	**100%**	**OU-6**	**Station-006**	**2.35E+02**	**2.20E+02**	**2.2E+00**	**No**	**YES**	**SQ > 1**
Mercury	**15**	**15**	**100%**	**OU-6**	**Station-004**	**7.75E-02**	**5.00E-04**	**2.6E+02**	**YES**	**YES**	**SQ > 1**
Nickel	15	15	100%	OU-6	Station-011	1.10E+01	3.00E+01	4.9E-01	YES	No	SQ < 1
Potassium	15	15	100%	OU-6	Station-011	3.99E+02	---	---	No	No	Ess. Nutr.
Selenium	**15**	**2**	**13%**	**OU-6**	**Station-011**	**1.25E+00**	**2.00E-01**	**6.5E+00**	**YES**	**YES**	**SQ > 1**
Vanadium	**15**	**15**	**100%**	**OU-6**	**Station-006**	**3.87E+01**	**2.00E+00**	**2.5E+01**	**No**	**YES**	**SQ > 1**
Zinc	**15**	**15**	**100%**	**OU-6**	**Station-002**	**4.96E+01**	**8.50E+00**	**1.5E+01**	**YES**	**YES**	**SQ > 1**

Notes:
Bold Font identifies Constituent of Potential Ecological Concern (COPEC)
BCOC - Bioaccumulative Chemical of Concern
Ess. Nutr. - Essential Nutrient
ESV - Ecological Screening Value
FOD - Frequency of Detection
J - Estimated Concentration
n/a - Ecological Screening Value Not Available
OU - Operable Unit
SQ - Screening Quotient

TABLE 3.3
SCREENING FOR CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN - SURFACE WATER
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Constituent	*No. Samples*	*No. Detects*	*FOD*	*Maximum Concentration AOI*	*Maximum Concentration Sample*	*Maximum Concentration Value*	*ESV*	*SQ*	*BCOC*	*COPEC*	*Rationale*
Metals µg/L											
Total Concentration											
Barium	**5**	**5**	**100%**	**AOI-26**	**SW1**	**2.32E+02**	**4.00E+00**	**1.6E+02**	**No**	**Yes**	**SQ > 1**
Calcium	5	5	100%	AOI-26	SW1	3.51E+04	1.16E+05	3.0E-01	No	No	SQ < 1/Ess. Nutr.
Iron	**5**	**5**	**100%**	**AOI-26**	**SW3**	**5.64E+02**	**3.00E+02**	**1.9E+00**	**No**	**Yes**	**SQ > 1**
Magnesium	5	5	100%	AOI-26	SW1	2.03E+04	8.20E+04	2.5E-01	No	No	SQ < 1/Ess. Nutr.
Potassium	5	5	100%	AOI-26	SW1	4.53E+03	5.30E+04	8.5E-02	No	No	SQ < 1/Ess. Nutr.
Sodium	5	5	100%	AOI-26	SW1	7.16E+04	6.80E+05	1.1E-01	No	No	SQ < 1/Ess. Nutr.
Zinc	**5**	**4**	**80%**	**AOI-26**	**SW1**	**1.41E+02**	**1.20E+00**	**1.2E+02**	**No**	**Yes**	**SQ > 1**
Dissolved Concentration											
Aluminum	**5**	**2**	**40%**	**AOI-26**	**SW4**	**2.18E+02**	**8.70E+01**	**2.5E+00**	**No**	**Yes**	**SQ > 1**
Barium	**5**	**5**	**100%**	**AOI-26**	**SW1**	**2.27E+02**	**4.00E+00**	**5.7E+01**	**No**	**Yes**	**SQ > 1**
Zinc	**5**	**3**	**60%**	**AOI-26**	**SW1**	**1.30E+02**	**1.20E+02**	**1.1E+00**	**No**	**Yes**	**SQ > 1**

Notes:

Bold Font identifies Constituent of Potential Ecological Concern (COPEC)
AOI - Area of Interest
BCOC - Bioaccumulative Chemical of Concern
Ess. Nutr. - Essential Nutrient
ESV - Ecological Screening Value
FOD - Frequency of Detection
J - Estimated Concentration
n/a - Ecological Screening Value Not Available
SQ - Screening Quotient

TABLE 3.4
SCREENING FOR CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN - SEDIMENT
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Constituent	*No. Samples*	*No. Detects*	*FOD*	*Maximum Concentration*			*ESV*	*SQ*	*BCOC*	*COPEC*	*Rationale*
				AOI	*Sample*	*Value*					
BTEX mg/kg											
Toluene	7	2	29%	AOI-26	SED 4-11	0.10	1.22	8.20E-02	No	No	SQ < 1
Semi-Volatile Organic Compounds (SVOCs) mg/kg											
bis(2-ethylhexyl)phthalate	**12**	**4**	**33%**	**AOI-26**	**SED 3-11**	**6.90E+00**	**1.80E-01**	**3.8E+01**	**No**	**Yes**	**SQ > 1**
Butylbenzylphthalate	12	6	50%	AOI-26	SED 4-11	9.70E+00	1.09E+01	8.9E-01	No	No	SQ < 1
Carbazole	**12**	**6**	**50%**	**AOI-26**	**SED 4-11**	**1.10E+01**	**n/a**	**---**	**No**	**Yes**	**No ESV**
Dibenzofuran	**12**	**3**	**25%**	**AOI-26**	**SED 4-11**	**3.10E+00**	**4.15E-01**	**7.5E+00**	**No**	**Yes**	**SQ > 1**
Di-n-octylphthalate	12	1	8.3%	AOI-26	SED 3-11	2.70E+00	4.06E+01	6.7E-02	No	No	SQ < 1
Polycyclic Aromatic Hydrocarbons (PAHs) mg/kg											
Total PAHs	**12**	**11**	**92%**	**AOI-26**	**SED 4-11**	**5.94E+02**	**1.60E+00**	**3.7E+02**	**No**	**Yes**	**SQ > 1**
Low Molecular Weight (LMW) PAHs	**12**	**9**	**75%**	**AOI-26**	**SED 4-11**	**1.03E+02**	**7.60E-02**	**1.4E+03**	**No**	**Yes**	**SQ > 1**
2-Methylnaphthalene	**12**	**3**	**25%**	AOI-26	**SED 4-11**	**1.50E+00**	**2.02E-02**	**7.4E+01**	**No**	**Yes**	**SQ > 1**
Acenaphthene	**12**	**3**	**25%**	**AOI-26**	**SED 4-11**	**8.10E+00**	**6.70E-03**	**1.2E+03**	**No**	**Yes**	**SQ > 1**
Anthracene	**12**	**6**	**50%**	**AOI-26**	**SED 4-11**	**1.40E+01**	**5.72E-02**	**2.4E+02**	**No**	**Yes**	**SQ > 1**
Fluorene	**12**	**3**	**25%**	**AOI-26**	**SED 4-11**	**5.20E+00**	**7.74E-02**	**6.7E+01**	**No**	**Yes**	**SQ > 1**
Naphthalene	**12**	**3**	**25%**	**AOI-26**	**SED 4-11**	**1.3.**	**1.76E-01**	**7.4E+00**	**No**	**Yes**	**SQ > 1**
Phenanthrene	**12**	**9**	**75%**	**AOI-26**	**SED 4-11**	**7.30E+01**	**2.04E-01**	**3.6E+02**	**No**	**Yes**	**SQ > 1**
High Molecular Weight (HMW) PAHs	**12**	**11**	**92%**	AOI-26	**SED 4-11**	**3.53E+02**	**1.90E-01**	**1.9E+03**	**No**	**Yes**	**SQ > 1**
Benzo(a)anthracene	**12**	**10**	**83%**	**AOI-26**	**SED 4-11**	**4.70E+01**	**1.08E-01**	**4.4E+02**	**No**	**Yes**	**SQ > 1**
Benzo(a)pyrene	**12**	**11**	**92%**	**AOI-26**	**SED 4-11**	**3.90E+01**	**1.50E-01**	**2.6E+02**	**No**	**Yes**	**SQ > 1**
Benzo(b)fluoranthene	**12**	**10**	**83%**	**AOI-26**	**SED 4-11**	**5.00E+01**	**1.04E+01**	**4.8E+00**	**No**	**Yes**	**SQ > 1**
Benzo(g,h,i)perylene	**12**	**9**	**75%**	**AOI-26**	**SED 4-11**	**2.90E+01**	**1.70E-01**	**1.7E+02**	**No**	**Yes**	**SQ > 1**
Benzo(k)fluoranthene	**12**	**9**	**75%**	**AOI-26**	**SED 4-11**	**2.60E+01**	**2.40E-01**	**1.1E+02**	**No**	**Yes**	**SQ > 1**
Chrysene	**12**	**10**	**83%**	**AOI-26**	**SED 4-11**	**5.10E+01**	**1.66E-01**	**3.1E+02**	**No**	**Yes**	**SQ > 1**
Dibenz(a,h)anthracene	**12**	**8**	**67%**	**AOI-26**	**SED 4-11**	**4.80E+00**	**3.30E-02**	**1.5E+02**	**No**	**Yes**	**SQ > 1**
Fluoranthene	**12**	**10**	**83%**	**AOI-26**	**SED 4-11**	**1.30E+02**	**4.23E-01**	**3.1E+02**	**No**	**Yes**	**SQ > 1**
Indeno(1,2,3-cd)pyrene	**12**	**10**	**83%**	**AOI-26**	**SED 4-11**	**3.30E+01**	**1.70E-02**	**1.9E+03**	**No**	**Yes**	**SQ > 1**
Pyrene	**12**	**10**	**83%**	**AOI-26**	**SED 4-11**	**8.10E+01**	**1.95E-01**	**4.2E+02**	**No**	**Yes**	**SQ > 1**
Petroleum Hydrocarbons											
C10-C28	**7**	**4**	**57%**	**AOI-26**	**SED 4-11**	**7.E+03**	**n/a**	**---**	**No**	**Yes**	**No ESV**

TABLE 3.4
SCREENING FOR CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN - SEDIMENT
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Constituent	*No. Samples*	*No. Detects*	*FOD*	*Maximum Concentration*			*ESV*	*SQ*	*BCOC*	*COPEC*	*Rationale*
				AOI	*Sample*	*Value*					
Metals mg/kg											
Aluminum	12	12	100%	AOI-26	SED 4-11	1.00E+04	5.80E+04	1.7E-01	No	No	SQ < 1
Antimony	**12**	**3**	**25%**	**AOI-26**	**SED 3-11**	**1.05E+01**	**2.00E+00**	**5.3E+00**	**No**	**Yes**	**SQ > 1**
Arsenic	12	3	25%	AOI-26	SED 3-11	6.70E+00	9.80E+00	6.8E-01	No	No	SQ < 1
Barium	**12**	**12**	**100%**	**AOI-26**	**SED 3-11**	**1.85E+02**	**1.57E+02**	**1.2E+00**	**No**	**Yes**	**SQ > 1**
Beryllium	12	5	42%	AOI-26	SED 3-11	8.40E-01	1.10E+00	7.6E-01	No	No	SQ < 1
Cadmium	**12**	**3**	**25%**	**AOI-26**	**SED 3-11**	**4.10E+00**	**9.90E-01**	**4.1E+00**	**Yes**	**Yes**	**SQ > 1**
Calcium	12	12	100%	AOI-26	SED 3-11	5.12E+04	n/a	---	No	No	Ess. Nutr.
Chromium	**12**	**11**	**92%**	**AOI-26**	**SED 3-11**	**1.17E+02**	**4.34E+01**	**2.7E+00**	**No**	**Yes**	**SQ > 1**
Cobalt	12	11	92%	AOI-26	SED 3-11	1.28E+01	5.00E+01	2.6E-01	No	No	SQ < 1
Copper	**12**	**8**	**67%**	**AOI-26**	**SED 3-11**	**3.94E+02**	**3.16E+00**	**1.2E+02**	**Yes**	**Yes**	**SQ > 1**
Iron	**12**	**10**	**83%**	**AOI-26**	**SED 8**	**4.84E+04**	**2.00E+04**	**2.4E+00**	**No**	**Yes**	**SQ > 1**
Lead	**12**	**12**	**100%**	**AOI-26**	**SED 3-11**	**5.26E+02**	**3.58E+01**	**1.5E+01**	**No**	**Yes**	**SQ > 1**
Magnesium	12	12	100%	AOI-26	SED 3-11	3.05E+04	n/a	---	No	No	Ess. Nutr.
Manganese	**12**	**12**	**100%**	**AOI-26**	**SED 10**	**5.66E+02**	**4.60E+02**	**1.2E+00**	**No**	**Yes**	**SQ > 1**
Mercury	**12**	**4**	**33%**	**AOI-26**	**SED 3-11**	**8.10E-01**	**1.80E-01**	**4.5E+00**	**Yes**	**Yes**	**SQ > 1**
Nickel	**12**	**12**	**100%**	**AOI-26**	**SED 3-11**	**4.26E+01**	**2.27E+01**	**1.9E+00**	**Yes**	**Yes**	**SQ > 1**
Potassium	12	12	100%	AOI-26	SED 8	1.04E+03	n/a	---	No	No	Ess. Nutr.
Sodium	12	4	33%	AOI-26	SED 1-11	5.78E+02	n/a	---	No	No	Ess. Nutr.
Vanadium	**12**	**11**	**92%**	**AOI-26**	**SED 3-11**	**5.40E+01**	**4.20E+01**	**1.3E+00**	**No**	**Yes**	**SQ > 1**
Zinc	**12**	**12**	**100%**	**AOI-26**	**SED 3-11**	**2.37E+03**	**1.21E+02**	**2.0E+01**	**Yes**	**Yes**	**SQ > 1**

