Total Maximum Daily Loads of Polychlorinated Biphenyls in the Northeast and Northwest Branches of the Nontidal Anacostia River, Montgomery and Prince George's Counties, Maryland

FINAL

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Submitted to:

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List of Abbreviations

ARS	Agricultural Research Service
BMP	Best Management Practice
CBP P5	Chesapeake Bay Program Phase 5 Watershed Model
CFR	Code of Federal Regulations
cfs	Cubic feet per second
COMAR	Code of Maryland Regulations
CV	Coefficient of Variation
CWA	Clean Water Act
DC	District of Columbia
DF	Delivery Factor
DNR	Department of Natural Resources
EOF	Edge-of-field
EOS	Edge-of-stream
GIS	Geographic Information System
g	Gram
GMU	George Mason University
kg	Kilogram
L	Liter
LA	Load Allocation
lb	Pound
LC	Land Cover
LMA	Land Management Administration
LRP-MAP	Land Restoration Program Geospatial Database
MD	Maryland
MDE	Maryland Department of the Environment
MDL	Maximum Daily Load
mg	Milligrams
MGD	Million gallons per day
MO Co.	Montgomery County
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer Systems
MWCOG	Metropolitan Washington Council of Governments
NEB	Northeast Branch of the Nontidal Anacostia River

ng	Nanograms
NHD	National Hydrography Dataset
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source
NRCS	Natural Resources Conservation Service
NWB	Northwest Branch of the Nontidal Anacostia River
PCB	Polychlorinated Biphenyl
PG Co.	Prince George’s County
ppb	Parts per billion
ppt	Parts per trillion
QEA	Quantitative Environmental Analysis
RUSLE2	Revised Universal Soil Loss Equation Version II
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SHA	State Highway Administration
SMRC	Stormwater Manager's Resource Center
SW	Stormwater
TMDL	Total Maximum Daily Load
tPCB	Total PCB
TSD	Technical Support Document
TSS	Total Suspended Solid
UMCES	University of Maryland Center for Environmental Science
US EPA	U. S. Environmental Protection Agency
USDA	United States Department of Agriculture
USGS	U. S. Geological Survey
WLA	Waste Load Allocation
WQBELS	Water Quality Based Effluent Limitations
WQLS	Water Quality Limited Segment
WQS	Water Quality Standard
WWTP	Waste Water Treatment Plant
yr	Year
µg	Micrograms

EXECUTIVE SUMMARY

This document upon approval by the U.S. Environmental Protection Agency (US EPA), establishes a Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) in the Northeast Branch (NEB) and Northwest Branch (NWB) of the nontidal Anacostia River watershed (basin number 02140205; *2008 Integrated Report Assessment Unit ID*: MD-02140205). Section 303(d) of the federal Clean Water Act (CWA) and the US EPA's implementing regulations direct each State to identify and list waters, known as water quality limited segments (WQLSs), in which current required controls of a specified substance are inadequate to achieve water quality standards (WQSs). For each WQLS, the State is to either establish a TMDL of the specified substance that the waterbody can receive without violating WQSs, or demonstrate that WQSs are being met (CFR 2010b).

Maryland (MD) WQSs state that all surface waters of the State shall be protected for water contact recreation, fishing, and protection of aquatic life and wildlife (COMAR 2010a). All waters of the nontidal Anacostia River have been designated as Use I – *Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life*. Additionally, Paint Branch and its tributaries upstream of the Capital Beltway have been designated as Use III – *Nontidal Cold Water,* and the Northwest Branch and its tributaries upstream of Route 410 as Use IV – *Recreational Trout Waters* (COMAR 2010b, c, d).

The Maryland Department of the Environment (MDE) has identified various portions of the nontidal Anacostia River watershed on the State's 2008 Integrated Report as impaired by the following (listing years in parentheses): nutrients (1996), sediments (1996), fecal bacteria (2002), trash/debris (2006), impacts to biological communities (2002), PCBs (2002), and heptachlor epoxide (2002) (MDE 2008). The 2002 PCB listing for the nontidal Anacostia River watershed refer solely to the NEB and NWB, where the water column samples were collected. Similarly, the 2002 heptachlor epoxide listing refers solely to the NWB.

The TMDL established herein by MDE will address the 2002 PCB listing for the NEB and NWB of the nontidal Anacostia River watershed, for which a data solicitation was conducted, and all readily available data from the past five years have been considered. Fecal bacteria and trash/debris TMDLs for the nontidal and tidal waters of the Anacostia River watershed were submitted to the US EPA in 2006 and 2010, respectively, and subsequently approved. Inter-jurisdictional TMDLs addressing sediment and nutrient listings in the nontidal and tidal waters of both the Maryland (MD) and District of Columbia (DC) portions of the watershed were submitted to the US EPA in 2007 and 2008, respectively, and subsequently approved. The remaining listings for the nontidal Anacostia River watershed will be addressed at a future date. Additionally, an inter-jurisdictional TMDL addressing a tidal Anacostia PCB listing, first identified on the Integrated Report as impaired in 2006, along with tidal Potomac PCB listings was submitted to and approved by the US EPA in 2007.

The Tidal Potomac and Anacostia PCB TMDL report (MDE 2007) characterizes and provides allocations for point and nonpoint sources from the direct drainage portion of the watershed (as defined within the Chesapeake Bay Program Phase 5 (CBP P5) Watershed Model, i.e., including Lower Beaverdam and Watts Branch watersheds within the Anacostia River MD 8-digit watershed), while the nontidal NEB and NWB PCB loads are represented as upstream tributary loads without any further characterization of these loads with respect to point and nonpoint sources. The objective of this report is to establish NEB and NWB PCB TMDLs supportive of the "fishing" designated use, which is protective of human health related to consumption of fish caught in these tributaries. And thus, NEB and NWB Tributary TMDL Allocations provided in the Tidal PCB TMDL report were reevaluated from the point of view of water quality standards in the NEB and NWB and were deemed protective of the "fishing" designated use in these tributaries (see Section 3). Consequently, these allocations serve as the bases for the NEB and NWB PCB TMDLs.

Point sources have been identified only in the Maryland portion of the NEB and NWB tributary drainage basins. These include two waste water treatment plants (WWTPs) and Maryland National Pollutant Discharge Elimination System (NPDES) regulated stormwater. Nonpoint sources include identified contaminated sites in the Maryland portion of the watershed, unregulated watershed runoff in the Maryland portion of the basin, and the DC upstream watershed.

All TMDLs need to be presented as a sum of waste load allocations (WLAs) for the identified point sources and load allocations (LAs) for nonpoint source loads generated within the assessment unit, and where applicable LAs for natural background, tributary, and adjacent segment loads. Furthermore, all TMDLs must include a margin of safety (MOS) to account for the lack of knowledge and the many uncertainties in the understanding and simulation of water quality parameters in natural systems (i.e., the relationship between modeled loads and water quality). The MOS is intended to account for such uncertainties in a manner that is conservative from the standpoint of environmental protection. In the methods used to establish the NEB and NWB Tributary PCB TMDLs, which are the bases of the TMDLs presented in this report, in addition to an implicit MOS incorporated through the use of conservative assumptions, an explicit MOS equal to 5% of the TMDL was reserved for loadings from tributary sources (MDE 2007). This becomes the MOS for the NEB and NWB TMDLs.

The NEB and NWB PCB Total Baseline (i.e., 2005) Loads are 429 and 298 grams/year (g/yr), respectively. These loads are further subdivided into Nonpoint Source Baseline Loads and Point Source Baseline Loads (see Equation ES-1).

$$TMDL_w = WLA_{WWTP} + WLA_{SW} + LA_{CS} + LA_{MD} + LA_{DC} + MOS \qquad \text{[Equation ES-1]}$$

Where:

$TMDL_w$ = Watershed TMDL (presented separately for NEB and NWB)
WLA_{WWTP} = WWTP WLA
WLA_{SW} = NPDES Regulated Stormwater WLA (presented separately for Montgomery and Prince George's County)
LA_{CS} = Contaminated Site LA
LA_{MD} = MD Unregulated Watershed Runoff LA
LA_{DC} = DC Upstream Watershed LA
MOS = Margin of Safety

The NEB and NWB PCB TMDLs are 8.57 and 5.96 g/yr, respectively (these values include a 5% MOS), with an overall reduction of 98% from the Total Baseline Loads (see Table ES-1). This TMDL when implemented will ensure that the PCB loads are at a level expected to support the "fishing" designated use in the NEB and NWB of the Anacostia River watershed.

Table ES- 1: Summary of PCB Baseline Loads, TMDL Allocations, Maximum Daily Loads (MDLs), and Associated Percent Reductions

Northeast Branch

Source	Baseline (g/yr)	TMDL (g/yr)	Reduction (%)	MDL (mg/day)
MD Unregulated Watershed Runoff	36.90	0.50	98.64	6.66
MD Contaminated Site Runoff	1.61	1.61	0.00	21.34
Nonpoint Source Baseline Loads / LAs	***38.51***	***2.11***	***94.52***	***27.99***
MD WWTPs	0.795	0.725	8.83	6.19
MO Co.[1] NPDES Regulated Stormwater	112.57	1.53	98.64	20.30
PG Co.[2] NPDES Regulated Stormwater	277.12	3.77	98.64	49.98
Point Source Baseline Loads / WLAs	***390.49***	***6.03***	***98.46***	***76.46***
Margin of Safety (5%)	***-***	***0.43***	***-***	***5.50***
Total	**429**	**8.57**	**98**	**109.96**

Northwest Branch

Source	Baseline (g/yr)	TMDL (g/yr)	Reduction (%)	MDL (mg/day)
MD Unregulated Watershed Runoff	20.5	0.39	98.10	4.97
DC Upstream Watershed[3]	49.9	0.95	98.10	12.11
Nonpoint Source Baseline Loads / LAs	***70.4***	***1.34***	***98.10***	***17.08***
MO Co.[1] NPDES Regulated Stormwater	134.5	2.56	98.10	32.62
PG Co.[2] NPDES Regulated Stormwater	93.0	1.77	98.10	22.57
Point Source Baseline Loads / WLAs	***227.6***	***4.32***	***98.10***	***55.19***
Margin of Safety (5%)	***-***	***0.30***	***-***	***3.80***
Total	***298***	***5.96***	***98***	***76.07***

Notes: [1] Montgomery County (MO Co.) NPDES Regulated Stormwater – refers to all known NPDES stormwater dischargers within Montgomery County NEB and NWB drainage basin, which are identified in Appendix C.

[2] Prince George's County (PG Co.) NPDES Regulated Stormwater – refers to all known NPDES stormwater dischargers within Prince George's County NEB and NWB drainage basin, which are identified in Appendix C.

[3] Point sources in the Washington, DC portion of the watershed have not been characterized.

