EXECUTIVE SUMMARY

The Sparrows Point Steel Mill Facility is located on approximately 2,300 acres on the north side of the Patapsco River in Baltimore County, Maryland, approximately 9 miles southeast of downtown Baltimore (**Figure ES-1**). The Coke Point Peninsula is part of a site regulated under the Resource Conservation and Recovery Act (RCRA) (USA et al. 1997). The Maryland Port Administration (MPA) has expressed an interest in acquiring the Coke Point Peninsula (Coke Point) on the Sparrows Point property as a potential site for a Dredged Material Containment Facility (DMCF) for placement of dredged material from channels in Baltimore Harbor. Site assessment of the area found that sediment quality is adversely affected adjacent to most of the Coke Point shoreline, and concentrations of polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and metals are elevated above background levels (EA Engineering, Science, and Technology, Inc. [EA] 2009b). MPA requested that a risk assessment of the offshore environment around the Coke Point Peninsula be performed to assess whether the observed impacts to surface sediment and surface water pose risks to natural resources or human health. The risk assessmentwas performed as part of MPA'sdue diligence in evaluating the feasibility of this site for a DMCF.

Figure ES-1. Coke Point Peninsula on the Sparrows Point Facility.

The purpose of this evaluationwas to provide a preliminary assessment of risks for the offshore environments around the Coke Point Peninsula under existing conditions. The risk assessment was conducted to identify site-related risks or remediation needs; to provide a baseline for quantifying potential risk reduction benefits of the proposedDMCF project; and to aid in design of remedial measures.This risk assessment of the area offshore of the Coke Point Peninsula quantifies the risks to both ecological systems and to people who would have access to the offshore area. The risk assessment does not evaluate future hypothetical risks that could occur if site conditions change due to redistribution of chemical concentrations in the sediment profile due to dredging, erosion or mixing.The risk assessment was undertaken to aid the MPA with internal decision making for site planning. The risk assessment for the Coke Point Offshore Area was conducted using methods identified in USEPA guidance (USEPA 1989, 1991, 1992, 1997a, 2002, 2004, 2005b, 2005c).

To support the purposes of the risk assessment, two separate human health risk assessments (HHRAs) are presented. The first HHRA evaluates potential exposure people would experience under the current conditions of the Coke Point offshore area. This HHRA evaluates the Coke Point Offshore Area for an expected low frequency of use as a recreational

area.TheHHRAevaluatedhuman exposures that provide an estimate of a site-specific exposure that takes into account mobility of aquatic organisms in the offshore area.This HHRA is called the Public Health Impact Risk Assessment (HHRA-PH). The second HHRAevaluated human health risks modeled from chemical contributions from the Coke Point Offshore Area.This HHRA was used as a Source Characterization (SC) and Site Planning tool that will aid the MPA with internal decision-making for future site planning. TheHHRA-SC evaluated a more conservative site use assumptionand a theoretical maximum exposure that provides a conservative indication of potential risk contribution from offshore sediment and surface water. The HHRA-SC relied on site-specific bioaccumulation studies rather than field-collected fish and crab to assess the potential contribution of the Coke Point Offshore Area to risk associated with fish and crab consumption.

CONCEPTUAL SITE MODEL (CSM)

A CSM was developed for the Coke Point Peninsula to define potential chemical sources, chemical fate and transport mechanisms, exposure routes, and potential receptors for offshore areas. The CSM identified complete exposure pathways that require quantitative assessment to characterize the potential for risks. The risk assessment focused on pathways that are potentially complete under existing environmental conditions. Potential future risk and exposure to subsurface sediments, due to erosion or dredging,were not considered in the risk assessment. The primary sources of chemicals in the offshore environment are groundwater seeps of VOCs and PAHs and slag/deposited sediments containing metalsand organic compounds. Important transport pathways include movement of chemicals from groundwater and sediment into surface water.

The ecological CSM identified complete exposure pathways for aquatic and benthic organisms and wildlife exposed to surface water and surface sediments. Only sediments within the top foot of the sediment surface were evaluated. The risk assessment considered exposure pathways to subsurface sediment (sediment deeper than 1 foot [ft]) incomplete for ecological receptors under existing conditions. The primary route of exposure for aquatic and benthic organisms is direct exposure, while the primary route for wildlife is ingestion through the food chain and ingested media. Receptor species are selected based on several factors including likelihood of site use, potential for exposure, availability of life history and exposure information, and the availability of toxicity information for the representative receptor species. Great blue heron, osprey, raccoon, and otter were selected as the representative receptor species for birds and mammals that consume prey from aquatic habitats.

For humans, the primary exposure pathways were incidental ingestion and direct contact (dermal contact) with surface water and direct contact with surface sediment by watermen and recreational users, as well as consumption of fish or crabs. Only sediments within the top foot of the sediment surface were evaluated. The risk assessment considered exposure pathways to subsurface sediment (sediment deeper than 1 ft) incomplete for humans under existing conditions. All receptors and complete exposure pathways were evaluated in both HHRAs.

DATA EVALUATED IN THE RISK ASSESSMENT

The risk assessment quantitatively evaluated chemical analytical data from surface sediment, surface water, field-collected crab tissue, field-collected fish tissue, and clam and worm tissue from laboratory bioaccumulation tests. These data were separated into exposure groupings. Data representing the area offshore of Coke Point were grouped as the Coke Point Offshore Area. Data representing background areas were grouped as the Patapsco River Background Area. In total, chemical data were available from 37sediment, 96 surface water, 10 composite fish tissue, and 10 composite crab tissue samplescollected in the Coke Point Offshore Area. Chemical data were also available from 5 composite clam and 5 composite worm tissue samples from laboratory bioaccumulation tests performed using Coke Point sediment. These samples were collected in an area extending approximately 0.5 miles offshore from the Coke Point shoreline, and represent the media most likely to be influenced by potential chemical sources at Coke Point (**Figure ES-2**). For the Patapsco River Background Area, data were available for6 sediment, 9 surface water, 10 composite fish tissue, and 10 composite crab tissue samples. In addition, data were available from 5 composite clam and 5 composite worm tissue samples from laboratory bioaccumulation tests performed using background area sediment. There were additional data available from other portions of the Patapsco River that were not evaluated quantitatively, but are considered qualitatively in the assessment. Data used in the risk assessment originated from the following studies:

- Site Assessment for the Proposed Coke Point Dredged Material Containment Facility at Sparrows Point (EA 2009b);
- Work Plan Addendum, Additional RCRA Facilities Investigation, Sparrows Point Peninsula, Offshore Area, Baltimore, Maryland (EA 2010a);
- Coke Point Dredged Material Containment Facility Pre-Pilot Study Sediment Characterization (EA 2009a);
- FY05 and FY08 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels (EA 2007, 2009c);
- Additional Offshore Delineation: Proposed Coke Point Dredged Material Containment Facility atSparrows Point (EA 2010c);
- Feasibility Studies of Sparrows Point as a Containment Site for Placement of Harbor Dredged Material: Environmental Conditions(EA 2004);
- Reconnaissance Study of Sparrows Point as a Containment Site for Placement of Harbor Dredged Material: Environmental Conditions (EA 2003); and
- Laboratory Bioaccumulation and Field-Collected Tissue Study (EA 2011).