Notes:

Bold Font identifies Constituent of Potential Ecological Concern (COPEC)
J - Estimated Concentration
n/a - Ecological Screening Value Not Available
AOI - Area of Interest
BCOC - Bioaccumulative Chemical of Concern
Ess. Nutr. - Essential Nutrient
ESV - Ecological Screening Value
FOD - Frequency of Detection
SQ - Screening Quotient
TPH - Total Petroleum Hydrocarbons

TABLE 3.5
SUMMARY OF CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN IDENTIFIED IN SCREENING ASSESSMENT
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	Soil		Surface Water	Sediment
	Main Manufacturing Area	Wooded Area		
Volatile Organic Compounds				
Cyclohexane	SQ > 1	---	---	---
cis-1,2-Dichloroethene	No ESV	---	---	---
Isopropylbenzene	No ESV	No ESV	---	---
Methylcyclohexane	No ESV	No ESV	---	---
BTEX				
Benzene	SQ > 1	---	---	---
Ethylbenzene	SQ > 1	---	---	---
Xylenes (total)	SQ > 1	---	---	---
Semi-Volatile Organic Compounds				
bis(2-ethylhexyl)phthalate	SQ > 1	---	---	SQ > 1
Butylbenzylphthalate	SQ > 1	SQ > 1	---	---
Carbazole	---	---	---	No ESV
Dibenzofuran	---	---	---	SQ > 1
Polycyclic Aromatic Hydrocarbons (PAHs)				
Low Molecular Weight PAHs	---	---	---	SQ > 1
High Molecular Weight PAHs	SQ > 1	---	---	SQ > 1
Polychlorinated Biphenyls (PCBs)				
Total PCBs	BCOC	---	---	---
Pesticides				
4,4'-DDT	BCOC	---		---
Endrin Aldehyde	SQ > 1	---	---	---
Endrin Ketone	No ESV	---	---	---
Petroleum Hydrocarbons				
TPH C10-C28	---	---	---	No ESV
Metals				
Aluminum	pH Unknown	pH Unknown	SQ > 1	
Antimony	SQ > 1	SQ > 1	---	SQ > 1
Arsenic	SQ > 1		---	---
Barium	SQ > 1		SQ > 1	SQ > 1
Cadmium	SQ > 1	BCOC	---	SQ > 1
Chromium	SQ > 1	SQ > 1	---	SQ > 1
Cobalt	SQ > 1		---	---
Copper	SQ > 1	BCOC	---	SQ > 1
Metals (Continued)				
Iron	SQ > 1	SQ > 1	---	SQ > 1
Lead	SQ > 1	SQ > 1	---	SQ > 1

TABLE 3.5
SUMMARY OF CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN IDENTIFIED IN SCREENING ASSESSMENT
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Soil*		*Surface Water*	*Sediment*
	Main Manufacturing Area	*Wooded Area*		
Manganese	SQ > 1	SQ > 1	---	SQ > 1
Mercury	SQ > 1	SQ > 1	---	SQ > 1
Nickel	SQ > 1		---	SQ > 1
Selenium	SQ > 1	SQ > 1	---	---
Titanium	SQ > 1		---	---
Vanadium	SQ > 1	SQ > 1	---	SQ > 1
Zinc	SQ > 1	SQ > 1	SQ > 1	SQ > 1

Notes:
BCOC -Constituent identified as a Constituent of Potential Ecological Concern (COPEC) because it is a Bioaccumulative Chemical of Concern (BCOC)
No ESV - Constituent identified as a COPEC because an Ecological Screening Value (ESV) is not available
SQ > 1 -Constituent identified as a COPEC because its Screening Quotient (SQ) is greater than 1.0

TABLE 4.1
REFINEMENT BENCHMARKS FOR SOIL INVERTEBRATES
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Units*	*Delaware Mean Background*		*ECO-SSL*	*ORNL*	*CCME*	*Refinement Benchmark*	*Source*
		Site 1	*Site 2*					
Volatile Organic Compounds								
Isopropylbenzene	mg/kg	n/a	n/a	n/a	n/a	n/a	---	---
Methylcyclohexane	mg/kg	n/a	n/a	n/a	n/a	n/a	---	---
Semi-Volatile Organic Compounds								
Butylbenzylphthalate	mg/kg	n/a	n/a	n/a	n/a	n/a	---	---
Metals								
Aluminum	mg/kg	2.29E+04	4.76E+04	n/a	n/a	n/a	2.29E+04	Background
Antimony	mg/kg	ND	ND	7.80E+01	n/a	n/a	7.80E+01	ECO-SSL
Cadmium	mg/kg	ND	ND	1.40E+02	2.00E+01	1.00E+01	1.40E+02	ECO-SSL
Chromium	mg/kg	4.00E+01	1.90E+02	n/a	4.00E-01	6.40E+01	6.40E+01	CCME
Copper	mg/kg	1.53E+01	5.89E+01	8.00E+01	5.00E+01	6.30E+01	8.00E+01	ECO-SSL
Iron	mg/kg	2.98E+04	5.05E+04	n/a	n/a	n/a	2.98E+04	Background
Lead	mg/kg	2.32E+01	2.01E+01	1.70E+03	5.00E+02	3.00E+02	1.70E+03	ECO-SSL
Manganese	mg/kg	6.56E+02	1.66E+03	4.50E+02	n/a	n/a	6.56E+02	Background
Mercury	mg/kg	5.40E-02	6.80E-02	n/a	1.00E-01	1.20E+01	1.00E-01	ORNL
Selenium	mg/kg	ND	ND	4.10E+00	7.00E+01	1.00E+00	4.10E+00	ECO-SSL
Vanadium	mg/kg	7.02E+01	1.55E+02	n/a	n/a	1.30E+02	1.30E+02	CCME
Zinc	mg/kg	4.83E+01	9.87E+01	1.20E+02	2.00E+02	2.00E+02	1.20E+02	ECO-SSL

Notes:
CCME - Canadian Council of Ministers of the Environment (2007)
ECO-SSL - Ecological Soil Screening Level
ND - Not Detected in Background Study (DNREC 2012)
ORNL (Efroymson et al. 1997a)

TABLE 4.2
REFINEMENT BENCHMARKS FOR TERRESTRIAL PLANTS
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Units*	*Delaware Mean Background*		*ECO-SSL*	*ORNL*	*CCME*	*Refinement Benchmark*	*Source*
		Site 1	*Site 2*					
Volatile Organic Compounds								
Isopropylbenzene	mg/kg	n/a	n/a	n/a	n/a	n/a	---	---
Methylcyclohexane	mg/kg	n/a	n/a	n/a	n/a	n/a	---	---
Semi-Volatile Organic Compounds								
Butylbenzylphthalate	mg/kg	n/a	n/a	n/a	n/a	n/a	---	---
Metals								
Aluminum	mg/kg	2.29E+04	4.76E+04	n/a	n/a	n/a	2.29E+04	Background
Antimony	mg/kg	ND	ND	n/a	5.00E+00	n/a	5.00E+00	ORNL
Cadmium	mg/kg	ND	ND	3.20E+01	4.00E+00	1.00E+01	3.20E+01	ECO-SSL
Chromium	mg/kg	4.00E+01	1.90E+02	n/a	1.00E+00	6.40E+01	6.40E+01	CCME
Copper	mg/kg	1.53E+01	5.89E+01	7.00E+01	1.00E+02	6.30E+01	7.00E+01	ECO-SSL
Iron	mg/kg	2.98E+04	5.05E+04	n/a	n/a	n/a	2.98E+04	Background
Lead	mg/kg	2.32E+01	2.01E+01	1.20E+02	5.00E+01	3.00E+02	1.20E+02	ECO-SSL
Manganese	mg/kg	6.56E+02	1.66E+03	2.20E+02	5.00E+02	n/a	6.56E+02	Background
Mercury	mg/kg	5.40E-02	6.80E-02	n/a	3.00E-01	1.20E+01	3.00E-01	ORNL
Selenium	mg/kg	ND	ND	5.20E-01	1.00E+00	1.00E+00	5.20E-01	ECO-SSL
Vanadium	mg/kg	7.02E+01	1.55E+02	n/a	2.00E+00	1.30E+02	1.30E+02	CCME
Zinc	mg/kg	4.83E+01	9.87E+01	1.60E+02	5.00E+01	2.00E+02	1.60E+02	ECO-SSL

Notes:
CCME - Canadian Council of Ministers of the Environment (2007)
ECO-SSL - Ecological Soil Screening Level
ND - Not Detected in Background Study (DNREC 2012)
ORNL (Efroymson et al. 1997b)

TABLE 4.3
REFINEMENT BENCHMARKS FOR AVIAN WILDLIFE
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Units*	*Delaware Mean Background*		*ECO-SSL*	*USEPA R5 ESL*	*CCME*	*Refinement Benchmark*	*Source*
		Site 1	*Site 2*					
Volatile Organic Compounds								
Isopropylbenzene	mg/kg	n/a		n/a	n/a	n/a	---	---
Methylcyclohexane	mg/kg	n/a		n/a	n/a	n/a	---	---
Semi-Volatile Organic Compounds								
Butylbenzylphthalate	mg/kg	n/a		n/a	n/a	n/a	---	---
Metals								
Aluminum	mg/kg	2.29E+04	4.76E+04	n/a	n/a	n/a	2.29E+04	Background
Antimony	mg/kg	ND	ND	n/a	n/a	n/a	---	Background
Cadmium	mg/kg	ND	ND	7.70E-01	n/a	3.80E+00	7.70E-01	ECO-SSL
Chromium	mg/kg	4.00E+01	1.90E+02	2.60E+01	n/a	n/a	4.00E+01	Background
Copper	mg/kg	1.53E+01	5.89E+01	2.80E+01	n/a	3.00E+02	3.00E+02	CCME
Iron	mg/kg	2.98E+04	5.05E+04	n/a	n/a	n/a	2.98E+04	Background
Lead	mg/kg	2.32E+01	2.01E+01	1.10E+01	n/a	7.00E+01	7.00E+01	CCME
Manganese	mg/kg	6.56E+02	1.66E+03	4.30E+03	n/a	n/a	4.30E+03	ECO-SSL
Mercury	mg/kg	5.40E-02	6.80E-02	n/a	n/a	n/a	5.40E-02	Background
Selenium	mg/kg	ND	ND	1.20E+00	n/a	n/a	1.20E+00	ECO-SSL
Vanadium	mg/kg	7.02E+01	1.55E+02	7.80E+00	n/a	n/a	7.02E+01	Background
Zinc	mg/kg	4.83E+01	9.87E+01	4.60E+01	n/a	6.40E+02	6.40E+02	CCME

Notes:
CCME - Canadian Council of Ministers of the Environment (2007)
ECO-SSL - Ecological Soil Screening Level
ND - Not Detected in Background Study (DNREC 2012)

TABLE 4.4
REFINEMENT BENCHMARKS FOR MAMMALIAN WILDLIFE
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Units*	*Delaware Mean Background*		*ECO-SSL*	*USEPA R5 ESL*	*CCME*	*Refinement Benchmark*	*Source*
		Site 1	*Site 2*					
Volatile Organic Compounds								
Isopropylbenzene	mg/kg	n/a		n/a	n/a	n/a	---	---
Methylcyclohexane	mg/kg	n/a		n/a	n/a	n/a	---	---
Semi-Volatile Organic Compounds								
Butylbenzylphthalate	mg/kg	n/a		n/a	n/a	n/a	---	---
Metals								
Aluminum	mg/kg	2.29E+04	4.76E+04	n/a	n/a	n/a	2.29E+04	Background
Antimony	mg/kg	ND	ND	2.70E-01	1.42E-01	n/a	2.70E-01	ECO-SSL
Cadmium	mg/kg	ND	ND	3.60E-01	2.22E-03	3.80E+00	3.60E-01	ECO-SSL
Chromium	mg/kg	4.00E+01	1.90E+02	3.40E+01	n/a	n/a	4.00E+01	Background
Copper	mg/kg	1.53E+01	5.89E+01	4.90E+01	5.40E+00	3.00E+02	3.00E+02	CCME
Iron	mg/kg	2.98E+04	5.05E+04	n/a	n/a	n/a	2.98E+04	Background
Lead	mg/kg	2.32E+01	2.01E+01	5.60E+01	5.37E-02	7.00E+01	5.60E+01	ECO-SSL
Manganese	mg/kg	6.56E+02	1.66E+03	4.00E+03	n/a	n/a	4.00E+03	ECO-SSL
Mercury	mg/kg	5.40E-02	6.80E-02	n/a	n/a	n/a	5.40E-02	Background
Selenium	mg/kg	ND	ND	6.30E-01	2.76E-02	n/a	6.30E-01	ECO-SSL
Vanadium	mg/kg	7.02E+01	1.55E+02	2.80E+02	1.59E+00	n/a	2.80E+02	Background
Zinc	mg/kg	4.83E+01	9.87E+01	7.90E+01	n/a	6.40E+02	6.40E+02	CCME