Federal regulations require that TMDL analysis take into account the impact of critical conditions and seasonality on water quality (CFR 2010b). The intent of this requirement is to ensure that the water quality is protected during the most vulnerable times. The TMDLs presented in this document implicitly account for seasonal variations as well as critical conditions. Given that at the observed concentrations acute conditions are not a concern and since PCB levels in fish become elevated due to long-term exposure, rather than temporary spikes in water column PCB concentration, it has been determined that the selection of the average PCB concentration as representing the baseline conditions adequately considers the impact of seasonal variations and critical conditions on the "fishing" designated use in the NEB and NWB. Furthermore, in order to meet downstream water quality standards (i.e., in Tidal Anacostia and Potomac Rivers), the proposed NEB and NWB TMDLs are lower (i.e., more protective) than would otherwise be required to meet water column concentrations protective of the "fishing" designated use in the NEB and NWB.

Once the US EPA has approved these TMDLs, MDE will begin an iterative process of implementation, focusing first on those sources with the largest impact on water quality while giving consideration to the relative cost and ease of implementation. The implementation efforts will be periodically evaluated, and if necessary, improved, in order to further progress toward achieving the water quality goals. Given that a number of contaminated sites have already undergone remediation and their baseline loads constitute a relatively small percentage of the Total Baseline Load (i.e., 0.38%), these sites are not intended to be targeted during the initial stages of implementation and thus at this point were not subjected to any reductions. However, if in the future it becomes clear that the TMDL goals cannot be achieved without load reductions from these sites, additional reduction measures might need to be considered. As part of Maryland's Watershed Cycling Strategy, follow-up monitoring and assessment will be routinely conducted to evaluate the implementation status in the NEB and NWB. MDE also monitors and evaluates concentrations of contaminants in recreationally caught fish, shellfish, and crabs throughout Maryland. MDE will use these monitoring programs to evaluate progress towards meeting the "fishing" designated use in NEB and NWB.

1. INTRODUCTION

This document upon approval by the U.S. Environmental Protection Agency (US EPA), establishes a Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) in the Northeast Branch (NEB) and Northwest Branch (NWB) of the nontidal Anacostia River watershed (basin number 02140205; 2008 *Integrated Report Assessment Unit ID*: MD-02140205). Section 303(d) of the federal Clean Water Act (CWA) and the US EPA's implementing regulations direct each State to identify and list waters, known as water quality limited segments (WQLSs), in which current required controls of a specified substance are inadequate to achieve water quality standards (WQSs). For each WQLS, the State is to either establish a TMDL of the specified substance that the waterbody can receive without violating WQSs, or demonstrate that WQSs are being met (CFR 2010b).

A WQS is the combination of a designated use for a particular body of water and the water quality criteria designed to protect that use. Designated uses include activities such as swimming, drinking water supply, protection of aquatic life, and fish and shellfish propagation and harvest, etc. Water quality criteria consist of narrative statements and numeric values designed to protect the designated uses. Criteria may differ among waters with different designated uses.

The Maryland Department of the Environment (MDE) has identified various portions of the nontidal Anacostia River watershed on the State's 2008 Integrated Report as impaired by the following (listing years in parentheses): nutrients (1996), sediments (1996), fecal bacteria (2002), trash/debris (2006), impacts to biological communities (2002), PCBs (2002), and heptachlor epoxide (2002) (MDE 2008). The 2002 PCB listing for the nontidal Anacostia River watershed refer solely to the NEB and NWB, where the water column samples were collected. Similarly, the 2002 heptachlor epoxide listing refers solely to the NWB.

The TMDL established herein by MDE will address the 2002 PCB listing for the NEB and NWB of the nontidal Anacostia River watershed, for which a data solicitation was conducted, and all readily available data from the past five years have been considered. Fecal bacteria and trash/debris TMDLs for the nontidal and tidal waters of the Anacostia River watershed were submitted to the US EPA in 2006 and 2010, respectively, and subsequently approved. Inter-jurisdictional TMDLs addressing sediment and nutrient listings in the nontidal and tidal waters of both the Maryland (MD) and District of Columbia (DC) portions of the watershed were submitted to the US EPA in 2007 and 2008, respectively, and subsequently approved. The remaining listings for the nontidal Anacostia River watershed will be addressed at a future date. Additionally, an inter-jurisdictional TMDL addressing a tidal Anacostia PCB listing, first identified on the Integrated Report as impaired in 2006, along with tidal Potomac PCB listings was submitted to and approved by the US EPA in 2007.

PCBs are a class of man-made compounds that were manufactured and used for a variety of industrial applications. They consist of 209 related chemical compounds (congeners) that were manufactured and sold as mixtures under various trade names (QEA 1999). Each of the 209 possible PCB compounds consists of two phenyl groups and one or more chlorine atoms. The congeners differ in the number and position of the chlorine atoms along the phenyl group. From the 1940s to the 1970s, they were extensively used as heat transfer fluids, flame retardants, hydraulic fluids, and dielectric fluids because of their dielectric and flame resistant properties. They have been identified as a pollutant of concern due to the following:

1. They are bioaccumulative and can cause both acute and chronic toxic effects;
2. They have carcinogenic properties;
3. They are persistent organic pollutants that do not readily breakdown in the environment.

In the late 1970s, concerns regarding potential human health effects led the United States government take action to cease PCB production, restrict PCB use, and regulate the storage and disposal of PCBs. Despite these actions, PCBs are still being released into the environment through fires or leaks from old PCB containing equipment, accidental spills, burning of PCB containing oils, leaks from hazardous waste sites, etc. As PCBs tend to bioaccumulate in aquatic organisms including fish, people who ingest fish may become exposed to PCBs. In fact, elevated levels of PCBs in fish are one of the leading causes of fish consumption advisories in the United States.

The NEB and NWB of the nontidal Anacostia River have been identified as impaired by PCBs on the State's 2008 Integrated Report based on total PCB (tPCB) water column data from MDE's monitoring program that exceeded the Maryland human health tPCB criterion of 0.64 nanograms/liter (ng/L, ppt) (COMAR 2010e; US EPA 2006). Besides identifying impaired waterbodies on the State's Integrated Report, MDE also issues statewide and site-specific fish consumption advisories (ranging from 0 to 4 meals per month) and recommendations (ranging from 4 to 8 meals per month). Current recreational fish consumption advisories suggest limiting the consumption of the following fish species caught in the Anacostia River: American eel, brown bullhead, channel catfish, and sunfish (MDE 2009b).

2. SETTING AND WATER QUALITY DESCRIPTION

2.1. General Setting

The NEB and NWB are tributaries of the Anacostia River, which in turn flows into the Potomac River, a tributary of the Chesapeake Bay. Approximately 70% of the Anacostia River watershed is drained by the NWB and the NEB. The Anacostia River watershed is located in two physiographic provinces, the Piedmont Plateau and the Atlantic Coastal Plain, and drains about 176 square miles of land from Washington, DC (30.2 miles, 17.2%), Montgomery County, MD (60.8 miles, 34.4%), and Prince George's County, MD (85.2 miles, 48.4%). The NEB and NWB watersheds combined are approximately 127 square miles and are home to approximately 519,000 residents (MWCOG 2008; US Census Bureau 2000). The location of the Anacostia River watershed as well as the NEB and NWB TMDL study areas are displayed in Figure 1.

The main channel of the Anacostia River is 8.4 miles (13.5 kilometers) in length, extending from the confluence of the NWB and the NEB, in Bladensburg, MD, to its confluence with the Potomac River. The main channel of the Anacostia River is an estuary with a variation in water level of approximately three feet over a tidal cycle. Tidal influence extends approximately to the locations of the U.S. Geological Survey (USGS) gaging station 01649500 on the NEB and the U.S. Route 1 (Rhode Island Avenue) bridge on the NWB.

According to the 2006 land cover data (USGS 2009), land use in the NEB and NWB watersheds can be classified as predominantly urban. Urban land occupies approximately 62.3% of these watersheds, while 24.4% is forested and 6.6% is agricultural. The remaining 6.7% is classified as barren, unconsolidated shore, grassland, herbaceous, scrub, shrub, water, or wetland. A summary of the land cover distribution is provided in Table 1. The Anderson level I urban classification includes level II developed open space as well as low, medium, and high intensity urban classifications. The Anderson level I agricultural classification includes level II pasture and cultivated land classifications (see Figure 2, Figure 3, and Table 1).

Table 1: Land Cover Distribution in the NEB and NWB Tributary Drainage Basins Acres (%)

	Urban	Forest	Agricultural	Water/ Wetlands	Grassland Herbaceous/ Scrub/Shrub	Barren/ Unconsolidated Shore
NEB	29,311 (61.1%)	11,812 (24.6%)	2,980 (6.2%)	2,596 (5.4%)	1,196 (2.5%)	90 (0.2%)
NWB	21,385 (64.2%)	7,998 (24.0%)	2,394 (7.2%)	647 (1.9%)	885 (2.7%)	15 (0.0%)
Total	50,696 (62.3%)	19,810 (24.4%)	5,374 (6.6%)	3,244 (4.0%)	2,081 (2.6%)	104 (0.1%)

Data source: USGS 2009.