Figure ES-2. Sampling locations around the Coke Point Peninsula

For sediment, only surface grab samples of 1 ft in depth or less were utilized in the assessment. Subsurface sediment samples collected from depth intervals of 0 to 2 ft or deeper were not used in the assessment because these were considered more representative of subsurface sediment, and exposure pathways for subsurface sediment were considered incomplete. Data were validated following U.S. Environmental Protection Agency (USEPA) protocol (USEPA 1992) and data quality evaluated per USEPA guidance (USEPA 1989). Chemical analytical data were used to statistically derive exposure point concentrations (EPCs) for surface sediment, surface water, and aquatic organism (e.g., fish, crab, clams, and worms) tissue exposed to these media. EPCs for aquatic organisms were derived from surface sediment and surface water concentrations using literature-based uptake factors and field-collected tissue concentrations. EPCs were used in the quantitative evaluation of risks. EPCs were selected to represent a screening exposure scenario and a reasonable maximum exposure scenario.

Spatial distributions of offshore chemical concentrations were evaluated in comparison to background concentrations to interpret relative risk. Spatial analysis indicates thatconcentrations of multiple metals(e.g., arsenic, copper, lead, and zinc), polychlorinated biphenyls (PCBs), and PAHs are elevated up to five times or more above background in surface sediment in two general areas: the area to the south and west of the mouth of the Turning Basin; and the area west of the Benzol Processing Area (**Figure ES-2**). Concentrations of metals, PCBs, and PAHsare elevated one to two times above background within a roughly 1,000-ft buffer along the Coke Point shoreline. In surface water, chemical concentrations of high molecular weight (HMW) PAHs, toluene, and ethylbenzene were detected at concentrations in surface water elevated above those in the Patapsco River Background Area. Concentrations of toluene and ethylbenzene in surface water are highest at locations immediately offshore of Coke Point. Concentrations of HMW

PAHs are highest in surface water at locations immediately offshore of Coke Point at locations BH-W-06 and -10B and along the shoreline.

ECOLOGICAL RISK ASSESSMENT (ERA)

An ERA is a process in which exposure and toxicity data are combined to develop an estimate of the potential for adverse impacts on ecological receptors including fish, invertebrates, and wildlife from chemicals in the environment. The ERA for the Coke Point Offshore Area was conducted in accordance with applicable USEPA guidance (USEPA 1997a). The ERA provided separate assessments of risks for two assessment endpoints:

- Viability of aquatic and benthic organism communities, and
- Viability of wildlife communities including piscivorous (fish-eating) birds and mammals.

Per USEPA guidance (USEPA 1997a), the ERA began with a precautionary evaluation of the potential for risks based on screening exposure scenarios. However, it also incorporated more refined evaluation methods, such as reasonable maximum exposure scenarios, consideration of background risks, and discussion of site-specific habitat, wildlife mobility, and bioavailability considerations. The ERA applied a weight-of-evidence approach for each assessment endpoint evaluated. In a weight-of-evidence approach, multiple lines of evidence are evaluated, and their individual significance, or weight, is considered to derive a conclusion. Each line of evidence is a measurement endpoint. Exposure and toxicity assessments were conducted to compile the data necessary to evaluate each of these endpoints.

Assessment of Risks for Aquatic and Benthic Organisms

For aquatic and benthic organisms, the ERA evaluatedseveral measurement endpoints as part of a weight-of-evidence approach. These include comparisons of EPCs in surface sediment and surface water to toxicological benchmarks; comparison of offshore concentrations of chemicals to background concentrations; and consideration of bioavailability based on sediment chemical testing and laboratory bioaccumulation test results. Subsurface sediment was not evaluated in the ERA. Exposure pathways for subsurface sediment are considered incomplete in this evaluation of current conditions.Potential future risk as a result of erosion or dredging was not considered in the ERA.

Results of the ecological risk assessment for aquatic and benthic organisms are provided in **Table ES.1**. For surface sediments, the results of the risk assessment indicated that concentrations of chemicals in surface sediment at Coke Point exceed both benchmarks protective of aquatic and benthic organisms as well as background concentrations. Comparison based on surface sediment concentrations identified metals, PAHs, and PCBs as exceeding threshold and probable effects benchmarks and background risks. These comparisons provide a strong indication that chemical concentrations in sediments in the Coke Point Offshore Area potentially cause risk to aquatic and benthic organisms that cannot be readily attributed to background sources in the Patapsco River. Arsenic, chromium, copper, lead, mercury, zinc, dioxins, HMW PAHs, low molecular weight (LMW) PAHs, and PCBs were identified as the chemicals most likely to cause risks. Site-specific bioavailability information indicated that risk from other metals may be somewhat overestimated because these metals may bind to sediment in

forms that are less toxic. This information was used to focus the list of metals identified as posing risks.

For surface water, the ecological risk assessment also indicatedthat, whilemaximum surface water concentrations of a few chemicals at the Coke Point Offshore Area exceed benchmarksand background risks, overall risks are relatively low and are generally comparable to background with the exception of risks for PAHs. Comparisons based on surface water concentrations identified several metals, ethylbenzene, toluene, and PAHs as exceeding benchmarks. Reasonable maximum case scenario concentrations were generally comparable between the Coke Point Offshore Area and the Patapsco River Background Area or do not exceed benchmarks, with the exception of PAHs. Therefore, the assessment concludes that PAHs are the only chemicals in surface water at Coke Point that are predicted to pose risks to aquatic and benthic organisms above those risks already posed by background sources.

The finding of the ERA is that aquatic and benthic organisms are potentially at risk from metals, PAHs, and PCBs in surface sediment at the Coke Point Offshore Area. Arsenic, chromium, copper, lead, mercury, zinc, PAHs, and PCBs in sediment were considered the chemicals most likely to drive risks, although high concentrations of PAHs in surface water in near-shore areas also contribute to risks. Chemical concentrations in surface sediment throughout the offshore area are elevated and contribute to risks to aquatic and benthic organisms.

Assessment of Risks for Wildlife

The CSM for Coke Point identified the viability of wildlife, including birds and mammals, as an assessment endpoint for protection. Great blue heron, osprey, raccoon, and river otter were selected as specific representative receptor species. Because wildlife may be exposed to multiple media via the food web, measurement endpoints for wildlife were based on food web modeling to estimate ingested doses. Measurement endpoints evaluated for wildlife include comparisons of doses fromprey, surface sediment and surface water to toxicological benchmarks; comparison of offshore doses of chemicals to background doses; and consideration of bioavailability based on sediment chemical testing and laboratory bioaccumulation test results.