Notes:
CCME - Canadian Council of Ministers of the Environment (2007)
ECO-SSL - Ecological Soil Screening Level
ND - Not Detected in Background Study (DNREC 2012)

TABLE 4.5
REFINEMENT SUMMARY FOR SOIL INVERTEBRATES - WOODED AREA
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Units*	*Refinement Benchmark for Soil Invertebrates*	*No. Samples*	*No. Detects*	*Maximum Concentration*	*No. > Refinement Benchmark*	*Percent > Refinement Benchmark*	*Retain as COPEC*	*Rationale*
Volatile Organic Compounds									
Isopropylbenzene	mg/kg	n/a	15	1	4.000E-03	---	---	No	See Text
Methylcyclohexane	mg/kg	n/a	15	5	4.700E-02	---	---	No	See Text
Semi-Volatile Organic Compounds									
Butylbenzylphthalate	mg/kg	n/a	15	14	2.7E+00	---	---	No	See Text
Metals									
Aluminum	mg/kg	2.29E+04	15	15	1.70E+04	0	0%	No	Max < RB
Antimony	mg/kg	7.80E+01	10	6	1.40E+01	0	0%	No	Max < RB
Cadmium	mg/kg	1.40E+02	15	2	1.00E+00	0	0%	No	Max < RB
Chromium	mg/kg	6.40E+01	15	15	3.85E+01	0	0%	No	Max < RB
Copper	mg/kg	8.00E+01	15	15	2.00E+01	0	0%	No	Max < RB
Iron	mg/kg	2.98E+04	15	15	2.28E+04	0	0%	No	Max < RB
Lead	mg/kg	1.70E+03	15	15	7.09E+02	0	0%	No	Max < RB
Manganese	mg/kg	6.56E+02	15	15	4.85E+02	0	0%	No	Max < RB
Mercury	mg/kg	1.00E-01	15	15	1.30E-01	2	13%	No	< 20% > RB
Selenium	mg/kg	4.10E+00	15	2	1.30E+00	0	0%	No	Max < RB
Vanadium	mg/kg	1.30E+02	15	15	5.08E+01	0	0%	No	Max < RB
Zinc	mg/kg	1.20E+02	15	15	1.24E+02	1	6.7%	No	< 20% > RB

Notes:
n/a - Value not available
Max - Maximum Concentration
RB - Refinement Benchmark

TABLE 4.6
REFINEMENT SUMMARY FOR TERRESTRIAL PLANTS - WOODLOT
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	Units	Refinement Benchmark for Soil Invertebrates	No. Samples	No. Detects	Maximum Concentration	No. > Refinement Benchmark	Percent > Refinement Benchmark	Retain as COPEC	Rationale
Volatile Organic Compounds									
Isopropylbenzene	mg/kg	n/a	15	1	4.000E-03	---	---	No	See Text
Methylcyclohexane	mg/kg	n/a	15	5	4.700E-02	---	---	No	See Text
Semi-Volatile Organic Compounds									
Butylbenzylphthalate	mg/kg	n/a	15	14	2.7E+00	---	---	No	See Text
Metals									
Aluminum	mg/kg	2.29E+04	15	15	1.70E+04	0	0%	No	Max < RB
Antimony	mg/kg	5.00E+00	10	6	1.40E+01	1	10%	No	< 20% > RB
Cadmium	mg/kg	3.20E+01	15	2	1.00E+00	0	0%	No	Max < RB
Chromium	mg/kg	6.40E+01	15	15	3.85E+01	0	0%	No	Max < RB
Copper	mg/kg	7.00E+01	15	15	2.00E+01	0	0%	No	Max < RB
Iron	mg/kg	2.98E+04	15	15	2.28E+04	0	0%	No	Max < RB
Lead	mg/kg	1.20E+02	15	15	7.09E+02	1	6.7%	No	Max < RB
Manganese	mg/kg	6.56E+02	15	15	4.85E+02	0	0%	No	Max < RB
Mercury	mg/kg	3.00E-01	15	15	1.30E-01	0	0%	No	Max < RB
Selenium	mg/kg	5.20E-01	15	2	1.30E+00	2	13%	No	Max < RB
Vanadium	mg/kg	1.30E+02	15	15	5.08E+01	0	0%	No	Max < RB
Zinc	mg/kg	1.60E+02	15	15	1.24E+02	0	0%	No	< 20% > RB

Notes:
n/a - Value not available
Max - Maximum Concentration
RB - Refinement Benchmark

TABLE 4.7
REFINEMENT SUMMARY FOR AVIAN WILDLIFE - WOODLOT
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Units*	*Refinement Benchmark for Avian Receptors*	*No. Samples*	*No. Detects*	*UCL*	*RQ_{UCL}*	*BCOC*	*Retain as COPEC*	*Rationale*
Volatile Organic Compounds									
Isopropylbenzene	**mg/kg**	**n/a**	**15**	**1**	**n/c**	**---**	**No**	**YES**	**No RB**
Methylcyclohexane	**mg/kg**	**n/a**	**15**	**5**	**4.280E-02**	**---**	**No**	**YES**	**No RB**
Semi-Volatile Organic Compounds									
Butylbenzylphthalate	**mg/kg**	**n/a**	**15**	**14**	**1.53E+00**	**---**	**No**	**YES**	**No RB**
Metals									
Aluminum	mg/kg	2.29E+04	15	15	1.51E+04	6.6E-01	No	No	$RB_{UCL} < 1$
Antimony	**mg/kg**	**n/a**	**10**	**6**	**5.61E+00**	**---**	**No**	**YES**	**No RB**
Cadmium	mg/kg	7.70E-01	15	2	7.94E-01	1.0E+00	YES	No	$RQ_{UCL} \leq 1$
Chromium	mg/kg	4.00E+01	15	15	3.21E+01	8.0E-01	Yes	No	$RQ_{UCL} < 1$
Copper	mg/kg	3.00E+02	15	15	1.41E+01	4.7E-02	Yes	No	$RQ_{UCL} < 1$
Iron	mg/kg	2.98E+04	15	15	1.74E+04	5.8E-01	No	No	$RQ_{UCL} < 1$
Lead	**mg/kg**	**7.00E+01**	**15**	**15**	**2.88E+02**	**4.1E+00**	**Yes**	**YES**	**$RQ_{UCL} > 1$**
Manganese	mg/kg	4.30E+03	15	15	2.98E+02	6.9E-02	No	No	$RQ_{UCL} < 1$
Mercury	**mg/kg**	**5.40E-02**	**15**	**15**	**8.92E-02**	**1.7E+00**	**Yes**	**YES**	**$RQ_{UCL} > 1$**
Selenium	**mg/kg**	**1.20E+00**	**15**	**2**	**1.34E+00**	**1.1E+00**	**Yes**	**YES**	**$RQ_{UCL} > 1$**
Vanadium	mg/kg	7.02E+01	15	15	4.19E+01	6.0E-01	No	No	$RQ_{UCL} < 1$
Zinc	mg/kg	6.40E+02	15	15	6.02E+01	9.4E-02	Yes	No	$RQ_{UCL} < 1$

Notes:
- **Bold Font** identifies constituent identified as Constituent of Potential Ecological Concern
- n/a - Value not available
- BCOC - Bioaccumulative Chemical of Concern
- RB - Refinement Benchmark
- RQ_{UCL} - Hazard Quotient based on 95% Upper Confidence Limit
- UCL - Upper Confidence Limit

TABLE 4.8
REFINEMENT SUMMARY FOR MAMMALIAN WILDLIFE - WOODLOT
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Units*	*Refinement Benchmark for Avian Receptors*	*No. Samples*	*No. Detects*	*UCL*	*RQ_{UCL}*	*BCOC*	*Retain as COPEC*	*Rationale*
Volatile Organic Compounds									
Isopropylbenzene	**mg/kg**	**n/a**	**15**	**1**	**n/c**	**---**	**No**	**YES**	**No RB**
Methylcyclohexane	**mg/kg**	**n/a**	**15**	**5**	**4.280E-02**	**---**	**No**	**YES**	**No RB**
Semi-Volatile Organic Compounds									
Butylbenzylphthalate	**mg/kg**	**n/a**	**15**	**14**	**1.53E+00**	**---**	**No**	**YES**	**No RB**
Metals									
Aluminum	mg/kg	2.29E+04	15	15	1.51E+04	6.6E-01	No	No	$RB_{UCL} < 1$
Antimony	**mg/kg**	**2.70E-01**	**10**	**6**	**5.61E+00**	**2.1E+01**	**No**	**YES**	**$RQ_{UCL} > 1$**
Cadmium	**mg/kg**	**3.60E-01**	**15**	**2**	**7.94E-01**	**2.2E+00**	**Yes**	**YES**	**$RQ_{UCL} > 1$**
Chromium	mg/kg	4.00E+01	15	15	3.21E+01	8.0E-01	Yes	No	$RQ_{UCL} < 1$
Copper	mg/kg	3.00E+02	15	15	1.41E+01	4.7E-02	Yes	No	$RQ_{UCL} < 1$
Iron	mg/kg	2.98E+04	15	15	1.74E+04	5.8E-01	No	No	$RQ_{UCL} < 1$
Lead	**mg/kg**	**5.60E+01**	**15**	**15**	**2.88E+02**	**5.2E+00**	**Yes**	**YES**	**$RQ_{UCL} > 1$**
Manganese	mg/kg	4.00E+03	15	15	2.98E+02	7.5E-02	No	No	$RQ_{UCL} < 1$
Mercury	**mg/kg**	**5.40E-02**	**15**	**15**	**8.92E-02**	**1.7E+00**	**Yes**	**YES**	**$RQ_{UCL} > 1$**
Selenium	**mg/kg**	**6.30E-01**	**15**	**2**	**1.34E+00**	**2.1E+00**	**Yes**	**YES**	**$RQ_{UCL} > 1$**
Vanadium	mg/kg	2.80E+02	15	15	4.19E+01	1.5E-01	No	No	$RQ_{UCL} < 1$
Zinc	mg/kg	6.40E+02	15	15	6.02E+01	9.4E-02	Yes	No	$RQ_{UCL} < 1$

Notes:
Bold Font identifies constituent identified as Constituent of Potential Ecological Cc
n/a - Value not available
BCOC - Bioaccumulative Chemical of Concern
RB - Refinement Benchmark
RQ_{UCL} - Hazard Quotient based on 95% Upper Confidence Limit
UCL - Upper Confidence Limit

TABLE 4.9
EXPOSURE PARAMETERS FOR INDICATOR SPECIES -AVIAN WILDLIFE
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Parameter	Units	American Woodcock [a]	Mourning Dove [a,b]	Red-Tailed Hawk [a]	Tree Swallow [c]	Belted Kingfisher [a]
		Terrestrial Insectivore	Herbivore	Carnivore	Aquatic Insectivore	Piscivore
Body Weight	kg	0.170	0.120	1.224	0.020	0.147
Food Ingestion						
Wet Weight	mg WW/kg BW-day	1.16	0.139	0.169	1.55	0.500
Dry Weight	mg DW/kg BW-day	0.186	0.021	0.054	0.372	0.125
Incidental Ingestion						
Soil/Sediment	Fraction	0.104	0.139	0.010	0.010	0.059
Water Ingestion	L/kg BW-day	0.100	0.146	0.057	0.22	0.014
Area Use						
Foraging Range	Acres/Feet	61.3 acres	536 acres	1,730 acres	77 acres	1,279 feet
Area Use Factor	Fraction	0.25 [1]	0.03 [1]	0.01 [1]	0.01 [2]	0.39 [3]
Diet						
Soil Invertebrates	Percent	100	0	0	0	0
Terrestrial Plants	Percent	0	100	0	0	0
Small Mammals	Percent	0	0	100	0	0
Benthic Invertebrates	Percent	0	0	0	100	0
Fish	Percent	0	0	0	0	100

Notes:

a- Exposure parameters from EPA Region 4 Wildlife Exposure Parameters Table Version 3 - Last revised May 20, 2013 (USEPA 2013b)

b- Body weight from Cornell Lab of Ornithology (http://www.allaboutbirds.org/guide/Mourning_Dove/lifehistory). Incidental ingestion from USEPA (2010)

c - Exposure parameters from USEPA (1999a)