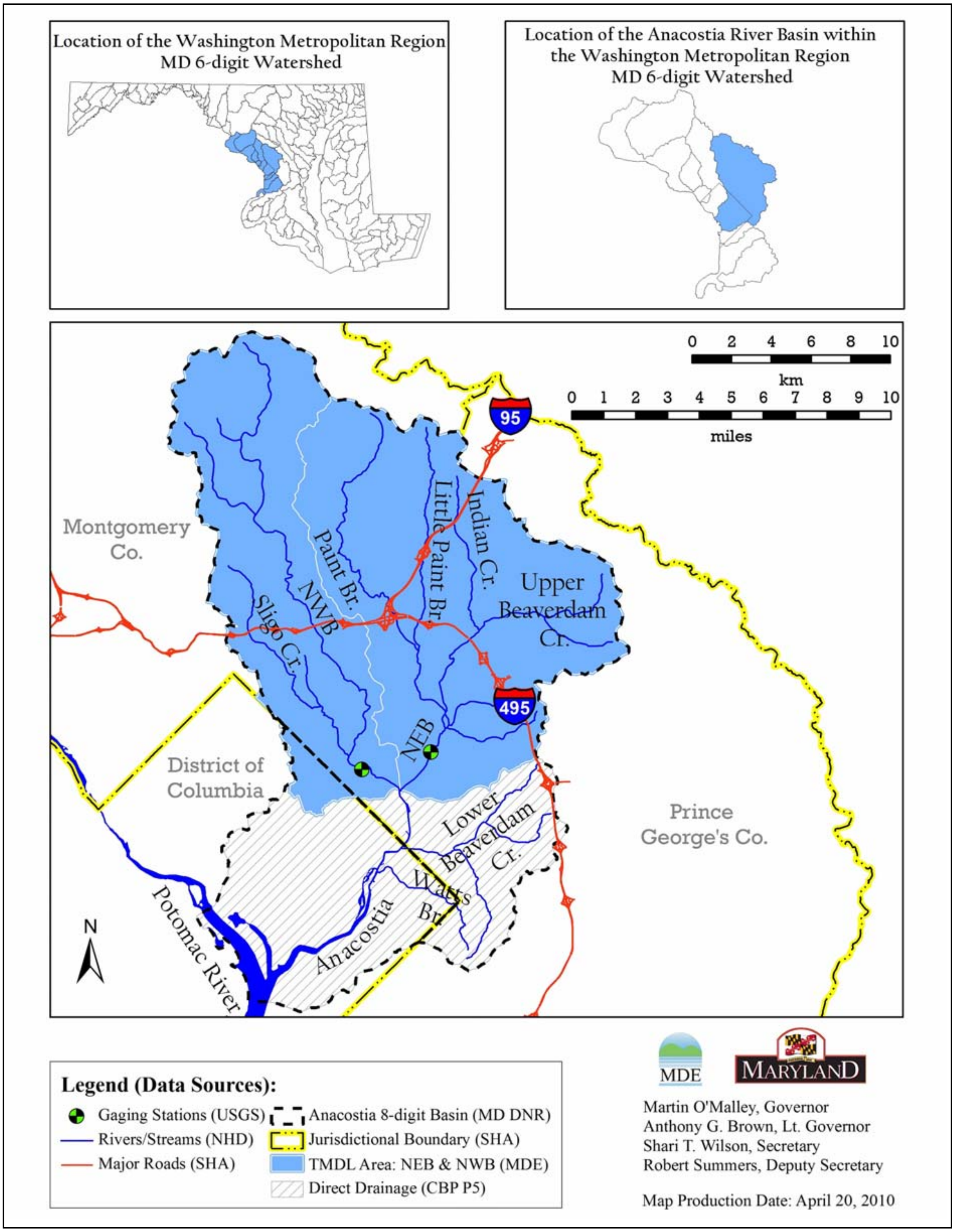


Figure 1: Location Map of the NEB and NWB Tributary Drainage Basins

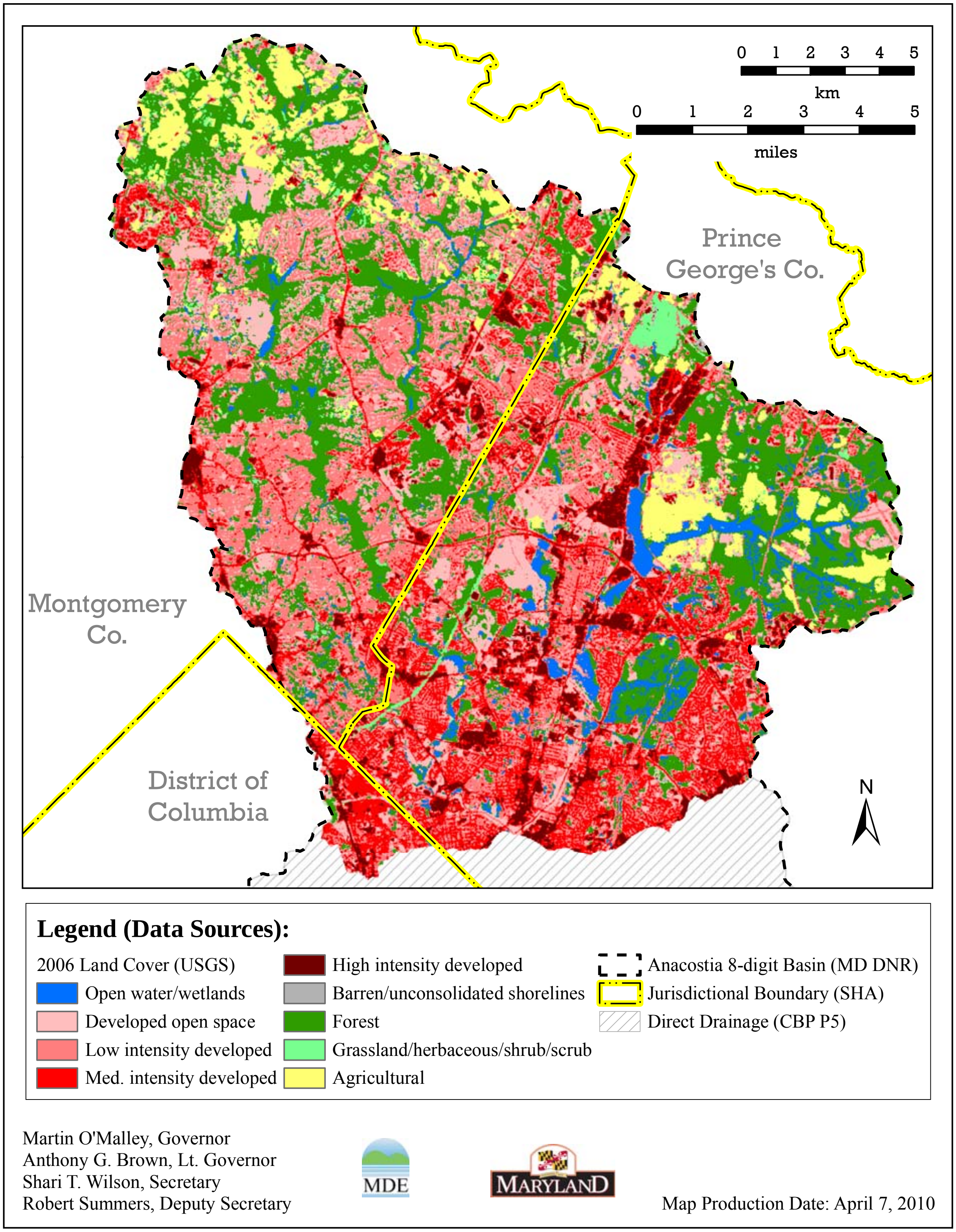


Figure 2: Land Cover Distribution in the NEB and NWB Tributary Drainage Basins

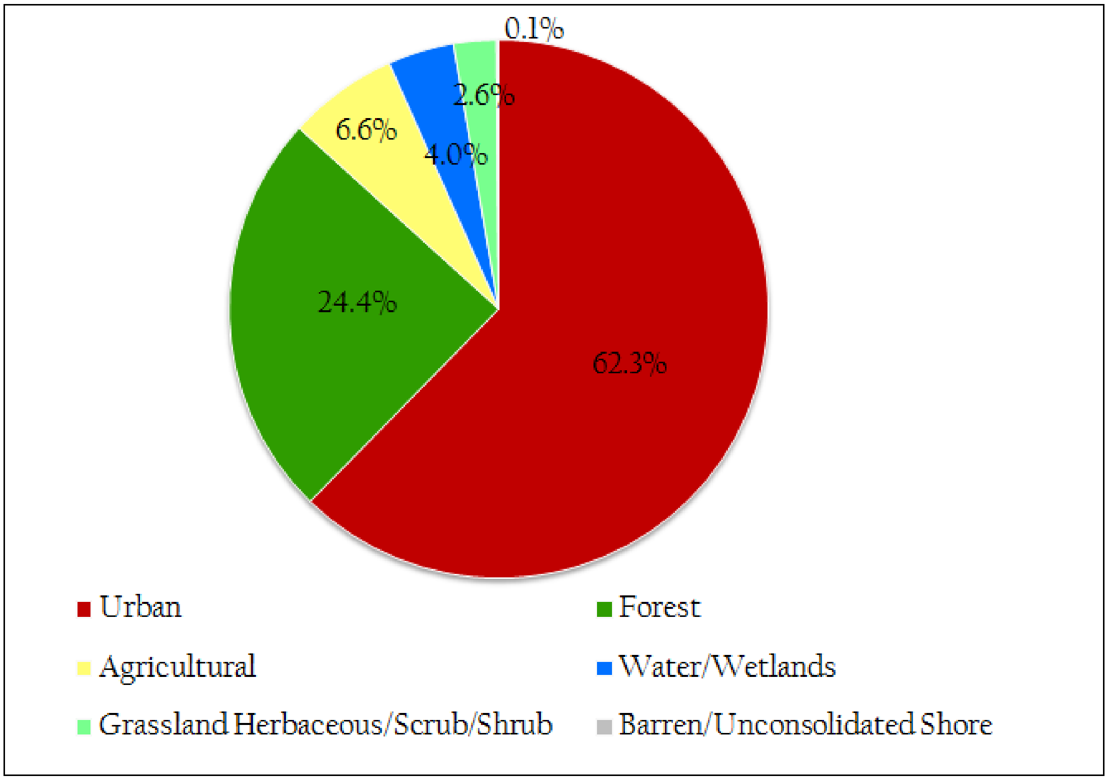


Figure 3: Land Cover in the NEB and NWB Tributary Drainage Basins

The PCB TMDLs summarized in this report are for the NEB and NWB of the nontidal Anacostia River only. A PCB TMDL outlining specific point and nonpoint source allocations for the direct drainage area of the Anacostia River watershed (as defined within the Chesapeake Bay Program Phase 5 Watershed Model (CBP P5), i.e., including nontidal portions of the watershed such as the Lower Beaverdam and Watts Branch watersheds) has already been approved by EPA as part of the Tidal Potomac and Anacostia PCB TMDLs (MDE 2007). As part of this effort, NEB and NWB tributary PCB loads and TMDL allocations protective of the downstream water quality have already been characterized.

2.2. Water Quality Characterization and Impairment

Maryland WQSs state that all surface waters of the State shall be protected for water contact recreation, fishing, and protection of aquatic life and wildlife (COMAR 2010a). All waters of the nontidal Anacostia River have been designated as Use I – *Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life*. Additionally, Paint Branch and its tributaries upstream of the Capital Beltway have been designated as Use III – *Nontidal Cold Water*, and the Northwest Branch and its tributaries upstream of Route 410 as Use IV – *Recreational Trout Waters* (COMAR 2010b, c, d).

Additionally, two stream reaches of the Upper Beaverdam Creek, in the NEB watershed, are designated as "high quality", or Tier II, stream segments (i.e., Benthic Index of Biotic Integrity and Fish Index of Biotic Integrity aquatic life assessment scores > 4 (scale 1 to 5)) requiring the implementation of Maryland's antidegradation policy (COMAR 2010f; MDE 2009a).

The State of Maryland adopted three separate water column tPCB criteria: criterion for protection of human health associated with consumption of PCB contaminated fish, as well as fresh and salt water chronic tPCB criteria for the protection of aquatic life (see Table 2). The Maryland human health tPCB criterion is set at 0.64 ng/L, ppt) (COMAR 2010e; US EPA 2006). This criterion is based on a cancer slope factor of 2 (milligrams/kilogram-day)$^{-1}$, a bioconcentration factor of 31,200 L/kg, a risk level of 10^{-5}, a lifetime exposure duration of 70 years, and a fish intake of 17.5 grams/day (g/day). A cancer risk level provides an estimate of the additional incidence of cancer that may be expected in an exposed population; a risk level of 10^{-5} indicates a probability of one additional case of cancer for every 100,000 people exposed. The Maryland fresh and salt water chronic aquatic life tPCB criteria are set at 14 ng/L and 30 ng/L, respectively (COMAR 2010e; US EPA 2006). A sediment tPCB criterion has not been established in Maryland.