The ERA evaluated exposure scenarios based on ingestion of three types of prey (benthos, fish, and crabs). Tissue concentrations representative of benthos were developed using site-specific bioaccumulation factors (BAFs), while tissue concentrations representative of fish and crab were calculated from analyses of specimens field-collected from the areas to be assessed. There are advantages to each of these two methods for calculating tissue concentrations. Laboratory bioaccumulation tests are a highly reliable means of linking exposure to chemical concentrations in sediment to concentrations accumulated in tissue because uptake is not influenced by the mobility of organisms or variations in field conditions. Thus, scenarios based on BAFs from laboratory bioaccumulation tests provide the most reliable measure of potential contributions from chemical sources in Coke Point sediments to regional exposures and risks. Alternatively, concentrations derived from field-collected tissue are more likely to incorporate the influence of field variations and organism movement beyond the site and provide a more reliable measure for predicting the actual exposures experienced by people and wildlife consuming these organisms from the site. Different scenarios were evaluated so that the advantages of each data source could be used to interpret risk assessment results.

Table ES.1. Summary of Ecological Risk Results for Aquatic and Benthic Organisms

Receptor of Concern	Screening Exposure Scenario		Reasonable Maximum Exposure Scenario		Qualitative Factors
	Chemicals Exceeding Benchmarks[A]	Chemicals Exceeding Both Benchmarks &Background[B]	Chemicals Exceeding Benchmarks[A]	Chemicals Exceeding Both Benchmarks &Background[B]	
AQUATIC AND BENTHIC ORGANISMS					
Sediment exposures	**Aluminum (1.39)** **Antimony (1.65)** **Arsenic (9.94)** **Cadmium (11.4)** **Chromium (9.64)** **Cobalt (5.30)** **Copper (31.8)** **Iron (6.00)** **Lead (42.3)** **Manganese (3.46)** **Mercury (13.1)** **Nickel (3.55)** Selenium (12.3) **Silver (3.84)** Tin (58.8) Vanadium (2.98) **Zinc (22.0)** **HMW PAH (440)** **LMW PAH (23,300)** PCBs (8.17) **TCDD TEQ (51.4)**	Aluminum [1.23] Antimony [1.94] Arsenic [4.44] Cadmium [4.81] Chromium [2.24] Cobalt [2.68] Copper [5.67] Iron [2.74] Lead [10.58] Manganese [1.26] Mercury [4.36] Nickel [1.51] Selenium [5.13] Silver [2.98] Tin [5.19] Vanadium [1.80] Zinc [6.36] HMW PAH [33.3] LMW PAH [468] PCBs [8.38] TCDD TEQ [3.79]	Aluminum (1.23) Arsenic (3.82) Cadmium (4.39) **Chromium (4.52)** Cobalt (2.94) **Copper (9.20)** **Iron (3.82)** **Lead (11.6)** **Manganese (2.76)** Mercury (5.28) Nickel (2.68) Selenium (4.61) Silver (1.90) Tin (25.1) Vanadium (2.04) **Zinc (8.06)** **HMW PAH (132)** **LMW PAH (7,050)** PCBs (5.52) TCDD TEQ (20.2)	Aluminum [1.09] Arsenic [2.57] Cadmium [2.58] Chromium [1.16] Cobalt [1.48] Copper [1.88] Iron [2.79] Lead [3.32] Manganese [1.01] Mercury [3.02] Nickel [1.74] Selenium [1.92] Silver [1.61] Tin [2.21] Vanadium [1.23] Zinc [2.66] HMW PAH [10.0] LMW PAH [141.3] PCBs [4.98] TCDD TEQ [2.10]	- -Bioaccumulation tests indicate that metals, PAHs, and PCBs are at least partially bioavailable based on observed uptake. - Analyses of sediment indicate that sulfides may bind some metals and decrease their toxicity compared to that assumed in toxicity benchmarks.
Surface water exposures	Aluminum (1.04) Manganese (1.65) Zinc (1.04) HMW PAH (5,420) LMW PAH (3.85) Ethylbenzene (5.48) Toluene (1.53)	Manganese [2.32] Zinc [9.40] HMW PAH [58.9] LMW PAH [4.71]	HMW PAH (438) LMW PAH (1.08)	HMW PAH (ND=DL) [4.76]	

Bolded chemicals in the list of exceedences indicate that concentrations exceed probable effects benchmarks in addition to threshold effects benchmarks; this provides a more definite indication of risks.

[A] Value in parentheses is the ratio of the concentration or dose to no-effects benchmarks; values greater than 1 indicate a potential for risk. Only chemicals with a value greater than 1 are presented in the table.

[B] Value in brackets is the ratio of the concentration (dose) of chemicals in the offshore area exceeding benchmarks to the concentration (dose) in background. Only chemicals with a value greater than 1 are presented in the table.

The ERA evaluated five lines of evidence, called measurement endpoints, to characterize risks to wildlife. These included:

- Comparison of modeled food web doses to no-effect and low-effectbenchmarks for birds and mammals using a precautionary screening level scenario assuming exposures to maximum detected concentrations.

- Comparison of modeled food web doses to no-effect and low-effectbenchmarks for birds and mammals using a reasonable maximum scenario based on statistically derived mean concentrations.

- Comparison of risk estimates for the Coke Point Offshore Area to risks for the Patapsco River Background Area.

- Comparison of reasonable maximum scenariofood web doses to no-effect and low-effectbenchmarks after they have been modified with Area Use Factors (AUFs) that account for wildlife movement.

- Qualitative evaluation of chemical bioavailability in sediment.

The first measurement endpoint – evaluation of risks using a precautionary screening scenario – identified numerous chemicals in the Coke Point Offshore Area whose doses exceeded both no-effects and low-effects benchmarks. These included metals, dioxins, PAHs, and PCBs (**Tables ES.2** and **ES.3**). However, the screening scenario is not representative of most exposures experienced by wildlife, and represents a conservative worst case scenario. The reasonable maximum scenario is more reflective of actual exposures within the project site boundary, and the reasonable maximum exposure scenario modified to account for wildlife mobility and area use is likely to be most representative of actual exposures. When a reasonable maximum exposure scenario is considered, several metals, dioxins, PCBs, and PAHs produce doses that exceed no-effects benchmarks, but only the doses of several metals and PCBs exceed low-effects benchmarks (**Tables ES.2** and **ES.3**). Exceedence of a low-effect benchmark is a more definite indicator of risk, while exceedence of a no-effect benchmark indicates that a risk is possible, but not definite. When area use and wildlife mobility were factored into exposures, doses of PCBs and a few metals exceeded low-effects level benchmarks.