[1] - Area Use based on 15.3 acres of terrestrial habitat

[2] - Area Use based on 0.11 acre of aquatic habitat

[3] - Area Use based on 500 feet of stream

TABLE 4.10
EXPOSURE PARAMETERS FOR INDICATOR SPECIES -MAMMALIAN WILDLIFE
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Parameter	***Units***	***Short-Tailed Shrew*** [a]	***Meadow Vole*** [a]	***Long-Tailed Weasel*** [b]	***Little Brown Bat*** [c]	***Mink*** [a]
		Terrestrial Insectivore	***Herbivore***	***Carnivore***	***Aquatic Insectivore***	***Piscivore***
Body Weight	kg	0.017	0.030	0.190	0.01	0.896
Food Ingestion						
Wet Weight	mg WW/kg BW-day	0.810	1.27	0.406	0.920	0.160
Dry Weight	mg DW/kg BW-day	0.130	0.191	0.130	0.221	0.040
Incidental Ingestion						
Soil/Sediment	Fraction	0.037	0.024	0.043	0	0.094
Water Ingestion	L/kg BW-day	0.290	0.003	0.116	0.140	0.079
Area Use						
Foraging Range	Acres/Feet	0.96 acres	0.21 acres	156 acres	0.63 acres	4,035 feet
Area Use Factor	Fraction	1.0 [1]	1.0 [1]	0.10 [1]	0.18 [2]	0.12 [3]
Diet						
Soil Invertebrates	Percent	100	0	0	0	0
Terrestrial Plants	Percent	0	100	0	0	0
Small Mammals	Percent	0	0	100	0	0
Benthic Invertebrates	Percent	0	0	0	100	0
Fish	Percent	0	0	0	0	100

Notes:

a- Exposure parameters from EPA Region 4 Wildlife Exposure Parameters Table Version 3 - Last revised May 20, 2013 (USEPA 2013b)
b- Body weight from USEPA (1999b) All other exposure parameters from USEPA (2010).
c - Exposure parameters from USEPA (1999)
[1] - Area Use based on 15.3 acres of terrestrial habitat
[2] - Area Use based on 0.11 acre of aquatic habitat
[3] - Area Use based on 500 feet of stream

TABLE 4.11
TOXICITY REFERENCE VALUES FOR AVIAN AND MAMMALIAN INDICATOR SPECIES
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	Toxicity Reference Value(mg/kg/day)					
	Avian Wildlife			Mammalian Wildlife		
	NOAEL	LOAEL	Source	NOAEL	LOAEL	Source
Volatile Organic Compounds						
Isopropylbenzene	n/a	n/a	---	1.54E+02	4.62E+02	Wolfe et al. 1956
Methylcyclohexane	n/a	n/a	---	1.00E+02	n/a	Kim et al. 2011
Semi-Volatile Organic Compounds						
bis(2-ethylhexyl)phthalate	1.10E+00	n/a	Sample et al. 1966	1.83E+01	1.83E+02	Sample et al. 1996
Butylbenzylphthalate	n/a	n/a	---	5.00E+01	n/a	Tyl et al. 2004
Carbazole	n/a	n/a	---	5.20E+00	5.20E+01	Derived - See Text
Dibenzofuran	n/a	n/a	---	5.20E+00	5.20E+01	Derived - See Text
Polycyclic Aromatic Hydrocarbons (PAHs)						
Low Molecular Weight PAHs	1.64E+03	n/a	USEPA 2007e	1.70E+02	4.35E+02	USEPA 2007e
High Molecular Weight PAHs	2.00E+00	2.00E+01	USEPA 2007e	1.80E+01	4.07E+01	USEPA 2007e
Petroleum Hydrocarbons						
Total Petroleum Hydrocarbons	n/a	n/a	---	2.11E+02	n/a	API 2004
Metals						
Antimony	n/a	n/a	---	1.83E+01	5.57E+01	USEPA 2005a
Barium	n/a	n/a	---	5.18E+01	2.69E+02	USEPA 2005b
Cadmium	1.47E+00	9.04E+00	USEPA 2005c	1.86E+00	7.98E+00	USEPA 2005c
Chromium	2.66E+00	1.45E+01	USEPA 2008a	2.40E+00	5.82E+01	USEPA 2008a
Copper	1.99E+01	3.67E+01	USEPA 2007a	1.82E+01	1.15E+02	USEPA 2007a
Lead	1.09E+01	4.27E+01	USEPA 2005d	2.68E+01	1.16E+02	USEPA 2005d
Manganese	1.79E+02	3.77E+02	USEPA 2007c	5.15E+01	2.24E+02	USEPA 2007c
Inorganic Mercury	4.50E-01	9.00E-01	Sample et al. 1966	1.00E+00	n/a	Sample et al. 1996
Methyl Mercury	6.40E-03	6.40E-02	Sample et al. 1966	1.50E-02	2.50E-02	Sample et al. 1996
Nickel	6.71E+00	1.74E+01	USEPA 2007d	7.70E+00	3.32E+01	USEPA 2007d
Selenium	6.06E-01	1.39E+00	USEPA 2007f	4.30E-01	8.37E-01	USEPA 2007f
Vanadium	1.19E+00	1.69E+00	USEPA 2005e	6.61E+00	7.67E+00	USEPA 2005e
Zinc	6.61E+01	1.54E+02	USEPA 2007g	7.54E+01	8.95E+02	USEPA 2007g

Notes:

n/a - Toxicity Reference Value not available
API - American Petroleum Institute
COPEC - Constituent of Potential Ecological Concern
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level

TABLE 4.12
UPTAKE EQUATIONS AND BIOACCUMULATION FACTORS - WOODED AREA
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	***Soil Invertebrates***		***Terrestrial Plants***		***Small Mammals***	
Volatile Organic Compounds						
Isopropylbenzene	$C_I = C_{soil} * 1.02$	a	$C_P = C_{soil} * 0.045$	b	C_M =Maximum of C_I and C_P	c
Methylcyclohexane	$C_I = C_{soil} * 1.02$	a	$C_P = C_{soil} * 0.048$	b	C_M =Maximum of C_I and C_P	c
Semi-Volatile Organic Compounds						
Butylbenzylphthalate	$C_I = C_{soil} * 5.07$	a	$CP = C_{soil} * 0.011$	b	C_M =Maximum of C_I and C_P	c
Semi-Volatile Organic Compounds						
High Molecular Weight PAHs	NA	-	NA	-	NA	-
Metals						
Antimony	$C_I = C_{soil} * 1.0 * (1-0.84)$	d	$C_P = EXP(0.938*(LN(C_{soil})-3.233)*(1-0.85)$	d	$C_M = C_I * 0.05$	d
Cadmium	$CI = EXP(0.795*(LN(C_{soil})+2.114)*(1-0.84)$	d	$C_P = EXP(0.546*(LN(C_{soil})-0.475)*(1-0.85)$	d	$C_M = EXP(0.4723*(LN(C_{soil})-1.2571)*(1-0.68)$	d
Lead	$CI = EXP(0.807*(LN(C_{soil})-0.218)*(1-0.84)$	d	$C_P = EXP(0.561*(LN(C_{soil})-1.328)*(1-0.85)$	d	$C_M = EXP(0.4422*(LN(C_{soil})+0.0761)*(1-0.68)$	d
Mercury	$C_I = C_{soil} * 0.04$	e	$C_P = C_{soil} * 0.0375 * (1-0.85)$	e	$C_M = C_{soil} * 0.0543 * (1-0.68)$	f
Selenium	CI = EXP(0.733*(LN(Csoil)-0.075)*(1-0.84)	d	CP = EXP(1.104*(LN(Csoil)-0.677)*(1-0.85)	d	CM = EXP(0.3764*(LN(Csoil)-0.4158)*(1-0.68)	d
Zinc	NA	-	NA	-	NA	-

Notes:

NA - Not analyzed
C_I - Concentration in soil invertebrates (mg/kg Wet Weight)
C_M - Concentration in small mammals (mg/kg Wet Weight)
C_P - Concentration in terrestrial plants (mg/kg Wet Weight)
C_{soil} - Concentration in soil (mg/kg Dry Weight)

The expression in parentheses at the end of some of the equations convert dry weight concentrations to wet weight concentrations. Water content is assumed to be 85% for plant foliage, 84% for soil invertebrates, and 68% for small mammals (USEPA 2010).

Source:

a - Jager (1998)
b - Log(BCF) = 1.558 – (0.578*Log(Kow))
c - No data available
d - ECO-SSL Guidance (USEPA 2010)
e - USEPA (1999a)
f - Sample et al. (1998)

TABLE 4.13
EXPOSURE POINT CONCENTRATIONS FOR AVIAN AND MAMMALIAN WILDLIFE - WOODED AREA
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	***Soil*** mg/kg DW		***Soil Invertebrates*** mg/kg WW	***Terrestrial Plants*** mg/kg WW	***Small Mammals*** mg/kg WW	***Surface Water*** mg/L	
Volatile Organic Compounds							
Isopropylbenzene	4.00E-03	M	4.08E-03	1.78E-04	4.08E-03	ND	-
Methylcyclohexane	4.70E-02	a		2.24E-03	2.24E-03	ND	-
Semi-Volatile Organic Compounds							
Butylbenzylphthalate	1.53E+00	b	7.76E+00	6.86E-04	7.76E+00	ND	-
METALS							
Antimony	5.61E+00	c	8.98E-01	2.98E-02	4.49E-02	ND	-
Cadmium	7.94E-01	a	1.10E+00	8.22E-02	8.16E-02	ND	-
Lead	2.88E+02	d	1.24E+01	9.53E-01	4.22E+00	6.50E-03	M
Mercury	8.92E-02	c	3.56E-03	5.01E-04	1.55E-03	ND	-
Selenium	1.34E+00	a	1.84E-01	1.05E-01	2.36E-01	ND	-

Notes:
DW - Dry Weight
WW - Wet Weight
a - 95% KM (t) UCL
b - 97.5% KM (Chebyshev) UCL
c - 95% Student's-t UCL
d- 95% Chebyshev (Mean, SD) UCL
M - Maximum concentration. Insufficient number of detected concentrations to calculate an Upper Confidence Limit (UCL)

TABLE 4.14
SUMMARY OF FOOD CHAIN MODEL FOR AMERICAN WOODCOCK - WOODED AREA
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	Ingestion (mg/kg-day)					NOAEL (mg/kg-day)	HQ $_{NOAEL}$ (unitless)	LOAEL (mg/kg-day)	HQ $_{LOAEL}$ (unitless)
	Diet	Soil	Surface Water	Total	Total $_{AUF}$				
Volatile Organic Compounds									
Isopropylbenzene	4.76E-03	7.72E-05	0.00E+00	4.83E-03	1.21E-03	n/a	---	n/a	---
Methylcyclohexane	5.55E-02	9.07E-04	0.00E+00	5.64E-02	1.41E-02	n/a		n/a	
Semi-Volatile Organic Compounds									
Butylbenzylphthalate	8.99E+00	2.95E-02	0.00E+00	9.02E+00	2.26E+00	n/a	---	n/a	---
Metals									
Antimony	1.04E+00	1.08E-01	0.00E+00	1.15E+00	2.87E-01	n/a	---	n/a	---
Lead	1.44E+01	5.56E+00	6.50E-04	2.00E+01	4.99E+00	1.09E+01	4.6E-01	---	---
Mercury	4.13E-03	1.72E-03	0.00E+00	5.85E-03	1.46E-03	4.50E-01	3.3E-03	---	---
Selenium	2.13E-01	2.59E-02	0.00E+00	2.39E-01	5.98E-02	6.06E-01	9.9E-02	---	---

Notes:
n/a - Toxicity Reference Value not available
AUF - Area Use Factor
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level

TABLE 4.15
SUMMARY OF FOOD CHAIN MODEL FOR MOURNING DOVE - WOODED AREA
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	Ingestion (mg/kg-day)					NOAEL (mg/kg-day)	HQ_{NOAEL} (unitless)	LOAEL (mg/kg-day)	HQ_{LOAEL} (unitless)
	Diet	Soil	Surface Water	Total	$Total_{AUF}$				
Volatile Organic Compounds									
Isopropylbenzene	2.48E-05	1.16E-05	0.00E+00	3.64E-05	1.09E-06	n/a	---	n/a	---
Methylcyclohexane	3.12E-04	1.37E-04	0.00E+00	4.48E-04	1.34E-05	n/a	---	n/a	---
Semi-Volatile Organic Compounds									
Butylbenzylphthalate	9.56E-05	4.44E-03	0.00E+00	4.54E-03	1.36E-04	n/a	---	n/a	---
Metals									
Antimony	4.16E-03	1.63E-02	0.00E+00	2.05E-02	6.14E-04	n/a	---	n/a	---
Lead	1.33E-01	8.37E-01	9.49E-04	9.70E-01	2.91E-02	1.09E+01	2.7E-03	---	---
Mercury	6.98E-05	2.59E-04	0.00E+00	3.28E-04	9.85E-06	4.50E-01	2.2E-05	---	---
Selenium	1.47E-02	3.89E-03	0.00E+00	1.86E-02	5.57E-04	6.06E-01	9.2E-04	---	---

Notes:
AUF - Area Use Factor
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level