Table 2: Summary of Maryland Water Column tPCB Criteria, ng/L

MD Criteria	tPCB
Water Column Human Health	0.64
Fresh Water Chronic Aquatic Life	14
Salt Water Chronic Aquatic Life	30

In addition to the water column criteria described above, fish tissue monitoring data can serve as an indicator of PCB water quality conditions. The Maryland fish tissue monitoring data is used to issue fish consumption advisories/recommendations and determine whether Maryland waterbodies are meeting the "fishing" designated use. Currently Maryland applies 39 ng/g as the tPCB fish tissue listing threshold (MDE 2008).

In 2002, MDE identified both the NEB and NWB as impaired by PCBs based on the exceedance of the tPCB water column criterion (Maryland human health tPCB criterion in 2002 was 1.7 ng/L). Additionally, water quality data collected between 2004 and 2005 in the NEB (station geographic coordinates: 38.96025, -76.92597) and NWB (station geographic coordinates: 38.95233, -76.96606) indicate that while the average particulate plus dissolved tPCB concentrations do not exceed the 14 ng/L Maryland fresh water chronic aquatic life tPCB criterion, the 0.64 ng/L Maryland water column human health tPCB criterion is exceeded (see Table 3). Detailed tPCB results for each measurement are presented in Appendix A.

Table 3: Average Water Column tPCB Concentrations in NEB and NWB, ng/L (2004-2005)

Tributary	Average tPCB
NEB	3.35
NWB	4.30

The water quality data summarized in Table 3 were collected and analyzed by the Department of Chemistry and Biochemistry at George Mason University (GMU). PCB congeners were identified and quantified by high resolution gas chromatography with electron capture detection. GMU uses a slightly modified version of the PCB congener specific method described in Foster et al. (2000), in which the identities and concentrations of each congener in a mixed Aroclor standard (25:18:18

mixture of Aroclors 1232, 1248, and 1262) are determined based on their chromatographic retention times relative to the internal standards (PCB 30 and PCB 204). Based on this method, 72 chromatographic peaks can be quantified (see Appendix E). Some of the peaks contain one PCB congener, while others are comprised of two or more co-eluting congeners. The PCB analysis presented in this document is based on tPCB concentrations that are calculated as the sum of the detected PCB congeners/congener groups representing the most common congeners that were historically used in the Aroclor commercial mixtures.

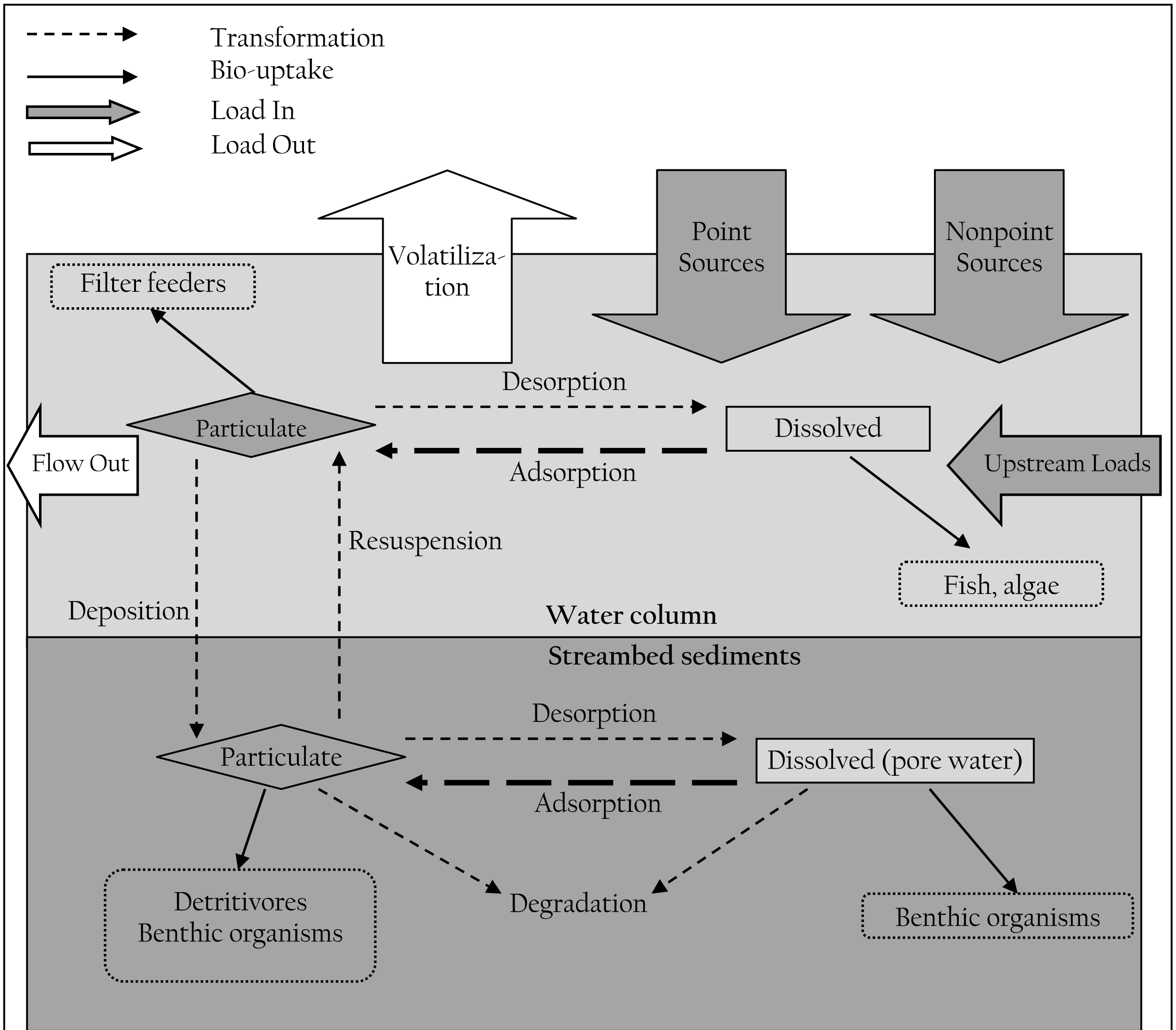
2.3. Source Assessment

PCBs do not occur naturally in the environment. Therefore, unless existing or historical anthropogenic sources are present, their natural background levels are expected to be zero. Although no longer manufactured in the United States, PCBs are still being released to the environment via accidental fires, leaks, or spills from older PCB-containing equipment; potential leaks from hazardous waste sites that contain PCBs; illegal or improper dumping; and disposal of PCB-containing products (e.g., transformers, old fluorescent lighting fixtures, electrical devices, or appliances containing PCB capacitors, old microscope oil, and old hydraulic oil) into landfills that are not designed to handle hazardous waste. Once in the environment, PCBs do not readily break down and tend to cycle between various environmental media such as air, water, and soil.

PCBs exhibit low water solubility, are moderately volatile, strongly adsorb to organics, and preferentially partition to upland and instream sediment. The major fate process for PCBs in water is adsorption to sediment or other organic matter. Adsorption and subsequent sedimentation may immobilize PCBs for relatively long periods of time. However, desorption into the water column may also occur; PCBs contained in layers near the sediment surface may be slowly released over time, while concentrations present in the lower layers may be effectively sequestered from environmental distribution (RETEC 2002).

The linkage between the “fishing” designated use and PCB concentrations in the water column is via the uptake and bioaccumulation of PCBs by aquatic organisms. Bioaccumulation occurs when the combined uptake rate of a given chemical from food, water, and/or sediment by an organism exceeds the organisms’ ability to remove the chemical through metabolic functions, dilution, or excretion, resulting in excess concentrations of the chemical being stored in the body of the organism. Humans can be exposed to PCBs via consumption of aquatic organisms, which over time have bioaccumulated PCBs. Depending on the life cycle and feeding patterns, aquatic organisms can bioaccumulate PCBs via exposure to concentrations present in the water column (in dissolved and/or particulate form) and sediments, as well as from consumption of other organisms resulting in the biomagnification of PCBs within the food chain (RETEC 2002).

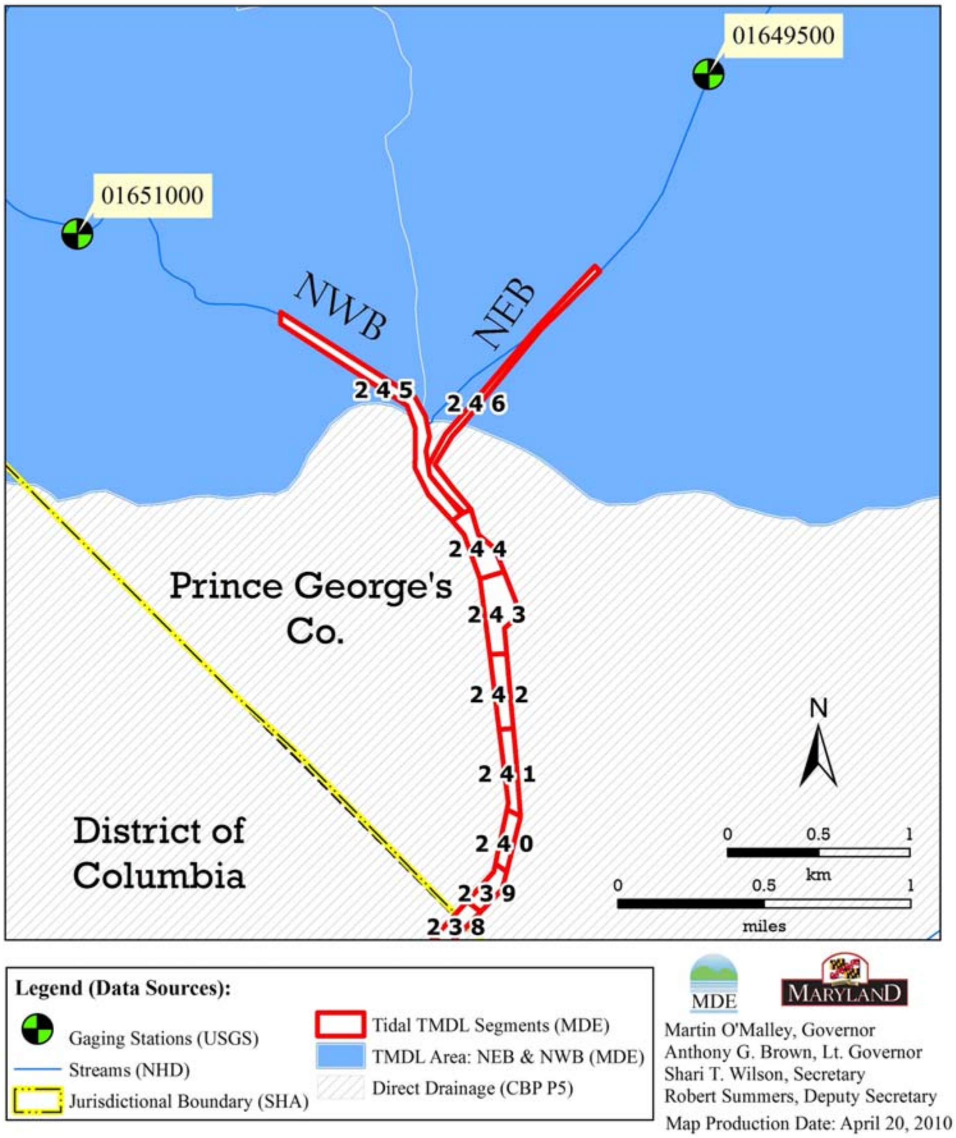
A simplified conceptual model of PCB fate and transport in the NEB and NWB is diagramed in Figure 4. PCB sources, resulting primarily from historical uses of these compounds and potential releases to the environment as described above, include point and nonpoint sources as well as upstream loads. The primary mechanism for the removal of PCBs from the aquatic system is by adsorption to sediments and downstream flushing to the tidal Anacostia River. Volatilization (i.e., escape into the atmosphere) and degradation are other removal mechanisms.