Comparison of risks between the Coke Point Offshore Area and Patapsco River Background Area indicates that risks to wildlife from PAHs, PCBs, dioxins, and some metals are higher near Coke Point (**Tables ES.2** and **ES.3**). Risks from many of the metals that produced doses above benchmarks for reasonable maximum scenarios at Coke Point are similar to those in background, indicating that these risks are not limited to Coke Point sources. Alternative statistical evaluation of background data were found to decrease background risks by an order of magnitude as documented in **Appendix G**, thus increasing the difference between ecological risks in the Coke Point Offshore Area and risks in the Patapsco River Background Area.

Table ES.2.Summary of Ecological Risk Results for Avian Wildlife

Receptor of Concern	Screening Exposure Scenario		Reasonable Maximum Exposure Scenario		
	Chemicals Exceeding No-Effects Level Benchmark[A]	**Chemicals Exceeding No-Effects Levels&Background[B]**	**Chemicals Exceeding No-Effects Level Benchmark[A]**	**Chemicals Exceeding No-Effects Levels&Background[B]**	**Chemicals Exceeding Low-Effects Level Benchmark[A]**
AVIAN WILDLIFE: GREAT BLUE HERON					
Modeled exposures using prey uptake from benthic organisms	Lead (1.22) Vanadium (5.26) HMW PAHs (2.68) LMW PAHs (11.4) PCBs (3.38)	Lead [10.6] Vanadium [1.80] HMW PAHs [44.1] LMW PAHs [165] PCBs [8.38]	***Vanadium (3.59)*** LMW PAHs (3.25) PCBs (1.83)	Vanadium [1.23] LMW PAHs [48.1] PCBs [4.98]	No LOAEL chemical exceedances
Modeled exposures using field-collected crabs	LMW PAH (2.00)	LMW PAHs [334]	No NOAEL chemical exceedances	No chemical exceedances	No LOAEL chemical exceedances
Modeled exposures using field-collected fish	Copper (1.65) Selenium (1.16) LMW PAH (1.99)	Copper [1.41] Selenium [1.32] LMW PAHs [314]	***Copper (1.39)*** Selenium (1.07)	Copper [1.34] Selenium [1.27]	No LOAEL chemical exceedances
AVIAN WILDLIFE: OSPREY					
Modeled exposures using prey uptake from benthic organisms	Lead (1.42) Vanadium (6.13) HMW PAHs (3.12) LMW PAHs (13.3) PCBs (3.94)	Lead [10.6] Vanadium [1.80] HMW PAHs [44.1] LMW PAHs [165] PCBs [8.38]	Vanadium (4.19) LMW PAHs (3.79) PCBs (2.14)	Vanadium [1.23] LMW PAHs [48.1] PCBs [4.98]	No LOAEL chemical exceedances
Modeled exposures using field-collected crabs	LMW PAH (2.33)	LMW PAHs [334]	No NOAEL chemical exceedances	No chemical exceedances	No LOAEL chemical exceedances
Modeled exposures field-collected fish	Copper (1.92) Selenium (1.35) LMW PAH (2.33)	Copper [1.41] Selenium [1.32] LMW PAHs [314]	Copper (1.63) Selenium (1.25)	Copper [1.34] Selenium [1.27]	No LOAEL chemical exceedances

Bold and italic- indicates a chemical exceedence after home range area use factor is applied.

[A] Value in parentheses is the ratio of the concentration or dose to no-effects benchmarks; values greater than 1 indicate a potential for risk. Only chemicals with a value greater than 1 are presented in the table.

[B] Value in brackets is the ratio of the concentration (dose) of chemicals in the offshore area exceeding benchmarks to the concentration (dose) in background. Only chemicals with a value greater than 1 are presented in the table.

Table ES.3. Summary of Ecological Risk Results for Mammalian Wildlife

Receptor of Concern	Screening Exposure Scenario		Reasonable Maximum Exposure Scenario		
	Chemicals Exceeding No-Effects Level Benchmark[A]	**Chemicals Exceeding No-Effects Levels&Background[B]**	**Chemicals Exceeding No-Effects Level Benchmark[A]**	**Chemicals Exceeding No-Effects Levels&Background[B]**	**Chemicals Exceeding Low-Effects Level Benchmark[A]**
MAMMALIAN WILDLIFE: RACCOON					
Modeled exposures using prey uptake from benthic organisms	TCDD TEQ (3.69) Aluminum (79.6) Antimony (1.39) Arsenic (2.78) Chromium (1.38) Lead (1.60) Selenium (3.37) Thallium (1.70) Vanadium (1.64) HMW PAHs (55.4) LMW PAHs (2.21) PCBs (255)	TCDD TEQ [2.48] Aluminum [1.23] Antimony [1.94] Arsenic [4.44] Chromium [2.24] Lead [10.6] Selenium [5.07] Thallium [3.49] Vanadium [1.80] HMW PAHs [44.1] LMW PAHs [167] PCBs [8.38]	***TCDD TEQ (1.46)*** ***Aluminum (70.3)*** ***Arsenic (1.07)*** Selenium (1.27) ***Vanadium (1.12)*** ***HMW PAHs (13.5)*** ***PCBs (138)***	TCDD TEQ [1.04] Aluminum [1.09] Arsenic [2.58] Vanadium [1.23] HMW PAHs [11.0] PCBs [4.98]	***Aluminum (7.03)*** ***PCBs (14.0)***
Modeled exposures using field-collected crabs	Aluminum (46.8) Arsenic (1.05) Copper (1.88) Selenium (5.42) HMW PAH (2.11) PCBs (16.0)	Aluminum [1.25] Arsenic [1.20] HMW PAHs [40.5]	Aluminum (41.3) Copper (1.41) Selenium (4.88) PCBs (15.1)	Aluminum [1.11]	***Aluminum (4.13)*** ***Selenium (2.12)*** ***PCBs (1.53)***
Modeled exposures field-collected fish	Aluminum (55.6) Antimony (1.15) Copper (4.50) Lead (1.04) Selenium (8.87) Thallium (1.32) HMW PAH (2.02) PCBs (42.3)	Antimony [1.28] Copper [1.41] Lead [7.07] Selenium [1.32] Thallium [10.2] HMW PAHs [42.4] PCBs [1.18]	***Aluminum (49.4)*** ***Copper (3.81)*** ***Selenium (8.22)*** Thallium (1.13) ***PCBs (40.9)***	Copper [1.34] Selenium [1.27] Thallium [8.69] PCBs [1.14]	***Copper (1.38)*** ***Selenium (3.56)*** ***PCBs (4.14)***
MAMMALIAN WILDLIFE: RIVER OTTER					
Modeled exposures using prey uptake from benthos	TCDD TEQ (3.47) Aluminum (74.9) Antimony (1.31) Arsenic (2.62) Chromium (1.30) Lead (1.50) Selenium (3.18) Thallium (1.60) Vanadium (1.55) HMW PAHs (52.1) LMW PAHs (2.08) PCBs (240)	TCDD TEQ [2.48] Aluminum [1.23] Antimony [1.94] Arsenic [4.44] Chromium [2.24] Lead [10.6] Selenium [5.07] Thallium [3.49] Vanadium [1.80] HMW PAHs [44.1] LMW PAHs [167] PCBs [8.38]	***TCDD TEQ (1.37)*** ***Aluminum (66.2)*** Arsenic (1.01) Selenium (1.19) Vanadium (1.06) ***HMW PAHs (12.8)*** ***PCBs (130)***	TCDD TEQ [1.04] Aluminum [1.09] Arsenic [2.58] Selenium [1.91] Vanadium [1.23] HMW PAHs [11.0] PCBs [4.98]	***Aluminum (6.62)*** ***PCBs (13.2)***
Modeled exposures using prey uptake from crabs	Aluminum (44.0) Copper (1.77) Selenium (5.10) HMW PAH (1.99) PCBs (15.1)	Aluminum [4.44] Copper [3.28] Selenium [3.53] HMW PAHs [144] PCBs [2.65]	Aluminum (38.9) Copper (1.32) Selenium (4.60) PCBs (14.3)	Aluminum [1.11]	***Aluminum (3.89)*** ***Selenium (1.99)*** ***PCBs (1.44)***
Modeled exposures using prey uptake from fish	Aluminum (52.3) Antimony (1.08) Copper (4.24) Selenium (8.35) Thallium (1.25) HMW PAH (1.90) PCBs (39.8)	Aluminum [3.02] Antimony [4.56] Copper [5.03]Selenium [4.68] Thallium [36.0] HMW PAHs [150] PCBs [4.19]	***Aluminum (46.5)*** ***Copper (3.58)*** ***Selenium (7.74)*** Thallium (1.06) ***PCBs (38.5)***	Copper [1.34] Selenium [1.27] Thallium [8.68] PCBs [1.14]	***Copper (1.30)*** ***Selenium (3.35)*** ***PCBs (3.89)***