TABLE 4.16
SUMMARY OF FOOD CHAIN MODEL FOR RED-TAILED HAWK - WOODED AREA
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	Ingestion (mg/kg-day)					NOAEL (mg/kg-day)	HQ $_{NOAEL}$ (unitless)	LOAEL (mg/kg-day)	HQ $_{LOAEL}$ (unitless)
	Diet	Soil	Surface Water	Total	Total $_{AUF}$				
Volatile Organic Compounds									
Isopropylbenzene	6.93E-04	2.16E-06	0.00E+00	6.95E-04	6.95E-06	n/a	---	n/a	---
Methylcyclohexane	8.08E-03	2.54E-05	0.00E+00	8.10E-03	8.10E-05	n/a	---	n/a	---
Semi-Volatile Organic Compounds									
Butylbenzylphthalate	1.31E+00	8.27E-04	0.00E+00	1.31E+00	1.31E-02	n/a	---	n/a	---
Metals									
Antimony	7.58E-03	3.03E-03	0.00E+00	1.06E-02	1.06E-04	n/a	---	n/a	---
Lead	7.14E-01	1.56E-01	3.71E-04	8.70E-01	8.70E-03	1.09E+01	8.0E-04	---	---
Mercury	2.61E-04	4.80E-05	0.00E+00	3.09E-04	3.09E-06	4.50E-01	6.9E-06	---	---
Selenium	3.98E-02	7.25E-04	0.00E+00	4.06E-02	4.06E-04	6.06E-01	6.7E-04	---	---

Notes:
AUF - Area Use Factor
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level

TABLE 4.17
SUMMARY OF FOOD CHAIN MODEL FOR SHORT-TAILED SHREW - WOODED AREA
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	Ingestion (mg/kg-day)					NOAEL (mg/kg-day)	HQ_{NOAEL} (unitless)	LOAEL (mg/kg-day)	HQ_{LOAEL} (unitless)
	Diet	Soil	Surface Water	Total	$Total_{AUF}$				
Volatile Organic Compounds									
Isopropylbenzene	3.32E-03	1.92E-05	0.00E+00	3.34E-03	3.34E-03	1.54E+02	2.2E-05	---	---
Methylcyclohexane	3.87E-02	2.25E-04	0.00E+00	3.89E-02	3.89E-02	1.00E+02	3.9E-04	---	---
Semi-Volatile Organic Compounds									
Butylbenzylphthalate	6.28E+00	7.34E-03	0.00E+00	6.29E+00	6.29E+00	5.00E+01	1.3E-01	---	---
Metals									
Antimony	7.27E-01	2.69E-02	0.00E+00	7.54E-01	7.54E-01	1.33E+01	5.7E-02	---	---
Cadmium	8.93E-01	3.81E-03	0.00E+00	8.97E-01	8.97E-01	1.86E+00	4.8E-01	---	---
Lead	1.01E+01	1.38E+00	1.89E-03	1.14E+01	1.14E+01	4.07E+01	2.8E-01	---	---
Mercury	2.88E-03	4.27E-04	0.00E+00	3.31E-03	3.31E-03	1.00E+00	3.3E-03	---	---
Selenium	1.49E-01	6.43E-03	0.00E+00	1.55E-01	1.55E-01	4.30E-01	3.6E-01	---	---

Notes:
AUF - Area Use Factor
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level

TABLE 4.18
SUMMARY OF FOOD CHAIN MODEL FOR MEADOW VOLE - WOODED AREA
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Ingestion (mg/kg-day)*					*NOAEL (mg/kg-day)*	*HQ $_{NOAEL}$ (unitless)*	*LOAEL (mg/kg-day)*	*HQ $_{LOAEL}$ (unitless)*
	Diet	*Soil*	*Surface Water*	*Total*	*Total $_{AUF}$*				
Volatile Organic Compounds									
Isopropylbenzene	2.26E-04	1.83E-05	0.00E+00	2.44E-04	2.44E-04	1.54E+02	1.6E-06	---	---
Methylcyclohexane	2.84E-03	2.15E-04	0.00E+00	3.06E-03	3.06E-03	1.00E+02	3.1E-05	---	---
Semi-Volatile Organic Compounds									
Butylbenzylphthalate	8.71E-04	7.00E-03	0.00E+00	7.87E-03	7.87E-03	5.00E+01	1.6E-04	---	---
Metals									
Antimony	3.79E-02	2.56E-02	0.00E+00	6.35E-02	6.35E-02	1.33E+01	4.8E-03	---	---
Cadmium	1.04E-01	3.63E-03	0.00E+00	1.08E-01	1.08E-01	1.86E+00	5.8E-02	---	---
Lead	1.21E+00	1.32E+00	1.95E-05	2.53E+00	2.53E+00	4.07E+01	6.2E-02	---	---
Mercury	6.36E-04	4.07E-04	0.00E+00	1.04E-03	1.04E-03	1.00E+00	1.0E-03	---	---
Selenium	1.34E-01	6.13E-03	0.00E+00	1.40E-01	1.40E-01	4.30E-01	3.3E-01	---	---

Notes:
AUF - Area Use Factor
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level

TABLE 4.19
SUMMARY OF FOOD CHAIN MODEL FOR LONG-TAILED WEASEL - WOODED AREA
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Ingestion (mg/kg-day)*					*NOAEL (mg/kg-day)*	*HQ $_{NOAEL}$ (unitless)*	*LOAEL (mg/kg-day)*	*HQ $_{LOAEL}$ (unitless)*
	Diet	*Soil*	*Surface Water*	*Total*	*Total $_{AUF}$*				
Volatile Organic Compounds									
Isopropylbenzene	1.67E-03	2.24E-05	0.00E+00	1.69E-03	1.69E-04	1.54E+02	1.1E-06	---	
Methylcyclohexane	1.94E-02	2.63E-04	0.00E+00	1.97E-02	1.97E-03	1.00E+02	2.0E-05	---	
Semi-Volatile Organic Compounds									
Butylbenzylphthalate	3.15E+00	8.55E-03	0.00E+00	3.16E+00	3.16E-01	5.00E+01	6.3E-03	---	
Metals									
Antimony	1.82E-02	3.14E-02	0.00E+00	4.96E-02	4.96E-03	1.33E+01	3.7E-04	---	
Cadmium	3.32E-02	4.44E-03	0.00E+00	3.76E-02	3.76E-03	1.86E+00	2.0E-03	---	
Lead	1.72E+00	1.61E+00	7.54E-04	3.33E+00	3.33E-01	4.07E+01	8.2E-03	---	
Mercury	6.28E-04	4.98E-04	0.00E+00	1.13E-03	1.13E-04	1.00E+00	1.1E-04	---	
Selenium	9.58E-02	7.49E-03	0.00E+00	1.03E-01	1.03E-02	4.30E-01	2.4E-02	---	

Notes:
AUF - Area Use Factor
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level

TABLE 4.20
REFINEMENT OF CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN - SURFACE WATER
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*ESV*	*Default Background Standard*	*Refinement Benchmark*	*Maximum Concentration*	*95% UCL Concentration*	*Retain/Eliminate*	*Rationale*
Dissolved Metals μg/L							
Aluminum	87	200	200	218	183	Eliminate	95% UCL < BG
Barium	4.0	4.0 [a]	220 [b]	227	192	Eliminate	95% UCL < ESL
Zinc	110	110 [a]	110	130	101	Eliminate	95% < ESV

Notes:
[a] - Default Background standard is the Uniform Risk-Based Remediation Standard (URS)
[b] - The refinement benchmark for barium is the Ecological Screening Level (ESL) identified by USEPA Region 5 (2003a)
BG - Background
COPEC - Constituent of Potential Ecological Concern
ESV - Ecological Screening Value
UCL - Upper Confidence Limit

TABLE 4.21
EQUILIBRIUM SEDIMENT BENCHMARKS - ORGANIC COMPOUNDS
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Parameter	*Chronic Value (mg/L)*	*Equilibrium Sediment Benchmark (mg/kg)*											
		SED 1-11	*SED 2-11*	*SED 3-11*	*SED 4-11*	*SED 5-11*	*SED 6-11*	*SED 7-11*	*SED 8*	*SED 9*	*SED 10*	*SED 11*	*SED 12*
Fraction Organic Carbon [a]		1.22E-02	1.22E-02	1.22E-02	1.22E-02	1.50E-02	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Fraction Solids		7.93E-01	7.00E-01	5.10E-01	4.26E-01	8.15E-01	7.99E-01	8.18E-01	7.93E-01	8.43E-01	8.04E-01	7.02E-01	6.73E-01
Organic Compound													
Toluene	2.14E+00	1.04E+01	1.07E+01	1.19E+01	1.27E+01	1.25E+01	1.34E+00	1.28E+00	1.36E+00	1.20E+00	1.33E+00	1.71E+00	1.84E+00
bis(2-ethylhexyl)phthalate	6.50E-02	5.09E+01	5.09E+01	5.09E+01	5.10E+01	6.26E+01	4.19E+00	4.18E+00	4.19E+00	4.18E+00	4.19E+00	4.20E+00	4.20E+00
Butylbenzylphthalate	7.30E-02	3.98E+01	3.98E+01	3.98E+01	3.99E+01	4.89E+01	3.28E+00	3.28E+00	3.28E+00	3.27E+00	3.28E+00	3.29E+00	3.30E+00
Carbazole	3.54E-01	9.70E+00	1.98E+01	1.99E+01	2.01E+01	2.42E+01	1.70E+00	1.69E+00	1.70E+00	1.67E+00	1.69E+00	1.76E+00	1.78E+00
Dibenzofuran	1.49E-01	2.04E+01	2.05E+01	2.06E+01	2.06E+01	2.51E+01	1.71E+00	1.71E+00	1.71E+00	1.70E+00	1.71E+00	1.74E+00	1.75E+00
Di-n-octylphthalate	6.00E-05	6.72E+01	6.72E+01	6.72E+01	6.72E+01	8.26E+01	5.51E+00	5.51E+00	5.51E+00	5.51E+00	5.51E+00	5.51E+00	5.51E+00
2-Methylnaphthalene	3.24E-02	9.23E+00	9.26E+00	9.32E+00	9.37E+00	1.13E+01	7.85E-01	7.81E-01	7.86E-01	7.77E-01	7.84E-01	8.06E-01	8.13E-01

Notes:
[a] - Data for organic carbon not available. Values based on 2014 samples.

TABLE 4.22
REFINEMENT OF CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN - SEDIMENT - ORGANIC COMPOUNDS
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Organic Compound	***Narcosis Quotient***											
	Stormwater Ditch				***Little Mill Creek***							
	SED 1-11	***SED 2-11***	***SED 3-11***	***SED 4-11***	***SED 5-11***	***SED 6-11***	***SED 7-11***	***SED-8***	***SED-9***	***SED-10***	***SED-11***	***SED-12***
Toluene	ND	ND	5.20E-03	**7.90E-03**	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-ethylhexyl)phthalate	1.90E-03	1.36E-02	1.36E-01	**6.28E-02**	ND	ND	ND	ND	ND	ND	ND	ND
Butylbenzylphthalate	1.42E-02	2.76E-02	8.79E-02	**2.43E-01**	ND	5.49E-02	3.66E-02	ND	ND	ND	ND	0.0486
Carbazole	ND	2.89E-01	2.66E-01	**5.48E-01**	ND	ND	ND	ND	ND	3.43E-02	ND	0.0467
Dibenzofuran	ND	7.82E-02	9.73E-02	**1.50E-01**	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octylphthalate	ND	ND	4.02E-02	**ND**	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	6.38E-02	1.18E-01	**1.60E-01**	ND	ND	ND	ND	5.02E-01	ND	ND	ND
Toxicity Index	1.61E-02	4.72E-01	7.50E-01	**1.17E+00**	0.00E+00	5.49E-02	3.66E-02	0.00E+00	5.02E-01	3.43E-02	0.00E+00	0.095
Potential Risk to Benthic Invertebrates	No	No	No	**Yes**	No	No	No	No	No	No	No	No

Notes:

Bold Font identifies sediment sample that potentially poses risk to benthic invertebrates
ND- Organic compound not detected in sample