Data Source: LWA 2010.

Figure 4: Conceptual Model of the Key Transport and Transformation Processes of PCBs in Surface Water and Streambed of the NEB and NWB and Entry Points to the Food Chain

The NEB and NWB Tributary PCB Baseline Loads of 429 and 298 g/yr, respectively (see Figure 5) were estimated as part of the Tidal Potomac and Anacostia PCB TMDL process (MDE 2007) based on PCB:TSS regressions, derived from observed PCB3+ (sum of homologs 3-10) water quality data and the total suspended solids (TSS) daily times series from the CBP P5 watershed model. In order to maintain consistency with the Tidal PCB TMDLs, these tributary loads will be used to characterize baseline conditions in the NEB and NWB tributaries. The purpose of this section is to identify PCB sources throughout the NEB and NWB tributary drainage basins and further subdivide the NEB and NWB Tributary PCB Baseline Loads among these sources.



Tidal PCB TMDL Water Quality Model Segment	Nontidal Tributary	Baseline PCB Tributary Load (g/yr)	Tributary PCB Allocation (g/yr)	MOS (g/yr)
246	NEB	429	8.14	0.43
245	NWB	298	5.66	0.30
	Total	727	13.80	0.73

Data Source: MDE 2007.

Figure 5: Summary of the NEB and NWB Tributary PCB Baseline Loads and TMDL Allocations as Characterized in the Tidal Potomac and Anacostia PCB TMDL Report

The NEB and NWB watersheds drain areas located in both Washington, DC and Maryland (see Figure 1). For the purpose of the NEB and NWB TMDL effort, DC upstream PCB baseline loads are presented in terms of a single DC Upstream Watershed Baseline Load to the NWB, while Maryland

NEB and NWB PCB baseline loads are further subdivided into loads from point and nonpoint sources.

Point sources in the NEB and NWB drainage basins include two waste water treatment plants (WWTPs) located in the NEB drainage basin and Maryland's stormwater discharges that are regulated under Phase I or Phase II of the National Pollutant Discharge Elimination System (NPDES) storm water program (US EPA 2002). Phase I and II permits can include the following types of discharges:

- Small, medium, and large Municipal Separate Storm Sewer Systems (MS4s) – these can be owned by local jurisdictions, municipalities, and state and federal entities (e.g., departments of transportation, hospitals, military bases);
- Industrial facilities permitted for stormwater discharges; and
- Small and large construction sites.

A list of all the NPDES regulated stormwater permits within Maryland's portion of the NEB and NWB drainage basins that could potentially convey PCB loads has been presented in Appendix C. Besides the two WWTPs and NPDES regulated stormwater entities, no other NPDES regulated facilities in the NEB and NWB drainage basins have been identified as potential sources of PCBs. Nonpoint sources include runoff from identified contaminated sites and other unregulated watershed areas as well as from the DC upstream watershed.

2.3.1. Contaminated Site Baseline Loads

The term contaminated site used throughout this report refers to areas with known PCB soil contamination, as documented by state or federal hazardous waste cleanup programs (i.e., state or federal Superfund programs). When compared against the human health screening criteria for soil and groundwater exposure pathways, PCBs are not necessarily a contaminant of concern at these sites, but have been screened for, reported, and detected during formal site investigations. Initially, three contaminated sites (comprised of multiple sub-sites) located in the NEB drainage basin were identified as part of the Tidal Potomac and Anacostia PCB TMDL effort (MDE 2007), and the edge-of-field (EOF) PCB baseline loads for these sites were estimated.

As part of the NEB and NWB Tributary PCB TMDL effort summarized in this report, the 2007 contaminated site list and the associated loadings have been refined (see Appendix D). The list of sites has been updated based on information gathered from the US EPA's Superfund and MDE's Land Restoration Program Geospatial Database (LRP-MAP) (US EPA 2010b; MDE 2010). A total of 15 sub-sites (see Table 4) have been identified with PCB soil concentrations at or above method detection levels, as determined via soil sample results contained within MDE Land Management Administration's (LMA) contaminated site survey and investigation records. All of the sites are located within the NEB watershed. PCB EOF loads from these sites have been calculated and subsequently converted to edge-of-stream (EOS) loads (see Table 4) using methods applied within Maryland's nontidal sediment TMDLs, thirteen of which have been approved by the EPA since 2006. Given that not all of the contaminated site PCB loads are expected to reach the nearby streams, EOS loads are thought to be a more accurate representation of actual PCB loads from these sites in terms of their impact on downstream water quality.

The Contaminated Site PCB Baseline Load from the identified sites in the NEB and NWB is estimated to be 1.61 g/yr. This load is the sum of individual PCB loads from 15 contaminated sites within the NEB drainage basin, a number of which have undergone remediation. The average PCB concentrations at the non-remediated sites are below levels detected at the already remediated sites. No contaminated sites have been identified in the NWB drainage basin. A more detailed methodology used to refine the 2007 contaminated site loadings is presented in Appendix D.

Table 4: Summary of the Contaminated Site PCB Baseline Loads

Facility	Site Description	Sub-watershed	EOS PCB Loads (g/yr)
United Rigging and Hauling	(post soil remediation)	17	$1.37{\times}10^{-2}$
Beltsville Agricultural Research Center	Site 7 (no soil remediation)	17	$1.39{\times}10^{-3}$
	Site 9 (no soil remediation)	16	$8.68{\times}10^{-3}$
	Site 32 (post soil remediation)	16	$3.51{\times}10^{-3}$
White Oak	Site 47 (post remediation)	3	$1.76{\times}10^{-2}$
	Site 8 (post remediation)	3	$2.57{\times}10^{-7}$
	Site 28 (post remediation)	3	1.09
	Site 4 (post remediation)	3	$5.42{\times}10^{-3}$
	Site 3 (post remediation)	3	$4.60{\times}10^{-1}$
Adelphi Laboratory	(no soil remediation)	3	$2.16{\times}10^{-7}$
Contee Sand and Gravel Landfill Area	(limited soil remediation)	17	$1.49{\times}10^{-3}$
NASA Goddard Space-Flight Center	Landfill A1 (no soil remediation)	16	$2.80{\times}10^{-5}$
	Landfill B (no soil remediation)	16	$6.69{\times}10^{-3}$
	Landfill C (no soil remediation	16	$5.82{\times}10^{-5}$
	Building 90 (no soil remediation)	16	$2.85{\times}10^{-5}$
Total Contaminated Site PCB Baseline Load (g/yr)			**1.61**

2.3.2. Waste Water Treatment Plant Baseline Loads

Two WWTPs, Beltsville United States Department of Agriculture (USDA) East and West (NPDES: MD0020842 and MD0020851), are located in the TMDL study area (Figure 6). Loads from these facilities have been estimate in the Tidal Potomac and Anacostia PCB TMDL based on data collected from other facilities in the direct drainage area of the Potomac River basin (MDE 2007). In order to refine these load estimates, MDE collected two 24-hour-composite samples from these facilities on February 25, 2010 and March 30, 2010. After adjusting the data based on levels detected in the blank samples and by excluding values for congeners with possible interferences (i.e., cong. 1, 3, and on one occasion cong. 40), MDE used these results along with the 2005 average monitored flow to calculate WWTP PCB Baseline Loads (Table 5). Data results and the analytical methods used are summarized in Appendix A and Appendix E, respectively.

Recently, the NPDES permit for Beltsville USDA East facility was renewed, and it now requires the collection of quarterly PCB grab samples. Similar requirements are expected to be part of the Beltsville USDA West permit once it comes up for renewal. This information will help to better characterize the actual loadings from these facilities and ensure that they are not contributing to the exceedance of the Maryland water column tPCB criteria.

Congener specific analytical methods should be used when collecting any future samples. Ideally, the most current version of EPA Method 1668 should be used, or other equivalent methods capable of providing low-detection level, congener specific results. Other methods deemed appropriate, and approved in advance by the permitting authority, could also be used. In establishing the necessity and extent of data collection, MDE will take into account data that is already available as well as the proper characterization of intake (or pass through) conditions, consistent with NPDES program "reasonable potential" determinations and the applicable provisions of the Environment Article and the Code of Maryland Regulations (COMAR) for permitted facilities, including regulated stormwater.