Bold and italic- indicates a chemical exceedence after area use factor is applied.

[A] Value in parentheses is the ratio of the concentration or dose to no-effects benchmarks; values greater than 1 indicate a potential for risk. Only chemicals with a value greater than 1 are presented in the table.

[B] Value in brackets is the ratio of the concentration (dose) of chemicals in the offshore area exceeding benchmarks to the concentration (dose) in background. Only chemicals with a value greater than 1 are presented in the table.

Taken together, the lines of evidence indicate that the PCBs and PAHs are the chemicals driving risks for the Coke Point Offshore Area. Metals, dioxins, and VOCs are not considered risk drivers because they demonstrate reasonable maximum scenario risks that are either comparable to background risks or below low-effects level benchmarks. PCBs are a site-related COC because both no-effects level benchmark and low-effects level benchmark reasonable maximum scenario risks are above acceptable levels and because risks for exposures to some prey types are greater than those in background. It must be noted however, that exposure pathways based on ingestion of crab produced higher risks for background. HMW PAHs and LMW PAHs were considered to be site-related risk drivers, but with a limited potential for impacts under maximum exposure scenarios only. Impact was considered limited because reasonable maximum scenario doses of PAHs exceed no-effects level benchmarks but not low-effects level benchmarks. HMW PAHs and LMW PAHs were maintained as risk drivers because both tissue concentrations and doses are higher in the Coke Point Offshore Area than in the background area and because screening level scenarios produce low-effects level benchmark exceedences.

The finding of the ERA is that wildlife which consume aquatic and benthic organisms are potentially at risk from chemicals insurface sediment at the Coke Point Offshore Area. The chemicals driving risks are PCBs, HMW PAHs, and LMW PAHs. HMW PAHs and LMW PAHs are also considered to be site-related risk drivers, but with a limited potential for impacts under maximum exposure scenarios only. Metals, dioxins, and VOCs are not considered risk drivers because they demonstrate reasonable maximum scenario exposures that are either comparable to background or below low-effect level benchmarks.

Summary of Ecological Risks

The conclusion of the ecological risk assessment is that specific chemicals in surface sediments of the Coke Point Offshore Areamay pose risks to ecological receptors and that those risks are greater than the background risks posed in the Patapsco River Background Area. A primary contributor to this risk is the accumulation of chemicals from sediment into benthic organisms. Concentrations of PAHs and PCBs in surface sediment are elevated in the offshore area. Therefore, chemicals in surface sediment and benthic tissues are considered the primary risk drivers.PCBs are identified as the chemicals most likely to cause risks. LMW PAHs and HMW PAHs are also identified as risk drivers, but with a limited potential for impacts associated primarily with the areas of highest exposure/highest concentrations.

HUMAN HEALTH RISK ASSESSMENT (HHRA)

The offshore area around the Coke Point Peninsula was evaluated in two separate HHRAs. The Risk Assessment for Public Health Impacts (HHRA-PH) characterized human exposures given the current conditions of the offshore area. Currently, the offshore area around Coke Point is not expected to be frequently used for swimming or other water activities, and it is expected that people would visit other, more easily accessible areas available in close proximity to Coke Point Offshore Area (e.g., state parks, private docks, etc.). However, there are no controls against these activities, so there is a potential for these activities to occur. This exposure scenario took into account exposures modeled in previous RCRA-related investigations and consultation with site-specific USEPA and MDE inputs (ISG 2005 and USEPA/MDE 2011a). The HHRA-PH

provides an estimate of a site-specific exposure that takes into account the mobility of aquatic organisms in the offshore area by evaluating sample results from studies of field-collected crab and fish tissue. The results of the HHRA-PH provide a long-term risk characterization of the people fishing/crabbing in the area under current conditions.

The Risk Assessment for Source Characterization and Site Planning (HHRA-SC) provides an evaluation of human health risks that will aid the MPA with internal decision making for future site planningand determining potential remediation requirements.The HHRA-SC provides a theoretical maximum exposure that provides conservative indication of potential contribution to risk from offshore sediment and surface water.The HHRA-SC focused on exposures limited to the Coke Point Offshore Area and analyzes crab and fish consumption based on site-specific data. The HHRA-SC relied on site-specific bioaccumulation studies to assess the contribution of the Coke Point Offshore Area to risk associated with fish and crab consumption.Potential receptor exposure to surface water, sediment, modeled fish tissue, and modeled crab tissue were evaluated. This HHRA evaluated potential risk contributions specifically from the offshore area evaluated without regard to the actual human use of the area.

Potential cumulative risks for both the HHRA-PH and the HHRA-SC were calculated for the adult recreational user, adolescent recreational user, child recreational user, and watermen for exposure to surface water, sediment, and fish and crab concentrations. Both the Coke Point Offshore Area and the Patapsco River Background Areawere evaluated for all receptors and exposures.