TABLE 4.23
REFINEMENT OF CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN - SEDIMENT - POLYCYCLIC AROMATIC HYDROCARBONS
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Polycyclic Aromatic Hydrocarbon	*FCV (mg/kg)*	*Equilibrium Sediment Benchmark Toxicity Units*											
		Stormwater Ditch				*Little Mill Creek*							
		SED 1-11	*SED 2-11*	*SED 3-11*	*SED 4-11*	*SED 5-11*	*SED 6-11*	*SED 7-11*	*SED-8*	*SED-9*	*SED-10*	*SED-11*	*SED-12*
Naphthalene	4.E+02	ND	1.81E-01	2.56E-01	2.77E-01	ND	ND	ND	ND	ND	ND	ND	0.00E+00
Acenaphthylene	5.E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00E+00
Acenaphthylene	5.E+02	ND	4.84E-01	8.51E-01	1.35E+00	ND	ND	ND	ND	ND	ND	ND	0.00E+00
Fluorene	5.E+02	ND	4.88E-01	4.57E-01	7.92E-01	ND	ND	ND	ND	ND	ND	ND	0.00E+00
Phenanthrene	6.E+02	2.89E-01	4.68E+00	5.09E+00	1.00E+01	ND	1.54E-01	3.19E-01	ND	ND	7.05E-01	1.38E-01	8.89E-01
Anthracene	6.E+02	2.21E-02	1.10E+00	8.97E-01	1.93E+00	ND	ND	ND	ND	ND	1.55E-01	ND	1.13E-01
Fluoranthene	7.E+02	5.68E-01	5.57E+00	6.49E+00	1.51E+01	ND	3.82E-01	5.66E-01	ND	1.56E-01	8.49E-01	1.98E-01	1.56E+00
Pyrene	7.E+02	3.29E-01	3.65E+00	5.41E+00	9.53E+00	ND	3.44E-01	4.74E-01	ND	1.42E-01	8.47E-01	1.87E-01	1.43E+00
Benzo(a)anthracene	4.E+03	2.57E-02	3.95E-01	ND	9.28E-01	ND	2.41E-02	3.85E-02	ND	1.11E-02	7.22E-02	1.44E-02	1.16E-01
Chrysene	8.E+02	1.94E-01	2.04E+00	2.72E+00	4.95E+00	ND	1.66E-01	2.37E-01	ND	7.35E-02	3.79E-01	8.29E-02	7.58E-01
Benzo(b)fluoranthene	1.E+03	1.42E-01	1.59E+00	2.43E+00	4.19E+00	ND	1.53E-01	2.04E-01	ND	7.35E-02	2.86E-01	7.25E-02	7.87E-01
Benzo(k)fluoranthene	1.E+03	6.85E-02	8.19E-01	1.17E+00	2.17E+00	ND	4.99E-02	1.02E-01	ND	ND	1.22E-01	2.55E-02	2.96E-01
Benzo(a)pyrene	1.E+03	1.10E-01	ND	1.78E+00	3.31E+00	1.45E-02	1.02E-01	1.66E-01	ND	4.35E-02	2.59E-01	4.35E-02	4.97E-01
Indeno(1,2,3-cd)pyrene	1.E+03	9.56E-02	1.44E+00	1.10E+00	2.43E+00	ND	6.55E-02	9.87E-02	ND	2.87E-02	1.08E-01	2.06E-02	3.59E-01
Dibenz(a,h)anthracene	1.E+03	1.31E-02	1.10E+00	1.90E-01	3.50E-01	ND	1.07E-02	1.69E-02	ND	ND	2.40E-02	ND	5.25E-02
Benzo(g,h,i)perylene	1.E+03	8.23E-02	1.90E-01	1.42E+00	2.17E+00	ND	6.67E-02	1.01E-01	ND	ND	9.13E-02	ND	3.38E-01
Sum of Toxicity Units		**1.94E+00**	**2.37E+01**	**3.03E+01**	**59.5**	1.45E-02	1.52E+00	**2.32E+00**	0.00.E+00	5.28E-01	3.90E+00	7.82E-01	**7.20E+00**
Potential Risk to Benthic Invertebrates		**Yes**	**Yes**	**Yes**	**Yes**	No	No	**Yes**	No	No	No	No	**Yes**

Notes:

Bold Font identifies sample with Sum of Toxicity Units greater than 1.0

ND - Individual Polycyclic Aromatic Hydrocarbon (PAH) not detected in sample

FCV - Final Chronic Value

TABLE 4.24
REFINEMENT OF CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN - SEDIMENT - METALS
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Metal	*ESV (mg/kg)*	*Lower Tier SQB (mg/kg)*	*Upper Tier SQB (mg/kg)*	*Source*	*No. Samples*	*No. Detects*	*Min. Detected*	*Max Detected*	*No. > Lower Tier SQB*	*No. > Upper Tier SQB*	*Retain/Eliminate*	*Rationale*
Antimony	2.00E+00	3.20E+00	1.90E+01	a	1.20E+01	3.00E+00	1.50E+00	1.05E+01	2	0	Eliminate	Max < UT SQB
Barium	2.00E+01	1.57E+02	3.00E+02	a	1.20E+01	1.20E+01	1.02E+01	1.85E+02	1	0	Eliminate	Max < UT SQB
Cadmium	1.00E+00	9.90E-01	4.98E+00	b	1.20E+01	3.00E+00	4.30E-01	4.10E+00	2	0	Eliminate	Max < UT SQB
Chromium	**8.10E+01**	**4.34E+01**	**1.11E+02**	**b**	**1.20E+01**	**1.10E+01**	**5.80E+00**	**1.17E+02**	**2**	**1**	**Retain**	**Max > UT SQB**
Copper	**3.40E+01**	**3.16E+01**	**1.49E+02**	**b**	**1.20E+01**	**8.00E+00**	**3.60E+00**	**3.94E+02**	**3**	**2**	**Retain**	**Max > UT SQB**
Iron	n/a	n/a	1.88E+05	c	1.20E+01	1.00E+01	2.37E+03	4.84E+04	---	0	Eliminate	Max< UT SQB
Lead	**4.70E+01**	**3.58E+01**	**1.28E+02**	**b**	**1.20E+01**	**1.20E+01**	**2.20E+00**	**5.26E+02**	**3**	**2**	**Retain**	**Max > UT SQB**
Manganese	4.60E+02	8.19E+02	1.67E+03	d	1.20E+01	1.20E+01	2.02E+01	5.66E+02	0	0	Eliminate	Max < UT SQB
Mercury	2.00E-01	1.80E-01	1.06E+00	b	1.20E+01	4.00E+00	2.50E-02	8.10E-01	2	0	Eliminate	Max < UT SQB
Nickel	2.10E+01	2.20E+01	4.86E+01	b	1.20E+01	1.20E+01	2.50E+00	4.26E+01	2	0	Eliminate	Max < UT SQB
Vanadium	4.20E+01	4.20E+01	5.60E+01	b	1.20E+01	1.10E+01	4.60E+00	5.40E+01	1	0	Eliminate	Max < UT SQB
Zinc	**1.50E+02**	**5.72E+01**	**4.59E+02**	**b**	**1.20E+01**	**1.20E+01**	**1.11E+01**	**2.37E+03**	**5**	**3**	**Retain**	**Max > UT SQB**

Notes:
Bold Font identifies metal retained as a Constituent of Potential Ecological Concern (COPEC)
ESV - Ecological Screening Value
SQB - Sediment Quality Benchmark
UT - Upper Tier

Source:
a - Crommentuijn et al. 1997
b - MacDonald et al. 2000
c - Buchman 2008
d - USEPA 1996

TABLE 4.25
UPTAKE EQUATIONS AND BIOACCUMULATION FACTORS - LITTLE MILL CREEK
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Sediment-to-Invertebrate*	*Source*	*Sediment-to-Fish*	*Source*
Semi-Volatile Organic Compounds				
bis(2-ethylhexyl)phthalate	$1 * C_{SED}$	a	$1 * C_{SED}$	a
Carbazole	$1 * C_{SED}$	a	$1 * C_{SED}$	a
Dibenzofuran	$1 * C_{SED}$	a	$1 * C_{SED}$	a
Polycyclic Aromatic Hydrocarbons (PAHs)				
Low Molecular Weight PAHs				
Acenaphthene	$2.04 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
Acenaphthylene	$2.04 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
Anthracene	$0.271 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
Fluorene	$1.73 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
2-Methylnaphthalene	$2.04 * C_{SED} * (1 - 0.84)$	b	$1 * C_{SED}$	c
Naphthalene	$2.04 * C_{SED} * (1 - 0.84)$	b	$1 * C_{SED}$	c
Phenanthrene	$0.652 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
High Molecular Weight PAHs				
Benzo(a)anthracene	$1.4 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
Benzo(a)pyrene	$0.191* C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
Benzo(b)fluoranthene	$0.15 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
Benzo(g,h,i)perylene	$0.295 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
Benzo(k)fluoranthene	$0.421 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
Chrysene	$0.335 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
Dibenz(a,h)anthracene	$0.271 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
Fluoranthene	$0.312 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
Indeno(1,2,3-cd)pyrene	$0.355 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
Pyrene	$0.803 * C_{SED} - (1 - 0.84)$	USEPA Region 2	$1 * C_{SED}$	USEPA Region 2
Petroleum Hydrocarbons				
Total Petroleum Hydrocarbons	$1 * C_{SED}$	a	$1 * C_{SED}$	a

TABLE 4.25
UPTAKE EQUATIONS AND BIOACCUMULATION FACTORS - LITTLE MILL CREEK
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Sediment-to-Invertebrate*	*Source*	*Sediment-to-Fish*	*Source*
Metals				
Antimony	$0.9 * C_{SED}$	USEPA 1999	$0.9 * C_{SED}$	d
Barium	$0.9 * C_{SED}$	USEPA 1999	$0.9 * C_{SED}$	d
Cadmium	$3.073 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$0.164 * C_{SED} * (1 - 0.75)$	USEPA Region 2
Chromium	$0.186 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$0.038 * C_{SED} * (1 - 0.75)$	USEPA Region 2
Copper	$7.957 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED} * (1 - 0.75)$	USEPA Region 2
Lead	$0.362 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$0.070 * C_{SED} * (1 - 0.75)$	USEPA Region 2
Manganese	$0.9 * C_{SED}$	USEPA 1999	$0.9 * C_{SED}$	d
Methyl Mercury	$2.868 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$4.58 * C_{SED} * (1 - 0.75)$	USEPA Region 2
Nickel	$0.214 * C_{SED} * (1 - 0.84)$	USEPA Region 2	$1 * C_{SED} * (1 - 0.75)$	USEPA Region 2
Vanadium	$0.9 * C_{SED}$	USEPA 1999	$0.9 * C_{SED}$	d
Zinc	$4.759 * C_{SED} - (1 - 0.84)$	USEPA Region 2	$1.47 * C_{SED} * (1 - 0.75)$	USEPA Region 2

Notes:

a - Bioaccumulation equation not available. Constituent is not a known bioaccumulative chemical of concern. Bioaccumulation assumed to be 1.0

b - Bioaccumulation equation not identified by USEPA Region 2. Bioaccumulation conservatively assumed to be equal to the highest factor for LMW PAHs

c - Bioaccumulation equation not identified by USEPA Region 2. Bioaccumulation assumed to be equal to all other HMW PAHs

d - Sediment-to-fish bioaccumulation equation not available. Bioaccumulation assumed to be 1.0

C_{SED} - Concentration in sediment (mg/kg dry weight)

TABLE 4.26
EXPOSURE POINT CONCENTRATIONS FOR FOOD CHAIN MODELS - LITTLE MILL CREEK
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	Sediment mg/kg DW		Benthic Invertebrates mg/kg WW	Fish mg/kg WW	Surface Water mg/L	
Semi-Volatile Organic Compounds						
Bis(2-ethylhexyl)phthalate	3.82E+00	a	3.82E+00	3.82E+00	0.00E+00	
Carbazole	3.86E+00	b	3.86E+00	3.86E+00	0.00E+00	
Dibenzofuran	2.03E+00	b	2.03E+00	2.03E+00	0.00E+00	
Polycyclic Aromatic Hydrocarbons (PAHs)						
Low Molecular Weight PAHs	3.46E+01	a	4.45E+00	3.46E+01	0.00E+00	
High Molecular Weight PAHs	2.10E+02	c	1.25E+01	2.10E+02	0.00E+00	
Petroleum Hydrocarbons						
Total Petroleum Hydrocarbons	4.52E+03	a	4.52E+03	4.52E+03	0.00E+00	
Metals						
Antimony	4.69E+00	b	4.22E+00	4.22E+00	0.00E+00	
Barium	1.01E+02	d	9.09E+01	9.09E+01	1.92E-01	g
Cadmium	1.62E+00	b	7.97E-01	6.60E-02	0.00E+00	
Chromium	7.75E+01	e	2.31E+00	7.36E-01	0.00E+00	
Copper	1.29E+02	c	1.64E+02	3.23E+01	0.00E+00	
Lead	5.26E+02 [a]	M	2.74E+01	9.21E+00	0.00E+00	
Manganese	2.80E+02	d	2.52E+02	2.52E+02	0.00E+00	
Mercury	3.43E-01	a	1.57E-01	3.93E-01	0.00E+00	
Nickel	2.09E+01	d	7.16E-01	5.23E+00	0.00E+00	
Vanadium	2.74E+01	b	2.47E+01	2.47E+01	0.00E+00	
Zinc	2.70E+03	f	2.06E+03	9.93E+02	1.01E-01	b

Notes:

DW - Dry Weight
WW - Wet Weight
a - 95% KM (Percentile Bootstrap) UCL
b - 95% KM (t) UCL
c - 95% KM (BCA) UCL
d - 95% Approximate Gamma UCL
e - 95% KM (Chebyshev) UCL
f - 99% Chebyshev (Mean, SD) UCL
g - 95% Student's-t UCL

M- Maximum concentration. Insufficient number of detected concentrations to calculate an Upper Confidence Limit (UCL)