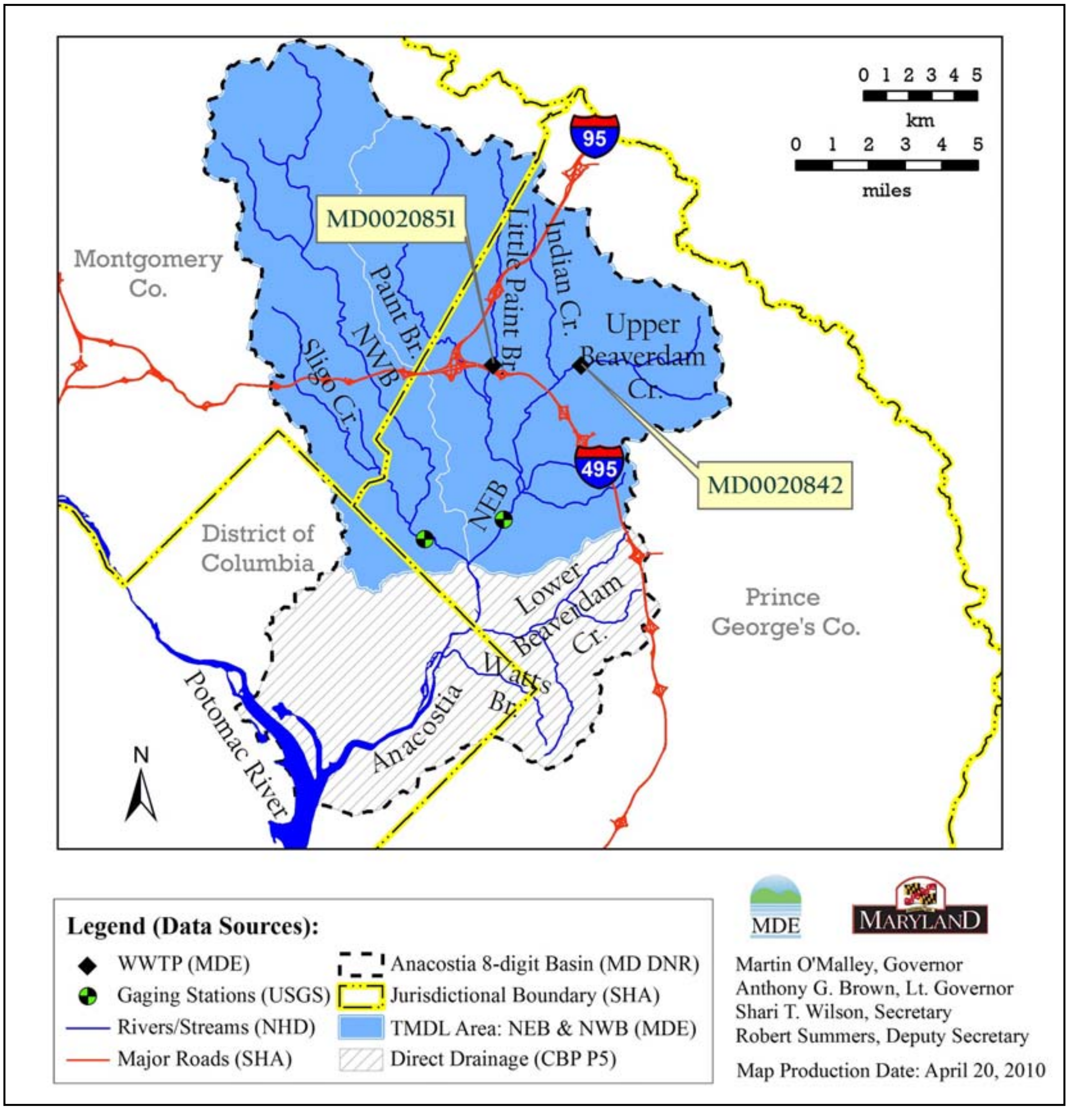


Figure 6: Locations of the WWTPs in the NEB Tributary Drainage Basins

Table 5: WWTP PCB Baseline Loads in the NEB Tributary Drainage Basins

WWTP	NPDES	tPCB Avg. Conc. (ng/L)[1]	2005 Avg. Monitored Flow (MGD)[2]	Baseline PCB Load (g/yr)[3]
USDA East	MD0020842	2.402	0.20	0.664
USDA West	MD0020851	1.059	0.09	0.132
Total WWTP PCB Baseline Loads				***0.795***

Notes: [1] tPCB concentrations are estimated based on 24-hour-composite samples collected by MDE on 2/25/2010 and 3/30/2010.
[2] MGD = Millions of Gallons per Day.
[3] WWTP Baseline Load = tPCB Conc. × 2005 Average Monitored Flow

2.3.3. Maryland NPDES Regulated Stormwater, Maryland Unregulated Watershed Runoff, and DC Upstream Baseline Loads

The remaining loads (i.e., NEB and NWB Tributary Baseline Load *minus* Contaminates Site and WWTP Baseline Loads) can be attributed to the following source categories: Maryland NPDES Regulated Stormwater (SW), Maryland Unregulated Watershed Runoff (NPS), or DC Upstream Watershed (DC). Proportional contributions from each of these source categories in the NEB and NWB tributary drainage basins have been calculated with the use of a weighted approach based on tPCB clam concentrations deployed in each characterized sub-watershed (see Figure 7 and the associated discussion below), the land cover (LC) area making up each source category (Equation 1), and a runoff coefficient for each land cover category (Equation 2).

$$\%SW_w = \frac{\sum(C_n \times A_{SW\text{-}LC\text{-}n} \times RC_{SW\text{-}LC\text{-}n})_w}{\sum(C_n \times A_{SW\text{-}LC\text{-}n} \times RC_{SW\text{-}LC\text{-}n} + C_n \times A_{NPS\text{-}LC\text{-}n} \times RC_{NPS\text{-}LC\text{-}n} + C_n \times A_{DC\text{-}LC\text{-}n} \times RC_{DC\text{-}LC\text{-}n})_w} \times 100$$

$$\%NPS_w = \frac{\sum(C_n \times A_{NPS\text{-}LC\text{-}n} \times RC_{NPS\text{-}LC\text{-}n})_w}{\sum(C_n \times A_{SW\text{-}LC\text{-}n} \times RC_{SW\text{-}LC\text{-}n} + C_n \times A_{NPS\text{-}LC\text{-}n} \times RC_{NPS\text{-}LC\text{-}n} + C_n \times A_{DC\text{-}LC\text{-}n} \times RC_{DC\text{-}LC\text{-}n})_w} \times 100 \quad \text{(Equation 1)}$$

$$\%DC_w = \frac{\sum(C_n \times A_{DC\text{-}LC\text{-}n} \times RC_{DC\text{-}LC\text{-}n})_w}{\sum(C_n \times A_{SW\text{-}LC\text{-}n} \times RC_{SW\text{-}LC\text{-}n} + C_n \times A_{NPS\text{-}LC\text{-}n} \times RC_{NPS\text{-}LC\text{-}n} + C_n \times A_{DC\text{-}LC\text{-}n} \times RC_{DC\text{-}LC\text{-}n})_w} \times 100$$

Where,
C_n = tPCB clam concentration at sub-watershed n
$A_{SW\text{-}LC\text{-}n}$ = Area of LC class n (SW)*
$A_{NPS\text{-}LC\text{-}n}$ = Area of LC class n (NPS)*
$A_{DC\text{-}LC\text{-}n}$ = Area of LC class n (DC)*
$RC_{SW\text{-}LC\text{-}n}$ = Runoff coefficient for LC class n (SW)
$RC_{NPS\text{-}LC\text{-}n}$ = Runoff coefficient for LC class n (NPS)
$RC_{DC\text{-}LC\text{-}n}$ = Runoff coefficient for LC class n (DC)
$_w$ = Watershed (i.e., NEB or NWB)
*These values are representative of the immediate sub-watershed drainage area (i.e., do not include upstream sub-watershed areas).

RC = 0.05 + 0.9 × Impervious Fraction (SMRC 2009) 〔Equation 2〕

Prior to performing these calculations, the land cover areas associated with the identified contaminated sites were subtracted. Areas regulated by the Maryland NPDES stormwater permits are represented in this analysis by the following 2006 land cover classifications: developed open space and low intensity, medium intensity, and high intensity urban (USGS 2009). The remaining land cover classifications in the Maryland portion of these watersheds are included in the Maryland Unregulated Watershed Runoff Baseline Loads. DC PCB baseline loads are not presented in terms of regulated and unregulated loads, but instead they are presented as a single DC Upstream Watershed Baseline Load (see Table 6).

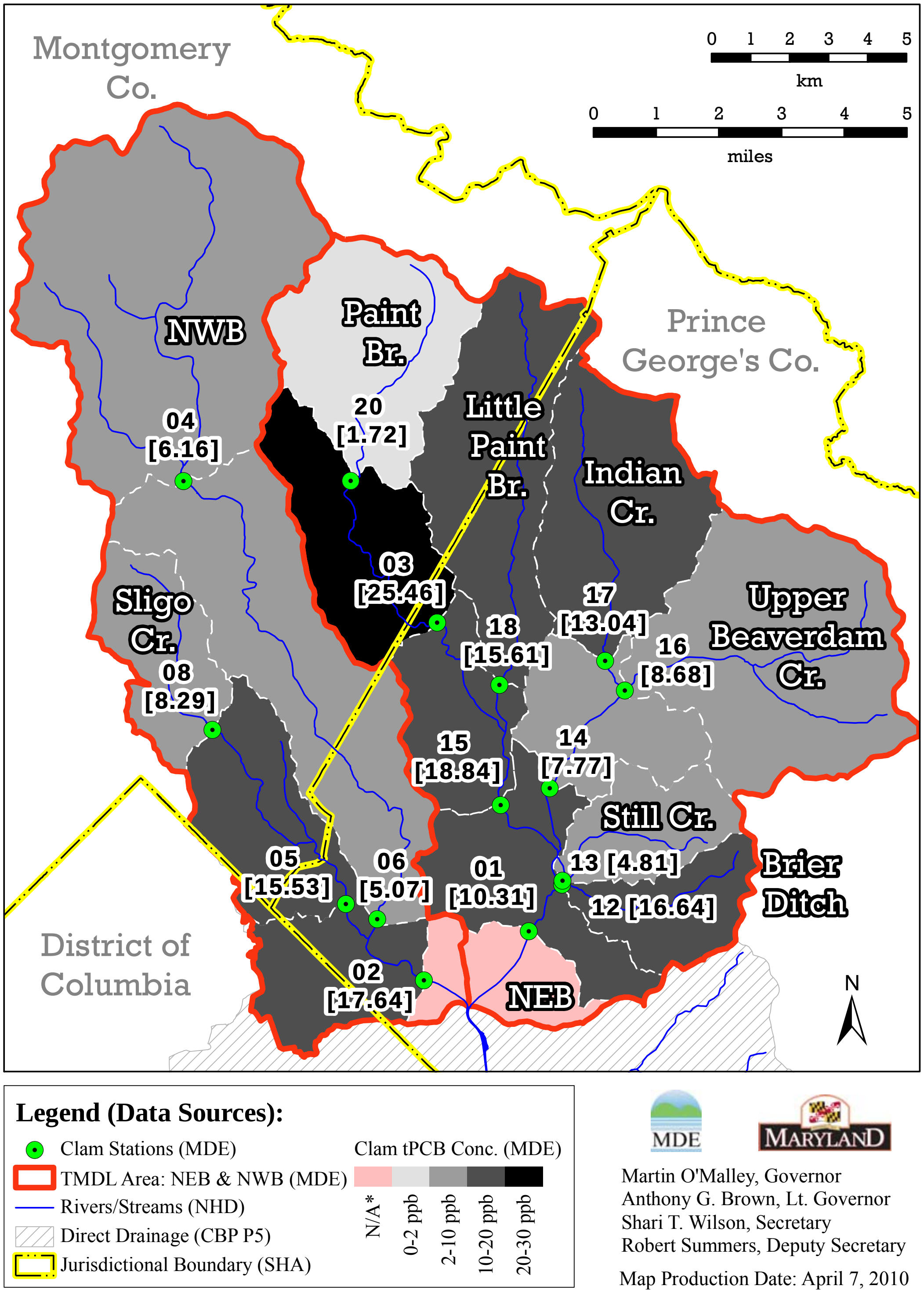
Table 6: 2006 Land Cover Classes and Associated Source Categories

<table>
<tr><th rowspan="2">Code</th><th rowspan="2">Land Cover Classes*</th><th colspan="2">Source Categories</th></tr>
<tr><th>Maryland</th><th>Washington, DC</th></tr>
<tr><td>21</td><td>Developed Open Space</td><td rowspan="4">SW</td><td rowspan="12">DC</td></tr>
<tr><td>22</td><td>Low Intensity Urban</td></tr>
<tr><td>23</td><td>Medium Intensity Urban</td></tr>
<tr><td>24</td><td>High Intensity Urban</td></tr>
<tr><td>11</td><td>Open Water</td><td rowspan="8">NPS</td></tr>
<tr><td>31</td><td>Barren</td></tr>
<tr><td>32</td><td>Unconsolidated Shore</td></tr>
<tr><td>40</td><td>Forest</td></tr>
<tr><td>52</td><td>Scrub Shrub</td></tr>
<tr><td>71</td><td>Grassland Herbaceous</td></tr>
<tr><td>80</td><td>Agricultural</td></tr>
<tr><td>90</td><td>Wetland</td></tr>
</table>

Note: *USGS 2009.