For both of the HHRAs, quantitative risk estimates were compared to MDE and USEPA risk thresholds. These comparisons aid in making risk management decisions for the site. For excess carcinogenic risk results, the USEPA defines the range of 10^{-4} to 10^{-6} as a target risk range. Cumulative carcinogenic risks that are below the lower end of the risk range (10^{-6}) typically do not require further action. Cumulative carcinogenic risks within the target range may require risk management decisions; however, cumulative or individual exposure pathway carcinogenic risks above the upper end of the target range (10^{-4}) typically require additional actions or consideration. Additionally, MDE considers cumulative carcinogenic risks greater than 10^{-5} as levels that may require remedial actions.

For non-carcinogenic hazards, MDE and USEPA have identified a target valueof 1 (USEPA 1989). Per input from USEPA, non-carcinogenic values below 1.5 were considered acceptable because they round to 1 (USEPA 2011b). Cumulative non-carcinogenic hazards above this threshold identify potential concerns with chemicals that may affect specific organs or systems (e.g., reproductive system, developmental, etc.) within the body. If cumulative non-carcinogenic hazards exceed the threshold, target organs or systems associated with Chemicals of Potential Concern (COPCs) are identified. If the COPCs affect the same target organ, there may be concern that potential adverse health effects will be observed. In general, the greater the value of the non-carcinogenic hazards above the threshold, the greater the level of concern. However, results above the threshold do not represent a statistical probability that an adverse health effect will occur.

Summary of HHRA-PH Risks

The HHRA-PH evaluated cumulative risks for exposure to surface water, sediment, and field-collected fish and crab tissue. The HHRA-PH evaluatedthe potential exposure people would experience under the current conditions of the Coke Point Offshore Area. The HHRA-PH evaluated the Coke Point Offshore Area for an expected low frequency of use as a recreational area.Results for the HHRA-PH reveal cumulative carcinogenic risk results that are above the USEPA carcinogenic target levels for all receptors, except the child recreational user. Non-carcinogenic hazards exceeded USEPA target levels for only the child recreational user.Dermal exposure to surface water was the primary contributor to cumulative carcinogenic risk results. Consumption of crab and fish also contributed to excess carcinogenic risk results. The carcinogenic results for the consumption of crab and fish were comparable to the results for the Patapsco River Background Area. However, the chemicals that contributed significantly to risk results differed according to the area evaluated. PAHs were the primary contributor to fish tissue in the Coke Point Offshore Area. Total PCBs were the primary contributors to consumption of crab tissue risks for both the Coke Point Offshore Area and the Patapsco River Background Area. It is noted that MDE hasa fish advisory in place for the Patapsco River (including the offshore area of the Coke Point Peninsula) to account for PCBs (MDE 2007). The analysis of uncertainties for the HHRA-PH indicated that the risk due to dermal exposure to surface water was over-estimated due to assumptions inherent in the dermal exposure model (USEPA 2004). Non-carcinogenic hazards are primarily from the consumption of crab tissue. For carcinogenic risks, PAHs, specifically benzo(a)pyrene and dibenz(a,h)anthracene, in surface water were the primary contributors to overall cumulative risks. Dioxins were the primary contributor to non-carcinogenic hazards. It is noted that the risk results for dioxin were based upon exposure modeled using a BAF from the scientific literature and were not a result of field-collected tissue samples. Tables ES.4 and ES.5 summarize the results of the HHRA-PH.

Table ES.4. Risk Assessment for Public Health Impacts
Summary of Carcinogenic Risk Results

Receptor of Concern	Exposure to Sediment	Exposure to Surface Water	Ingestion of Crabs	Ingestion of Fish	Cumulative Carcinogenic Risk
Coke Point Offshore Area					
Adult Recreational User	$3.4x10^{-7}$	$1.1x10^{-4}$	$8.8x10^{-5}$	$2.9x10^{-5}$	$2.3x10^{-4}$
Adolescent Recreational User	$1.4x10^{-6}$	$1.3x10^{-4}$	$3.7x10^{-5}$	$1.1x10^{-5}$	$1.8x10^{-4}$
Child Recreational User	$7.3x10^{-7}$	$4.9x10^{-5}$	$1.4x10^{-5}$	$4.2x10^{-6}$	$6.8x10^{-5}$
Watermen	$9.6x10^{-6}$	$2.4x10^{-4}$	$1.1x10^{-4}$	$3.6x10^{-5}$	$4.0x10^{-4}$
Patapsco River Background Area					
Adult Recreational User	$2.9x10^{-8}$	$7.1x10^{-6}$	$5.0x10^{-5}$	$4.1x10^{-5}$	$9.8x10^{-5}$
Adolescent Recreational User	$9.9x10^{-8}$	$8.2x10^{-6}$	$1.9x10^{-5}$	$1.6x10^{-5}$	$4.3x10^{-5}$
Child Recreational User	$5.0x10^{-8}$	$3.0x10^{-6}$	$7.2x10^{-6}$	$5.9x10^{-6}$	$1.6x10^{-5}$
Watermen	$8.0x10^{-7}$	$1.5x10^{-5}$	$6.1x10^{-5}$	$5.0x10^{-5}$	$1.3x10^{-4}$

Table ES.5. Risk Assessment for Public Health Impacts
Summary of Non-Carcinogenic Hazard Indices

Receptor of Concern	Exposure to Sediment	Exposure to Surface Water	Ingestion of Crabs	Ingestion of Fish	Cumulative Non-Carcinogenic Risk
Coke Point Offshore Area					
Adult Recreational User	0.0008	0.0005	1.1	0.1	1.2
Adolescent Recreational User	0.004	0.0006	1.3	0.2	1.4
Child Recreational User	0.006	0.0007	1.6	0.2	1.8
Watermen	0.02	0.0009	1.4	0.2	1.5
Patapsco River Background Area					
Adult Recreational User	0.00009	0.0002	0.4	0.2	0.6
Adolescent Recreational User	0.0004	0.0002	0.4	0.2	0.6
Child Recreational User	0.0007	0.0002	0.5	0.3	0.8
Watermen	0.003	0.0003	0.5	0.2	0.7

Summary of HHRA-SC Risks

The HHRA-SC evaluated cumulative risks for exposure to surface water, sediment, and BAF modeled fish and crab tissue. Fish and crab tissue were modeled from laboratory bioaccumulation tests of Coke Point sediment. These laboratory bioaccumulation tests provided a link between chemical concentrations in sediment and chemical concentrations taken up into tissue. The uptake into tissue is not influenced by the mobility of organisms or variations in field conditions. The HHRA-SC evaluated a theoretical maximum exposure that provides a conservative indication of potential contribution to risk from offshore sediment and surface water. Results for the HHRA-SC revealedcumulative carcinogenic risk results that were above the USEPA carcinogenic target levels for all receptors. Non-carcinogenic hazards also exceeded USEPA target levels for all receptors evaluated. For all receptors, the consumption of modeled crab and fish tissue and dermal exposure to surface water were the primary pathway contributing to carcinogenic and non-carcinogenic risks. As in the HHRA-PH, it is noted that the predicted risks associated with dermal surface water contact were likely over-estimated. For carcinogenic risks, PAHs, specifically benzo(a)pyrene and dibenz(a,h)anthracene, in modeled fish and crab tissue, surface water, and total PCBs in modeled crab tissue were significant contributors. Dioxin and naphthalene were the primary contributor to non-carcinogenic hazards. Table ES.6 and ES.7 summarize the results of the HHRA-SC.