TABLE 4.27
SUMMARY OF FOOD CHAIN MODEL FOR TREE SWALLOW
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Ingestion (mg/kg-day)*					*NOAEL (mg/kg-day)*	*HQ_{NOAEL} (unitless)*	*LOAEL (mg/kg-day)*	*HQ_{LOAEL} (unitless)*
	Diet	*Sediment*	*Surface Water*	*Total*	*$Total_{AUF}$*				
Semi-Volatile Organic Compounds									
Bis(2-ethylhexyl)phthalate	5.92E+00	1.42E-02	0.00E+00	5.93E+00	5.93E-02	1.10E+00	5.4E-02	---	---
Carbazole	5.98E+00	1.44E-02	0.00E+00	6.00E+00	6.00E-02	n/a	---	n/a	---
Dibenzofuran	3.14E+00	7.50E-03	0.00E+00	3.15E+00	3.15E-02	n/a	---	n/a	---
Polycyclic Aromatic Hydrocarbons (PAHs)									
LMW PAHs	6.89E+00	1.29E-01	0.00E+00	7.02E+00	7.02E-02	1.64E+03	4.3E-05	---	---
HMW PAHs	1.93E+01	7.82E-01	0.00E+00	2.01E+01	2.01E-01	2.00E+00	1.0E-01	---	---
Petroleum Hydrocarbons									
TPH	7.01E+03	1.68E+01	0.00E+00	7.03E+03	7.03E+01	n/a	---	n/a	---
Metals									
Antimony	6.54E+00	1.74E-02	0.00E+00	6.56E+00	6.56E-02	n/a	---	n/a	---
Barium	1.41E+02	3.76E-01	1.00E-03	1.41E+02	1.41E+00	n/a	---	n/a	---
Cadmium	1.23E+00	6.00E-03	0.00E+00	1.24E+00	1.24E-02	1.47E+00	8.4E-03	---	---
Chromium	3.57E+00	2.88E-01	0.00E+00	3.86E+00	3.86E-02	2.66E+00	1.5E-02	---	---
Copper	2.55E+02	4.80E-01	0.00E+00	2.55E+02	2.55E+00	1.99E+01	1.3E-01	---	---
Lead	4.25E+01	1.96E+00	0.00E+00	4.45E+01	4.45E-01	1.09E+01	4.1E-02	---	---
Manganese	3.91E+02	1.04E+00	0.00E+00	3.92E+02	3.92E+00	1.79E+02	2.2E-02	---	---
Mercury	2.44E-01	1.28E-03	0.00E+00	2.45E-01	2.45E-03	6.40E-03	3.8E-01	---	---
Nickel	1.11E+00	7.77E-02	0.00E+00	1.19E+00	1.19E-02	6.71E+00	1.8E-03	---	---
Vanadium	3.82E+01	1.02E-01	0.00E+00	3.83E+01	3.83E-01	1.19E+00	3.2E-01	---	---
Zinc	3.19E+03	1.01E+01	4.00E-04	3.20E+03	3.20E+01	6.61E+01	4.8E-01	---	---

Notes:
n/a - Toxicity Reference Value not available
AUF - Area Use Factor
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level

TABLE 4.28
SUMMARY OF FOOD CHAIN MODEL FOR BELTED KINGFISHER
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Ingestion (mg/kg-day)*					*NOAEL (mg/kg-day)*	*HQ $_{NOAEL}$ (unitless)*	*LOAEL (mg/kg-day)*	*HQ $_{LOAEL}$ (unitless)*
	Diet	*Sediment*	*Surface Water*	*Total*	*Total $_{AUF}$*				
Semi-Volatile Organic Compounds									
Bis(2-ethylhexyl)phthalate	1.91E+00	2.82E-02	0.00E+00	1.94E+00	7.55E-01	1.10E+00	6.9E-01	---	---
Carbazole	1.93E+00	2.85E-02	0.00E+00	1.96E+00	7.64E-01	n/a	---	n/a	---
Dibenzofuran	1.01E+00	1.49E-02	0.00E+00	1.03E+00	4.01E-01	n/a	---	n/a	---
Polycyclic Aromatic Hydrocarbons (PAHs)									
LMW PAHs	1.73E+01	2.55E-01	0.00E+00	1.76E+01	6.85E+00	1.64E+03	4.2E-03	---	---
HMW PAHs	**1.05E+02**	**1.55E+00**	**0.00E+00**	**1.07E+02**	**4.16E+01**	**2.00E+00**	**2.1E+01**	**2.00E+01**	**2.1E+00**
Petroleum Hydrocarbons									
TPH	2.26E+03	3.34E+01	0.00E+00	2.30E+03	8.95E+02	n/a	---	n/a	---
Metals									
Antimony	2.11E+00	3.46E-02	0.00E+00	2.15E+00	8.37E-01	n/a	---	n/a	---
Barium	4.55E+01	7.45E-01	2.69E-03	4.62E+01	1.80E+01	n/a	---	n/a	---
Cadmium	3.30E-02	1.19E-02	0.00E+00	4.52E-02	1.76E-02	1.47E+00	1.2E-02	---	---
Chromium	3.68E-01	5.72E-01	0.00E+00	9.40E-01	3.66E-01	2.66E+00	1.4E-01	---	---
Copper	1.61E+01	9.51E-01	0.00E+00	1.71E+01	6.66E+00	1.99E+01	3.3E-01	---	---
Lead	4.60E+00	3.88E+00	0.00E+00	8.48E+00	3.31E+00	1.09E+01	3.0E-01	4.27E+01	7.7E-02
Manganese	1.26E+02	2.07E+00	0.00E+00	1.28E+02	4.99E+01	1.79E+02	2.8E-01	---	---
Mercury	**1.96E-01**	**2.53E-03**	**0.00E+00**	**1.99E-01**	**7.76E-02**	**6.40E-03**	**1.2E+01**	**6.40E-02**	**1.2E+00**
Nickel	2.61E+00	1.54E-01	0.00E+00	2.77E+00	1.08E+00	6.71E+00	1.6E-01	---	---
Vanadium	**1.23E+01**	**2.02E-01**	**0.00E+00**	**1.25E+01**	**4.89E+00**	**1.19E+00**	**4.1E+00**	**1.69E+00**	**2.9E+00**
Zinc	**4.96E+02**	**1.99E+01**	**1.41E-03**	**5.16E+02**	**2.01E+02**	**6.61E+01**	**3.0E+00**	**1.54E+02**	**1.3E+00**

Notes:

Bold Font identifies constituent retained as a Constituent of Potential Ecological Concern
n/a - Toxicity Reference Value not available
AUF - Area Use Factor
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level

TABLE 4.29
SUMMARY OF FOOD CHAIN MODEL FOR LITTLE BROWN BAT
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Ingestion (mg/kg-day)*					*NOAEL (mg/kg-day)*	*HQ $_{NOAEL}$ (unitless)*	*LOAEL (mg/kg-day)*	*HQ $_{LOAEL}$ (unitless)*
	Diet	*Sediment*	*Surface Water*	*Total*	*Total $_{AUF}$*				
Semi-Volatile Organic Compounds									
Bis(2-ethylhexyl)phthalate	3.51E+00	0.00E+00	0.00E+00	3.51E+00	6.32E-01	1.83E+01	3.5E-02	---	---
Carbazole	3.55E+00	0.00E+00	0.00E+00	3.55E+00	6.39E-01	5.20E+00	1.3E-01	---	---
Dibenzofuran	1.86E+00	0.00E+00	0.00E+00	1.86E+00	3.35E-01	5.20E+00	6.4E-02	---	---
Polycyclic Aromatic Hydrocarbons (PAHs)									
LMW PAHs	4.09E+00	0.00E+00	0.00E+00	4.09E+00	7.36E-01	1.70E+02	4.0E-03	---	---
HMW PAHs	1.15E+01	0.00E+00	0.00E+00	1.15E+01	2.07E+00	1.80E+01	1.2E-01	---	---
Petroleum Hydrocarbons									
TPH	**4.16E+03**	**0.00E+00**	**0.00E+00**	**4.16E+03**	**7.49E+02**	**2.11E+02**	**3.6E+00**	**n/a**	**---**
0									
Antimony	3.88E+00	0.00E+00	0.00E+00	3.88E+00	6.98E-01	1.83E+01	3.8E-02	---	---
Barium	8.36E+01	0.00E+00	2.69E-02	8.36E+01	1.50E+01	5.18E+01	2.9E-01	---	---
Cadmium	7.33E-01	0.00E+00	0.00E+00	7.33E-01	1.32E-01	1.86E+00	7.1E-02	---	---
Chromium	2.12E+00	0.00E+00	0.00E+00	2.12E+00	3.82E-01	2.40E+00	1.6E-01	---	---
Copper	1.51E+02	0.00E+00	0.00E+00	1.51E+02	2.72E+01	1.82E+01	1.5E+00	1.15E+02	2.4E-01
Lead	2.52E+01	0.00E+00	0.00E+00	2.52E+01	4.54E+00	2.68E+01	1.7E-01	---	---
Manganese	2.32E+02	0.00E+00	0.00E+00	2.32E+02	4.18E+01	5.15E+01	8.1E-01	---	---
Mercury	1.45E-01	0.00E+00	0.00E+00	1.45E-01	2.61E-02	1.50E-02	1.7E+00	2.50E-02	1.0E+00
Nickel	6.58E-01	0.00E+00	0.00E+00	6.58E-01	1.18E-01	7.70E+00	1.5E-02	---	---
Vanadium	2.27E+01	0.00E+00	0.00E+00	2.27E+01	4.09E+00	6.61E+00	6.2E-01	---	---
Zinc	1.89E+03	0.00E+00	1.41E-02	1.89E+03	3.41E+02	7.54E+01	4.5E+00	8.95E+02	3.8E-01

Notes:

Bold Font identifies constituent retained as a Constituent of Potential Ecological Concern
n/a - Toxicity Reference Value not available
AUF - Area Use Factor
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level

TABLE 4.30
SUMMARY OF FOOD CHAIN MODEL FOR MINK
ECOLOGICAL RISK ASSESSMENT
FORMER GM WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Ingestion (mg/kg-day)*					*NOAEL (mg/kg-day)*	*HQ_{NOAEL} (unitless)*	*LOAEL (mg/kg/-ay)*	*HQ_{LOAEL} (unitless)*
	Diet	*Sediment*	*Surface Water*	*Total*	*$Total_{AUF}$*				
Semi-Volatile Organic Compounds									
Bis(2-ethylhexyl)phthalate	6.11E-01	5.74E-02	0.00E+00	6.68E-01	8.02E-02	1.83E+01	4.4E-03	---	---
Carbazole	6.17E-01	5.80E-02	0.00E+00	6.76E-01	8.11E-02	5.20E+00	1.6E-02	---	---
Dibenzofuran	3.24E-01	3.05E-02	0.00E+00	3.54E-01	4.25E-02	5.20E+00	8.2E-03	---	---
Polycyclic Aromatic Hydrocarbons (PAHs)									
LMW PAHs	5.54E+00	5.21E-01	0.00E+00	6.06E+00	7.28E-01	1.70E+02	4.3E-03	---	---
HMW PAHs	3.36E+01	3.16E+00	0.00E+00	3.68E+01	4.42E+00	1.80E+01	2.5E-01	---	---
Petroleum Hydrocarbons									
TPH	7.24E+02	6.80E+01	0.00E+00	7.92E+02	9.50E+01	2.11E+02	4.5E-01	---	---
Metals									
Antimony	6.75E-01	7.05E-02	0.00E+00	7.46E-01	8.95E-02	1.83E+01	4.9E-03	---	---
Barium	1.45E+01	1.52E+00	1.52E-02	1.61E+01	1.93E+00	5.18E+01	3.7E-02	---	---
Cadmium	1.06E-02	2.44E-02	0.00E+00	3.50E-02	4.20E-03	1.86E+00	2.3E-03	---	---
Chromium	1.18E-01	1.17E+00	0.00E+00	1.28E+00	1.54E-01	2.40E+00	6.4E-02	---	---
Copper	5.16E+00	1.94E+00	0.00E+00	7.10E+00	8.52E-01	1.82E+01	4.7E-02	---	---
Lead	1.47E+00	7.91E+00	0.00E+00	9.38E+00	1.13E+00	2.68E+01	4.2E-02	---	---
Manganese	4.03E+01	4.21E+00	0.00E+00	4.45E+01	5.34E+00	5.15E+01	1.0E-01	---	---
Mercury	6.28E-02	5.16E-03	0.00E+00	6.80E-02	8.16E-03	1.50E-02	5.4E-01	---	---
Nickel	8.36E-01	3.14E-01	0.00E+00	1.15E+00	1.38E-01	7.70E+00	1.8E-02	---	---
Vanadium	3.95E+00	4.12E-01	0.00E+00	4.36E+00	5.23E-01	6.61E+00	7.9E-02	---	---
Zinc	1.59E+02	4.06E+01	7.98E-03	1.99E+02	2.39E+01	7.54E+01	3.2E-01		

Notes:
n/a - No Observed Adverse Effect Level (NOAEL) of Lowest Observed Adverse Effect Level (LOAEL) available
AUF - Area Use Factor
COPEC - Constituent of Potential Ecological Concern
HQ - Hazard Quotient