Clam Study

In 2007, MDE conducted a caged clam study in the Anacostia River nontidal watershed with the intent of using this information to further characterize the NEB and NWB Tributary PCB Baseline Loads defined as part of the Tidal Potomac and Anacostia PCB TMDL (MDE 2007). The rationale for using a bivalve exposure study, as opposed to ambient water quality or extensive sediment studies, was that the results focus on those PCB congeners that are bioavailable to aquatic organisms (i.e., a fraction of tPCB that enter the food web). Also, because clams filter-feed over an extended period of time, the results are more representative of the average long-term conditions when compared with ambient water column grab samples.



Note: * N/A – refers to the most downstream sub-watersheds in each basin, where clam concentrations are not available. For the purpose of the NEB and NWB PCB TMDL analysis clam data from the most adjacent station were used instead.

Figure 7: Location of Clam Stations in the NEB and NWB Tributary Drainage Basins

The study was conducted in a similar manner as described in MDE's 2005 clam study report (MDE 2009c). MDE personnel carried out all of the activities associated with clam collection, deployment, and retrieval. Staff biologists collected Asiatic Clams, *Corbicula fluminea,* from a relatively uncontaminated population in the Upper Choptank River at Red Bridges (i.e., reference site). Caged clams were then deployed throughout the NEB and NWB tributaries (see Figure 7). Samples were retrieved, depurated, frozen, and stored for tissue removal and PCB analysis after either 14 or 28 days of deployment. PCB analytical services were provided by the University of Maryland Center for Environmental Science (UMCES) (see Appendix E for the description of the analytical methods).

With a few exceptions, clams which were deployed over 28 days have been used in this analysis. In general, clam concentrations from all but one station (Station 20: 1.72 ng/g wet weight) were higher than the average reference concentration (2.21 ng/g wet weight, n= 9), indicating that there are existing sources of PCBs located throughout most of the NEB and NWB drainage areas. The highest and the lowest concentrations were observed in different portions of Paint Branch, a tributary of the NEB.

Clam concentrations were initially intended to be used to quantify PCB baseline loads in the specific sub-watersheds via a simple mass-balance approach. However, this was not feasible in certain areas of the watershed, where downstream concentrations were lower than upstream concentrations. This loss of mass could not be accounted for in the calculation. Consequently, after accounting for WWTP and Contaminated Site PCB Baseline Loads, a weighted approach was used (see Equation 1) to distribute the remaining NEB and NWB Tributary PCB Baseline Loads between Maryland NPDES Regulated Stormwater, Maryland Unregulated Watershed Runoff, and DC Upstream Watershed source categories. This approach incorporates the best available information pertaining to PCB loadings from the sub-watersheds making up the NEB and NWB drainage basins, as well as the associated land cover categories and runoff coefficients, attributing the highest loads to areas with the highest clam tPCB concentrations and the highest runoff coefficients.

The majority of the loads are attributed to the Maryland NPDES Regulated Stormwater source category (see Table 7), which is consistent with information provided in a journal article by Hwang and Foster (2008), where urban stormwater is identified as a likely major source of PCBs to the Anacostia River. Also, the San Francisco Bay PCB TMDL (2008) points out that "contribution to the total load from non-urban runoff [in the San Francisco Bay watershed] is much smaller than that from urban runoff since the mean sediment concentration in open spaces is about 2 µg/kg, whereas it is about 500 µg/kg in urban spaces" (SFBRWQCB 2009).

2.3.4. Summary

In summary, areas of the watershed served by Maryland NPDES Regulated Stormwater followed by the DC Upstream Watershed and Maryland Unregulated Watershed Runoff constitute the major PCB sources in the NEB and NWB drainage basins. The remaining sources (particularly the identified Contaminated Sites and WWTP) comprise a relatively smaller portion of the Total Baseline Load (0.38% and 0.19%, respectively). Table 7 summarizes the estimated Total PCB Baseline Loads from all identified source categories.

Table 7: Summary of the NEB and NWB PCB Baseline Loads

Northeast Branch		
Source	**Baseline Load (g/yr)**	**Baseline Contribution (%)**
MD Unregulated Watershed Runoff	36.90	8.60
MD Contaminated Site Runoff	1.61	0.38
Nonpoint Source Baseline Loads	38.51	***8.98***
MD WWTPs	0.795	0.19
MO Co. NPDES Regulated Stormwater[1]	112.57	26.24
PG Co. NPDES Regulated Stormwater[2]	277.12	64.60
Point Source Baseline Loads	***390.49***	***91.02***
Total	**429**	**-**

Northwest Branch		
Source	**Baseline Load (g/yr)**	**Baseline Contribution (%)**
MD Unregulated Watershed Runoff	20.5	6.88
DC Upstream Watershed[3]	49.9	16.76
Nonpoint Source Baseline Loads	***70.4***	***23.64***
MO Co. NPDES Regulated Stormwater[1]	134.5	45.14
PG Co. NPDES Regulated Stormwater[2]	93.0	31.22
Point Source Baseline Loads	***227.6***	***76.36***
Total	**298**	**-**

Notes: [1] Montgomery County (MO Co.) NPDES Regulated Stormwater – refers to all known NPDES stormwater dischargers within Montgomery County NEB and NWB drainage basin, which are identified in Appendix C.

[2] Prince George's County (PG Co.) NPDES Regulated Stormwater – refers to all known NPDES stormwater dischargers within Prince George's County NEB and NWB drainage basin, which are identified in Appendix C.

[3] Point sources in the Washington, DC portion of the watershed have not been characterized.

3. TMDL ENDPOINTS

The objective of this report is to establish NEB and NWB PCB TMDLs supportive of the "fishing" designated use, which is protective of human health related to consumption of fish caught in these tributaries. Additionally, given that the downstream tidal waters are also impaired for PCBs in fish tissue and an already approved Tidal Potomac and Anacostia PCB TMDL report calls for 98% reductions of the NEB and NWB Tributary Baseline Loads in order to meet downstream TMDL targets (MDE 2007), the PCB TMDLs developed for the NEB and NWB will need to be at least as protective as the tributary allocations proposed in the Tidal PCB TMDL.

As described in Section 2.2, MDE evaluates PCB water quality conditions with the use of either the Maryland water column human health tPCB criterion (0.64 ng/L, ppt) or the tPCB fish tissue listing threshold (currently 39 ng/g, ppb). For the purpose of addressing the NEB and NWB PCB listings, the 0.64 ng/L water column criteria is used as the TMDL endpoint.

Table 8: Baseline PCB Load Reductions Required to Meet Maryland Water Column Human Health Criterion in the NEB and NWB

	NEB	NWB
Average tPCB (ng/L)	3.35	4.30
Water Column Human Health Criterion (ng/L)	0.64	
Required Baseline Load Reduction to Meet MD Water Column Human Health Criterion	**81%**	**85%**

As summarized in Table 8, on average the tPCB baseline (i.e., 2004-2005) concentrations in the NEB and NWB will need to be reduced by 81% and 85%, respectively in order to meet WQS that are protective of the "fishing" designated use in these tributaries. Since the Tidal Potomac and Anacostia PCB TMDL tributary allocations require higher PCB load reductions than would be necessary to meet WQS in the NEB and NWB tributaries (see Table 9), the Tidal PCB TMDL allocations have been adopted as the NEB and NWB PCB TMDLs.

Table 9: Comparison of Baseline Load Reductions Required to Meet Downstream TMDL Targets and Maryland Water Column Human Health Criterion in the NEB and NWB

	NEB	NWB
Required Baseline Load Reduction to Meet Downstream Tidal TMDL Targets	98%	98%
Required Baseline Load Reduction to Meet MD Water Column Human Health Criterion in NEB and NWB	81%	85%

4. TOTAL MAXIMUM DAILY LOADS AND LOAD ALLOCATIONS

4.1. Overview

A TMDL is the total amount of an impairing substance that a waterbody can receive and still meet WQSs. The TMDL may be expressed as a mass per unit time, toxicity, or other appropriate measure and should be presented in terms of wasteload allocations (WLAs), load allocations (LAs), and either implicitly or explicitly margin of safety (MOS) (CFR 2010a):

$$TMDL = WLAs + LAs + MOS \qquad \text{(Equation 3)}$$

This section describes how the PCB TMDL and the corresponding LAs and WLAs have been developed for the NEB and NWB watersheds. The analysis framework is described in Section 4.2, Section 4.3 addresses critical conditions and seasonality, while Section 4.4 presents the allocation of loads between point and nonpoint sources. The MOS is discussed in Section 4.5. Finally, the TMDL is summarized in Section 4.6.

4.2. Analysis Framework

Given that the Tidal Potomac and Anacostia PCB TMDLs already dictate reductions from the NEB and NWB that are required in order to meet WQSs in the Tidal Potomac and Anacostia Rivers and that these reductions were deemed protective of the "fishing" designated use in the NEB and NWB (see Section 3), no additional modeling was necessary in order to establish NEB and NWB TMDL values. Instead, the main purpose of the NEB and NWB TMDL effort summarized in this report was to further characterize NEB and NWB Tributary Baseline Loads in terms of specific source categories (see Section 2.3 and Equation 4) and provide each source category with appropriate baseline and TMDL allocations.

4.3. Critical Conditions and Seasonality

Federal regulations require that TMDL analysis take into account the impact of critical conditions and seasonality on water quality (CFR 2010b). The intent of this requirement is to ensure that the water quality is protected during the most vulnerable times. The TMDLs presented in this document implicitly account for seasonal variations as well as critical conditions. Given that at the observed concentrations acute conditions are not a concern and since PCB levels in fish become elevated due to long-term exposure, rather than temporary spikes in water column PCB concentration, it has been determined that the selection of the average PCB concentration as representing the baseline conditions adequately considers the impact of seasonal variations and critical conditions on the "fishing" designated use in the NEB and NWB. Furthermore, in order to meet downstream water quality standards (i.e., in Tidal Anacostia and Potomac Rivers), the proposed NEB and NWB TMDLs are lower (i.e., more protective) than would otherwise be required to meet water column concentrations protective of the "fishing" designated use in the NEB and NWB.

4.4. TMDL Allocations

All TMDLs need to be presented in terms of WLAs for point sources and LAs for nonpoint source loads generated within the assessment unit, and if applicable LAs for the natural background, tributary, and adjacent segment loads (CFR 2010a). As part of the TMDL analysis presented in this report, point sources have been identified throughout the Maryland portion of the NEB and NWB tributary drainage basins and include two WWTPs and Maryland NPDES Regulated Stormwater discharges (presented separately for Montgomery and Prince George's County). Nonpoint sources include identified contaminated sites in the Maryland portion of the watershed, unregulated watershed runoff within the Maryland portion of these watersheds, and DC upstream watershed sources (see Equation 4).

$$TMDL_w = WLA_{WWTP} + WLA_{SW} + LA_{CS} + LA_{MD} + LA_{DC} + MOS \quad \text{(Equation 4)}$$

Where:

$TMDL_w$ = Watershed TMDL (presented separately for NEB and NWB)
WLA_{WWTP} = WWTP WLA
WLA_{SW} = NPDES Regulated Stormwater WLA (presented separately for Montgomery and Prince George's County)
LA_{CS} = Contaminated Site LA
LA_{MD} = MD Unregulated Watershed Runoff LA
LA_{DC} = DC Upstream Watershed LA
MOS = Margin of Safety

This section summarizes the NEB and NWB of the Anacostia River PCB TMDL allocations. The State reserves the right to revise these allocations among different sources as long as they remain protective of the "fishing" designated use in the NEB and NWB of the nontidal Anacostia River.