Table ES.6. Risk Assessment for Source Characterization and Site Planning Summary of Carcinogenic Risk Results

Receptor of Concern	Exposure to Sediment	Exposure to Surface Water	Ingestion of Modeled Crabs	Ingestion of Modeled Fish	Cumulative Carcinogenic Risk
Coke Point Offshore Area					
Adult Recreational User	$2.7x10^{-6}$	$9.2x10^{-4}$	$1.0x10^{-3}$	$6.1x10^{-4}$	$2.6x10^{-3}$
Adolescent Recreational User	$1.2x10^{-5}$	$1.1x10^{-3}$	$9.7x10^{-4}$	$7.0x10^{-4}$	$2.7x10^{-3}$
Child Recreational User	$5.9x10^{-6}$	$3.9x10^{-4}$	$3.6x10^{-4}$	$2.6x10^{-4}$	$1.0x10^{-3}$
Watermen	$9.6x10^{-6}$	$4.9x10^{-4}$	$1.3x10^{-3}$	$7.4x10^{-4}$	$2.5x10^{-3}$
Patapsco River Background Area					
Adult Recreational User	$3.0x10^{-7}$	$5.8x10^{-5}$	$1.3x10^{-4}$	$4.0x10^{-5}$	$2.3x10^{-4}$
Adolescent Recreational User	$1.1x10^{-6}$	$6.7x10^{-5}$	$9.7x10^{-5}$	$4.5x10^{-5}$	$2.1x10^{-4}$
Child Recreational User	$5.7x10^{-7}$	$2.5x10^{-5}$	$3.6x10^{-5}$	$1.7x10^{-5}$	$7.9x10^{-5}$
Watermen	$1.1x10^{-6}$	$1.5x10^{-5}$	$1.6x10^{-4}$	$4.8x10^{-5}$	$2.2x10^{-4}$

Table ES.7. Risk Assessment for Source Characterization and Site Planning Summary of Non-Carcinogenic Hazard Indices

Receptor of Concern	Exposure to Sediment	Exposure to Surface Water	Ingestion of Modeled Crabs	Ingestion of Modeled Fish	Cumulative Non-Carcinogenic Risk
Coke Point Offshore Area					
Adult Recreational User	0.01	0.006	1.7	0.3	2.0
Adolescent Recreational User	0.04	0.006	1.9	0.4	2.4
Child Recreational User	0.07	0.008	2.4	0.5	3.0
Watermen	0.03	0.005	2.0	0.4	2.5
Patapsco River Background Area					
Adult Recreational User	0.003	0.003	0.6	0.3	0.9
Adolescent Recreational User	0.02	0.004	0.7	0.3	1.0
Child Recreational User	0.03	0.004	0.8	0.4	1.3
Watermen	0.01	0.003	0.7	0.4	1.1

The results of the HHRAs indicate that calculated risks for potential human exposure to the Coke Point Offshore Area are above those for the Patapsco River Background Area.

HHRA Conclusions

Surface Water

A primary contributor to cumulative carcinogenic risks in both the HHRA-PH and HHRA-SC was the dermal contact with surface water exposure pathway. The risk results for this pathway present a number of uncertainties that need to be taken into account in risk management decisions. PAHs were the only class of chemicals that contributed to the carcinogenic risks determined for the surface water exposure pathway. The USEPA dermal guidance (USEPA 2004) notes that the permeability coefficients (PCs) estimated for PAHs are outside of a predictive range and cannot be verified. As a result, the actual absorbed dose of PAHs through

the skin was most likely over-estimated. Additionally, the surface water exposure pathway also estimated potential risks for exposure to the entire study area around the Coke Point Peninsula, including water within the turning basin and along the Coke Point shoreline. The use of the USEPA ProUCL program takes into account sample results over the entire exposure area to eliminate some uncertainty and determine the concentration contacted over the entire area, including samples with non-detects. However, actual PAH detections in surface water were spatially limited. **Figures 3.13** through **3.15**in the risk assessment present the detected PAH concentrations, as represented by benzo(a)pyrene. PAHs are highest in surface water locations immediately offshore of Coke Point Peninsula at locations BH-W-06 and BH-W-10B. These locations are not expected to attract recreational swimmers based on current site conditions. Furthermore, surface water PAH detections were not consistently detected throughout the study area which is a result of typical surface water movement and influences from other conditions, including groundwater discharge, tidal flow, etc. Due to these limitations, potential carcinogenic risks for dermal contact with surface water were likely over-estimated. The results of the HHRA should be used in context with the known groundwater contamination discharge to surface water to determine risk management decisions for potential human health concerns and potential project design. The Site Assessment (EA 2009b) noted that impacted groundwater fluxes from the northwestern and eastern parts of the Coke Point Peninsula to the adjacent Patapsco River and Turning Basin. This discharge of groundwater to surface water has negatively affected surface water quality (EA 2009b). Additionally, sediments along the Coke Point shoreline are impacted with residual NAPL and have the potential to be disturbed along the shoreline by wave action (EA 2009b). Both factors could potentiallycontributeto elevated concentrations of PAHs in surface water and act as a continual source.

Sediment

Overall risk results for exposure to sediment were within acceptable levels for both the Coke Point Offshore Area and the Patapsco River Background Area. However, risks for the Coke Point Offshore Area were greater than those for the Patapsco River Background Area. The highest concentrations of PAHs in surface sediment were found along the Coke Point shoreline, but the area of impacted sediments is not confined to one or two localized regions. Elevated concentrations of PAHs and metals were detected in surface sediments all around the Coke Point Peninsula. As noted in **Appendix H**, average concentrations of metals, PAHs, and PCBs were higher in clams exposed to Coke Point sediments compared to concentrations in clams exposed to control sediments and compared to clams prior to testing (pre-test tissues). The same trends were apparent for aquatic worms. This is a strong indication that uptake from sediments into tissue occurs and that at least some portion of the chemicals in sediment is bioavailable to aquatic organisms. Therefore, chemicals within sediment along the Coke Point Offshore area are available for uptake and present a potential continual source of chemicals to fish and potentially humans.