TABLE 5.1
REFINEMENT OF CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN - SUPPLEMENTAL SURFACE WATER ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Metals (µg/L)	*2014 DNREC Surface Water Screening Level*	*Stormwater Outfall*	*Outfall 001*	*Little Mill Creek*			*Comparison to DNREC Surface Water Screening Level*				
							Stormwater Outfall	*Outfall 001*	*Little Mill Creek*		
				Maximum	*KM Mean*	*UCL*			*Maximum*	*KM Mean*	*UCL*
Barium	4.00E+00	3.34E+01	8.40E+01	1.23E+02	1.22E+02	1.23E+02	**> SWSL**	**> SWSL**	**> SWSL**	**> SWSL**	**> SWSL**
Calcium	n/a	3.30E+04	2.32E+04	3.61E+04	3.52E+04	3.59E+04	---	---	---	---	---
Iron	3.00E+02	< 150	< 150	6.41E+01	6.26E+01	6.59E+01	ND	ND	< SWSL	< SWSL	< SWSL
Lead	2.50E+00	< 10.0	< 10.0	6.50E+00	6.50E+00	n/c	ND	ND	**> SWSL**	**> SWSL**	---
Magnesium	n/a	9.42E+03	9.20E+03	1.72E+04	1.69E+04	1.71E+04	---	---	---	---	---
Manganese	1.20E+02	1.55E+02	5.70E+01	6.55E+01	5.48E+01	6.18E+01	**> SWSL**	< SWSL	< SWSL	< SWSL	< SWSL
Potassium	n/a	2.79E+03	3.00E+03	3.44E+03	3.37E+03	3.42E+03	---	---	---	---	---
Sodium	n/a	1.32E+04	2.33E+04	3.49E+04	3.43E+04	3.49E+04	---	---	---	---	---
Zinc	1.20E+02	9.30E+00	8.11E+01	1.07E+01	9.53E+00	1.08E+01	< SWSL	< SWSL	< SWSL	< SWSL	< SWSL

Notes:

Bold Font identifies concentration > Water Quality Standard
DNREC - Delaware Natural Resources and Environmental Control
KM - Kaplan-Meier
UCL - Upper Confidence Limit
SWSL - Surface Water Screening Level

TABLE 5.2
SEDIMENT SUMMARY FOR POLYCYCLIC AROMATIC HYDROCARBONS - SEDIMENT QUALITY BENCHMARKS
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Constituent	*Sediment Quality Benchmark*	*Stormwater Ditch*	*Little Mill Creek*		*Comparison to SQBs*			
					Stormwater Ditch	*Little Mill Creek*		
			Minimum	*Maximum*		*Maximum*	*No.*	*No. > ESV*
Polycyclic Aromatic Hydrocarbons								
Total PAHs	1.61E+00	1.20E+02	1.06E+00	2.80E+01	**> SQB**	**> SQB**	5	1
LMW PAHs	7.60E-02	1.19E+01	7.04E-02	5.17E+00	**> SQB**	**> SQB**	5	4
2-Methylnaphthalene	2.02E-02	ND	2.70E-04	2.70E-02	---	**> SQB**	5	1
Acenaphthene	6.70E-03	2.70E-01	1.50E-03	2.70E-01	**> SQB**	**> SQB**	5	2
Acenaphthylene	5.87E-03	ND	7.30E-04	8.30E-04	---	< SQB	5	0
Anthracene	5.72E-02	2.40E-01	4.40E-03	2.10E-01	**> SQB**	**> SQB**	5	1
Fluorene	7.74E-02	2.00E-01	2.10E-03	2.80E-01	**> SQB**	**> SQB**	5	1
Phenanthrene	2.04E-01	1.00E+01	5.40E-02	4.20E+00	**> SQB**	**> SQB**	5	3
HMW PAHs	1.90E-01	1.08E+02	9.62E-01	2.29E+01	**> SQB**	**> SQB**	5	5
Benzo(a)anthracene	1.08E-01	8.10E+00	7.50E-02	1.80E+00	**> SQB**	**> SQB**	5	5
Benzo(a)pyrene	1.50E-01	7.70E+00	7.70E-02	1.70E+00	**> SQB**	**> SQB**	5	4
Benzo(b)fluoranthene	1.04E+01	1.00E+01	1.20E-01	2.20E+00	< SQB	< SQB	5	0
Benzo(g,h,i)perylene	1.70E-01	5.10E+00	6.10E-02	1.20E+00	**> SQB**	**> SQB**	5	1
Benzo(k)fluoranthene	2.40E-01	8.50E+00	7.70E-02	1.70E+00	**> SQB**	**> SQB**	5	1
Chrysene	1.66E-01	1.20E+01	9.70E-02	2.40E+00	**> SQB**	**> SQB**	5	4
Dibenz(a,h)anthracene	3.30E-02	1.70E+00	1.80E-02	3.60E-01	**> SQB**	**> SQB**	5	5
Fluoranthene	4.23E-01	2.90E+01	1.80E-01	5.90E+00	**> SQB**	**> SQB**	5	5
Indeno(1,2,3-cd)pyrene	1.70E-02	5.00E+00	5.70E-02	1.00E+00	**> SQB**	**> SQB**	5	1
Pyrene	1.95E-01	2.10E+01	1.50E-01	4.60E+00	**> SQB**	**> SQB**	5	4

Notes:

Bold Font identifies concentration > Sediment Quality Guideline
DNREC - Delaware Department of Natural Resources and Environmental Control
SQB - Sediment Quality Benchmark
[a] - Exceedence is an estimated concentration in a duplicate sample. Concentration in duplicate (3.4 mg/kg) < SQB.

TABLE 5.3
SEDIMENT SUMMARY-POLYCYCLIC AROMATIC HYDROCARBONS - EQUILIBRIUM PARTITIONING SEDIMENT BENCHMARKS
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Parameter	*Units*	*Stormwater Ditch*	*Little Mill Creek*				
			Upstream				*Downstream*
			SED-100-07	***SED-100-04***	***SED-100-03***	***SED-100-02***	***SED-100-01***
Total Organic Carbon	Fraction	1.22E-02	1.50E-03	< 1.00E-03	< 1.00E-03	< 1.00E-03	< 1.00E-03
Black Carbon	Fraction	< 1.00E-03	< 1.00E-03	< 1.00E-03	< 1.00E-03	< 1.00E-03	< 1.00E-03
ESBTU	Unitless	**1.4E+01**	**2.5E+00**	**3.7E+00**	**1.5E+00**	**4.3E+01**	**1.5E+00**

Notes:

Bold Font identifies sum of Equilibrium Partition Sediment Benchmark Toxicity Units > 1

TABLE 5.4
SEDIMENT SUMMARY FOR METALS - SEDIMENT QUALITY BENCHMARKS
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Constituent	*Sediment Quality Benchmark* [a]	*Stormwater Ditch*	*Little Mill Creek*		*Comparison to SQBs*			
					Stormwater Ditch	*Little Mill Creek*		
			Minimum	*Maximum*		*Maximum*	*No.*	*No. > ESV*
Metals								
Copper	3.16E+01	2.52E+01	2.00E+00	4.71E+01	< SQB	**> SQB**	**5**	1 [b]
Lead	3.58E+01	7.88E+01	2.90E+00	4.80E+00	**> SQB**	< SQB	5	0
Mercury	1.80E-01	4.00E-03	ND	ND	< SQB	---	5	0
Nickel	2.27E+01	5.40E+00	9.90E-01	2.20E+00	< SQB	< SQB	5	0
Zinc	1.21E+02	2.73E+02	8.20E+00	1.93E+01	**> SQB**	< SQB	5	0

Notes:

Bold Font identifies concentration > Sediment Quality Guideline

SQB - Sediment Quality Benchmark

[a] - All SQBs are from the Delaware Department of Natural Resources and Environmental Control (2014)

b - Exceedence is an estimated concentration in a duplicate sample. Concentration in duplicate (3.4 mg/kg) < SQB.

TABLE 5.5
SEDIMENT EXPOSURE POINT CONCENTRATIONS - 2013 v 2014
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Constituent	2013					2014				
	Sediment EPC (mg/kg)	Potential Risk Identified				Sediment EPC (mg/kg)	Re-Evaluate Risk			
		Insectivores		Piscivores			Insectivores		Piscivores	
		Tree Swallow	Little Brown Bat	Belted Kingfish	Mink		Tree Swallow	Little Brown Bat	Belted Kingfish	Mink
Polycyclic Aromatic Hydrocarbons										
HMW PAHs	2.10E+02	No	No	**YES**	No	2.44E+01	No	No	**YES**	No
Petroleum Hydrocarbons										
TPH	4.52E+03	n/a	**YES**	n/a	No	NA	---	---	---	---
Metals										
Antimony	4.69E+00	n/a	No	No	No	NA	---	---	---	---
Barium	1.01E+02	n/a	No	No	No	NA	---	---	---	---
Cadmium	1.62E+00	No	No	No	No	NA	---	---	---	---
Chromium	7.75E+01	No	No	No	No	NA	---	---	---	---
Copper	1.29E+02	No	No	No	No	4.71E+01	No	No	No	No
Lead	5.26E+02	No	No	No	No	4.66E+00	No	No	No	No
Manganese	2.80E+02	No	No	No	No	NA	---	---	---	---
Mercury	3.43E-01	No	No	**YES**	No	ND	No	No	No	No
Nickel	2.09E+01	No	No	No	No	1.98E+00	No	No	No	No
Vanadium	2.74E+01	No	No	**YES**	No	NA	---	---	---	---
Zinc	2.70E+03	No	No	**YES**	No	1.64E+01	No	No	**YES**	No

Notes:
EPC - Exposure Point Concentration
PAH - Polycyclic Aromatic Hydrocarbon
NA - Constituent Not Analyzed
n/a - Not applicable. Toxicity Reference Value not available.
ND - Not Detected
HMW - High Molecular Weight
TPH - Total Petroleum Hydrocarbons

TABLE 5.6
EXPOSURE POINT CONCENTRATIONS FOR LITTLE MILL CREEK - SUPPLEMENT DATA
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	***Sediment*** mg/kg DW		***Fish*** mg/kg WW	***Surface Water*** mg/L	
Polycyclic Aromatic Hydrocarbons					
HMW PAHs	2.44E+01	a	2.44E+01	ND	-
Metals					
Zinc	1.64E+01	b	6.03E+00	1.07E-02	M

Notes:
DW - Dry Weight
WW - Wet Weight
a- 95% Chebyshev (Mean, SD) UCL
b- 95% Student's-t UCL
M - Maximum Concentration
ND - Not Detected. Exposure concentration set to 0.

TABLE 5.7
SUMMARY OF FOOD CHAIN MODEL FOR BELTED KINGFISHER - SUPPLEMENTAL DATA
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

COPEC	*Ingestion (mg/kg-day)*					*NOAEL (mg/kg-day)*	*HQ_{NOAEL}*	*LOAEL (mg/kg-day)*	*HQ_{LOAEL} (unitless)*
	Diet	*Sediment*	*Surface Water*	*Total*	*$Total_{AUF}$*				
Polycyclic Aromatic Hydrocarbons (PAHs)									
HMW PAHs	1.22E+01	1.80E-01	0.00E+00	1.24E+01	4.83E+00	2.00E+00	2.4E+00	2.00E+01	2.4E-01
Metals									
Zinc	3.01E+00	1.21E-01	3.14E+00	3.14E+00	1.22E+00	6.61E+01	1.9E-02	---	---

Notes:
AUF - Area Use Factor
COPEC - Constituent of Potential Ecological Concern
HMW - High Molecular Weight
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level

TABLE 5.8
SUMMARY OF MASS LOADING EVALUATION
ECOLOGICAL RISK ASSESSMENT
FORMER WILMINGTON ASSEMBLY PLANT
WILMINGTON, DELAWARE

Metal	*Groundwater*				*Little Mill Creek*			
	DNREC Groundwater Screening	*Minimum*	*Maximum*	*Exceedence of DNREC Groundwater Screening Value*	*DNREC Surface Water Screening Value*	*Minimum*	*Maximum*	*Exceedence of DNREC Surface Water Screening*
Aluminum	1.60E+03	2.90E+02	5.60E+02	0/5	8.70E+01	ND	ND	---
Arsenic	4.50E-02	2.90E+02	5.60E+02	**1/5**	5.00E+00	ND	ND	---
Barium	2.90E+02	8.52E+01	6.55E+02	**1/5**	4.00E+00	1.19E+02	1.23E+02	**5/5**
Calcium	n/a	2.55E+04	5.62E+04	No GWSL	n/a	3.41E+04	3.61E+04	No SWSL
Cobalt	4.70E-01	8.10E+00	5.15E+01	**3/5**	2.30E+01	ND	ND	---
Iron	1.10E+03	3.61E+03	3.25E+04	**2/5**	3.00E+02	6.10E+01	6.41E+01	0/5
Lead	5.00E+00	ND	ND	---	2.50E+00	6.50E+00	6.50E+00	**1/5**
Magnesium	n/a	1.50E+04	4.60E+04	No GWSL	n/a	1.65E+04	1.72E+04	No SWSL
Manganese	3.20E+01	3.02E+01	6.37E+03	**3/5**	1.20E+02	4.92E+01	6.55E+01	0/5
Nickel	3.00E+01	4.47E+01	4.47E+01	**1/5**	5.20E+01	ND	ND	---
Potassium	n/a	2.40E+03	5.96E+03	No GWSL	n/a	3.29E+03	3.44E+03	No SWSL
Silver	7.10E+00	3.70E+00	4.10E+00	0/5	3.20E+00	ND	ND	---
Sodium	n/a	3.22E+04	1.59E+05	No GWSL	n/a	3.33E+04	3.49E+04	No SWSL
Zinc	4.70E+02	6.90E+00	7.23E+01	0/5	1.20E+02	8.90E+00	1.07E+01	0/5

Notes:

Bold Font identifies exceedence of standard
n/a - Standard not available
DNREC - Delaware Natural Resources and Environmental Control
GWSL - Groundwater Screening Level
SWSL - Surface Water Screening Level