Fish and Crab Tissue

The overall risk results for the consumption of field-collected fish and crab tissue, when evaluated as separate exposures, were acceptable per USEPA guidance. Carcinogenic and non-carcinogenic risk estimates for Coke Point crab consumption were higher than background, but

still acceptable, though only marginally for certain receptors.Concentrations of chemicals in field-collected crab tissue from the Coke Point Offshore Area were statistically significantly higher than those in the background area for a number of chemicals, including metals and some PAHs (**Appendix H**). For field-collected fish tissue, fish filets from the Patapsco River Background Area contained higher overall concentrations of total PCB congeners, arsenic, and selenium than filets from the Coke Point Offshore Area.Bioaccumulation studies, **Appendix H**, provide evidence that chemicals from sediment are taken up into the aquatic food chain at concentrations higher than those in background. Therefore, chemicals within the Coke Point Offshore Area are available for uptake and present a potential continual source of chemicals to fish and potentially humans.

UNCERTAINTIES

Risk assessments involve a number of uncertaintiesthat must be taken into consideration when interpreting risk assessment results. The risk assessment for the Coke Point Offshore Area bears a number of uncertainties. The risk assessment was based on existing conditions, and did not evaluate hypothetical future scenarios that could arise should erosion or dredging expose deeper sediments with different exposure concentrations. Risk assessment methods as specified by guidance (USEPA 1997a, 2002) are precautionary; as such, they are protective but may over-estimate risks to assure protectiveness of public health and the environment. The chemical analytical data set used for the risk assessment was subject to limitations associated with environmental variability. In particular, surface water concentrations can be highly variable due to changing sources. There is also uncertainty associated with extrapolation from modeled effects to individuals to community level effects for ecological receptors. Use of site-specific tissue data to characterize bioaccumulation decreased the uncertainty of the risk assessment overall, but introduced some uncertainty associated with field-collection of fish and crabs (i.e., a single sampling event; a single fish species, etc.). Methods of mitigating uncertainty were incorporated into the risk assessment approach to the greatest extent possible. It is not possible to quantify the degree of uncertainty within the risk assessment. However, a relative comparison of the risk assessment results to reduced risksas a result of potential project design can be performed subsequent to this study.

CONCLUSIONS AND RECOMMENDATIONS

The results of the risk assessment support the following conclusions:

- **Ecological Risks:** Specific chemicals in sediments of the Coke Point Offshore Area may pose risks to ecological receptors that are greater than the background risks posed in the Patapsco River Background Area.

    - Arsenic, chromium, copper, lead, mercury, zinc, LMW PAHs, HMW PAHs, dioxins, and total PCBs in surface sediment pose predicted risks to aquatic organisms such as clams, worms, and crustaceans. Several of the same chemicals were found in surface water and also contribute risks.

    - Total PCBs pose risks to wildlifesuch as birds and mammals that are higher than background for some prey types; LMW PAHs and HMW PAHs may pose risks

for wildlife, but their potential for impacts is limited to those portions of the site with the highest concentrations.

- Risks to wildlife are due to both incidental ingestion of sediment and ingestion of bottom-dwelling organisms such as clams and worms that have accumulated chemicals in their tissue. Highest risks to wildlife are driven by ingestion of sediment and benthic orgamisms (as opposed to surface water, crabs, and fish).

- **Human Health Risks:**Specific chemicals in sediments and surface water of the Coke Point Offshore Area pose potential risks to human receptors that are greater than the risks posed in the Patapsco River Background Area.

  - For both HHRAs, carcinogenic risks are primarily driven by total PCBs and the PAHs benzo(a)pyrene and dibenz(a,h)anthracene.

  - BothHHRAs predicted that a primaryexposure pathway that contributes to risks above acceptable levels and greater than the Patapsco River Background is dermal exposure to surface water during swimming, commercial fishing, or other water activities. While the numeric estimate of this risk is probably over-estimated, the indicator that risk associated with the Coke Point Offshore Area is higher than the Patapsco River Background Area is relevant.

  - Both HHRAs predicted risk for surface sediment that is within levels generally considered acceptable, although risks are elevated at levels higher than the Patapsco River Background Area.

  - The HHRA-PH risk results for field-collected crab and fish tissue were comparable between the Coke Point Offshore Area and the Patapsco River Background Area. When evaluated as separate exposure pathways, risks were considered acceptable in accordance with USEPA guidance, although risks from crab consumption are at the upper limit of the risk range typically considered acceptable. Risks were attributable to total PCBs for both areas and PAHs for the Coke Point Offshore Area. It is noted that MDE has issued a fish advisory for the Patapsco River to account for total PCBs (MDE 2007).

  - The HHRA-SC risk results reveal that long-term consumption of fish and crab, based upon results of laboratory bioaccumulation tests and uptake modeling, are above levels generally considered acceptable. Risk results for the Coke Point Offshore Area are also elevated above the Patapsco River Background Area.

  - The HHRA-SC reveals that the Coke Point Offshore Area contributes risks through the local food chain due to uptake by aquatic organisms such as clams and worms. Basing exposures on tissue concentrations from lower trophic level organisms, such as clams and worms produced higher risks than basing exposures on concentrations from field-collected fish and crab which are higher on the food chain. However, chemical contributions from Coke Point were still evident in tissue concentrations from crabs and fish.

A recommendation of the risk assessment is that the MPA project team incorporates the finding of potential risks from sediment into DMCF project planning, as this may be relevant to how the DMCF and associated features may be designed. It is therefore recommended that risk reduction be considered as means for informing potential project design. The risk assessment provides models and tools that could be used to formulate design options and predict their effective risk reduction.

Future risk reduction efforts should focus on chemicals identified as primary risk drivers in surface sediment and surface water. Risk reduction efforts for these chemicals would also address elevated concentrations of other chemicals that also contribute to overall, cumulative risks and are co-located in the same area. The primary focus of the offshore risk reduction should target the highest concentrations of chemicals identified as primary risk drivers, located in surface sediments to the west and southeast of Coke Point. Subsurface sediment was not evaluated in the risk assessment. Exposure pathways for subsurface sediment were considered incomplete in this evaluation of current conditions. As a result, potential future risk as a result of erosion or dredging has not been considered in the risk assessment. Risk reduction efforts should take into account subsurface sediments if current conditions within the Coke Point Offshore Area are expected to change; additional evaluation of subsurface sediment may be required as part of the MPA's site planning for a DMCF.

To address these recommendations, MPA should complete a risk management study to evaluate the extent to which offshore and onshore remedial measures implemented in conjunction with proposed DMCF would lead to overall risk reduction. Information from the risk assessment and risk management study will assist MPA in determining whether a DMCF at Coke Point could be part of a clean-up effort for the site.