4.4.1. Point Sources

Waste Water Treatment Plant

WWTP WLAs were calculated as the facilities' design flow times the Maryland water column human health tPCB criterion. The estimated WWTP PCB WLA is 0.725 g/yr (see Table 10), which constitutes an overall reduction of 8.83% from the estimated Baseline Load. Given that the WWTP Baseline Loads are based on very limited water quality data, the actual loads might be slightly different. Thus, this characterization of WWTP Baseline Loads will need to be evaluated during the initial stages of the implementation process. This information will help to better characterize the actual loadings from these facilities and ensure that they are not contributing to the exceedance of the Maryland water column tPCB criteria.

Table 10: WWTP PCB Waste Load Allocations

WWTP	NPDES	MD tPCB Water Column Criterion (ng/L)	Design Flow (MGD)	PCB WLA[1] (g/yr)	Load Reduction ↓ or Allowable Increase ↑ (%)
USDA East	MD0020842	0.64	0.620	0.548	17.4↓
USDA West	MD0020851	0.64	0.200	0.177	34.3↑
Total WWTP PCB WLA				***0.725***	***8.83↓***

Note: [1]WWTP WLA = MD tPCB Water Column Criterion × Facility Design Flow

NPDES Regulated Stormwater

Per US EPA requirements, "stormwater discharges that are regulated under Phase I or Phase II of the NPDES stormwater program are point sources that must be included in the WLA portion of a TMDL" (US EPA 2002). US EPA recognizes that available data and information are usually not detailed enough to determine WLAs for NPDES regulated stormwater discharges on an outfall-specific basis (US EPA 2002). Therefore, NPDES regulated stormwater allocations to the NEB and NWB of the nontidal Anacostia River watershed will be expressed as a single WLA for each County. Upon approval of the TMDLs, "NPDES-regulated municipal stormwater and small construction storm water discharges effluent limits should be expressed as BMPs or other similar requirements, rather than as numeric effluent limits" (US EPA 2002).

The NPDES Regulated Stormwater WLAs were established by reducing NPDES Regulated Stormwater Baseline Loads by 98.64% and 98.10% in NEB and NWB, respectively (see Table 11). For more information on methods used to calculate the NPDES Regulated Stormwater PCB Baseline Loads, please see Section 2.3.3. The NPDES Regulated Stormwater WLAs may include any or all of the NPDES stormwater discharges listed in Section 2.3; see Appendix C for a list of specific stormwater permits within the watershed. As stormwater assessment and/or other program monitoring efforts result in a more refined source assessment, MDE reserves the right to revise the current NPDES Regulated Stormwater WLA provided the revisions are protective of the "fishing" designated use in the NEB and NWB of the nontidal Anacostia River watershed.

4.4.2. Nonpoint Sources

Load allocations have been assigned to the following nonpoint sources: contaminated sites within the Maryland portion of the watershed, unregulated watershed runoff within the Maryland portion of the watershed, and DC upstream watershed. Given that a number of contaminated sites have already undergone remediation and their baseline loads constitute a relatively small percentage of the Total Baseline Load (i.e., 0.38%), these sites are not intended to be targeted during the initial stages of implementation and thus at this point were not subjected to any reductions. However, if in the future it becomes clear that the TMDL goals cannot be achieved without load reductions from these sites, additional reduction measures might need to be considered. As for the remaining nonpoint sources, LAs to the Unregulated Watershed Runoff within the Maryland portion of the watershed and DC Upstream Watershed were established by reducing the Baseline Loads from each source category by 98.64% and 98.10% in the NEB and NWB, respectively (see Table 11).

4.5. Margin of Safety

All TMDLs must include a margin of safety to account for the lack of knowledge and the many uncertainties in the understanding and simulation of water quality parameters in natural systems (i.e., the relationship between modeled loads and water quality). The MOS is intended to account for such uncertainties in a manner that is conservative from the standpoint of environmental protection. In the methods used to establish the NEB and NWB Tributary PCB TMDLs, which are the bases of the TMDLs presented in this report, in addition to an implicit MOS incorporated through the use of conservative assumptions, an explicit MOS equal to 5% of the TMDL was reserved for loadings from tributary sources (MDE 2007). This becomes the MOS for the NEB and NWB TMDLs (see Table 11).

4.6. Summary of Total Maximum Daily Loads

Table 11 summarizes the PCB TMDL allocations for the NEB and NWB of the nontidal Anacostia River watershed as well as the corresponding baseline loads, the maximum daily loads (MDLs) (see Appendix B for details regarding MDL calculations), and the associated percent reductions.

Table 11: Summary of PCB Baseline Loads, TMDL Allocations, MDLs, and Associated Percent Reductions

Northeast Branch				
Source	**Baseline (g/yr)**	**TMDL (g/yr)**	**Reduction (%)**	**MDL (mg/day)**
MD Unregulated Watershed Runoff	36.90	0.50	98.64	6.66
MD Contaminated Site Runoff	1.61	1.61	0.00	21.34
Nonpoint Source Baseline Loads / LAs	***38.51***	***2.11***	***94.52***	***27.99***
MD WWTPs	0.795	0.725	8.83	6.19
MO Co.[1] NPDES Regulated Stormwater	112.57	1.53	98.64	20.30
PG Co.[2] NPDES Regulated Stormwater	277.12	3.77	98.64	49.98
Point Source Baseline Loads / WLAs	***390.49***	***6.03***	***98.46***	***76.46***
Margin of Safety (5%)	***-***	***0.43***	***-***	***5.50***
Total	**429**	**8.57**	**98**	**109.96**

Northwest Branch				
Source	**Baseline (g/yr)**	**TMDL (g/yr)**	**Reduction (%)**	**MDL (mg/day)**
MD Unregulated Watershed Runoff	20.5	0.39	98.10	4.97
DC Upstream Watershed[3]	49.9	0.95	98.10	12.11
Nonpoint Source Baseline Loads / LAs	***70.4***	***1.34***	***98.10***	***17.08***
MO Co.[1] NPDES Regulated Stormwater	134.5	2.56	98.10	32.62
PG Co.[2] NPDES Regulated Stormwater	93.0	1.77	98.10	22.57
Point Source Baseline Loads / WLAs	***227.6***	***4.32***	***98.10***	***55.19***
Margin of Safety (5%)	***-***	***0.30***	***-***	***3.80***
Total	***298***	***5.96***	***98***	***76.07***

Notes: [1] Montgomery County (MO Co.) NPDES Regulated Stormwater – refers to all known NPDES stormwater dischargers within Montgomery County NEB and NWB drainage basin, which are identified in Appendix C.

[2] Prince George's County (PG Co.) NPDES Regulated Stormwater – refers to all known NPDES stormwater dischargers within Prince George's County NEB and NWB drainage basin, which are identified in Appendix C.

[3] Point sources in the Washington, DC portion of the watershed have not been characterized.

5. ASSURANCE OF IMPLEMENTATION

The TMDLs presented in this report call for substantial reductions in PCB loads from diffuse sources present throughout the two highly urbanized watersheds. Given that PCBs are no longer manufactured and their use has been substantially restricted, it is reasonable to expect that with time PCB concentrations in the aquatic environment will decline due to natural attenuation, such as burial of contaminated sediments with newer, less contaminated materials, flushing of sediments during periods of high stream flow, and biodegradation. Data from other parts of the state indicate that PCB levels in ambient water are declining (MDE 2009d). However, PCBs are still being released to the environment via accidental fires, leaks, or spills from older PCB-containing equipment; potential leaks from hazardous waste sites that contain PCBs; illegal or improper dumping; and disposal of PCB containing products (e.g., transformers, old fluorescent lighting fixtures, electrical devices, or appliances containing PCB capacitors, old microscope oil, and old hydraulic oil) into landfills that are not designed to handle hazardous waste. Therefore, natural attenuation alone is not expected to completely eliminate the PCB impairment in the NEB and NWB.

Due to the potential existence of unidentified sources of PCB contamination through the watershed and the significant load reductions required to meet the PCB water column criteria, achievement of the NEB and NWB PCB TMDLs may not be feasible by solely enforcing effluent limitations on known point sources and implementing best management practices (BMPs) on nonpoint sources. Therefore, an adaptive approach of implementation is anticipated, with subsequent monitoring to assess the effectiveness of the ongoing implementation efforts to manage potential risks to both recreational and subsistence fish consumers.

The success of the implementation process will depend in large part on the feasibility of locating and evaluating opportunities to control on-land PCB sources, such as unidentified contaminated sites, leaky equipment, and contaminated soil or sediment. A collaborative approach involving MDE and the identified NPDES permit holders as well as those responsible for nonpoint PCB runoff throughout the watersheds will be used to work toward attaining the WLAs and LAs presented in this report. The reductions will be implemented in an adaptive and iterative process, focusing first on sources with the largest impact on water quality while giving consideration to the relative cost and ease of implementation. The implementation efforts will be periodically evaluated, and if necessary, improved, in order to further progress toward achieving the water quality goals. The implementation actions will focus first on the sub-watersheds with the highest clam tPCB concentrations (see Figure 7), since the discovery and elimination of ongoing PCB sources in these sub-watersheds is expected to produce the most beneficial results.

Any future monitoring should include congener specific analytical methods. Ideally, the most current version of EPA Method 1668 should be used, or other equivalent methods capable of providing low-detection level, congener specific results. In establishing the necessity and extent of data collection, MDE will collaborate with the affected stakeholders, and take into account data that is already available as well as the proper characterization of intake (or pass through) conditions, consistent with NPDES program “reasonable potential” determinations and the applicable provisions of the Environment Article and the Code of Maryland Regulations for permitted facilities.

Under certain conditions, EPA’s NPDES regulations allow the use of non-numeric, BMP water quality based effluent limits (WQBELs). BMP WQBELs can be used where “numeric effluent limitations are infeasible; or the practices are reasonably necessary to achieve effluent limitations and standards or to carry out the purposes and intent of the CWA" (CFR 2010c). For example, MDE's Phase I MS4 permits require restoration targets for impervious surfaces (i.e., restore 10% or 20% of a jurisdiction's total impervious cover with no stormwater management/BMPs), and these restoration efforts have known TSS reduction efficiencies. Since PCBs are known to adsorb to sediments and their concentrations correlate with TSS concentrations, the significant restoration requirements in the MS4 permits, which will lead to a reduction in sediment loads entering the NEB and NWB stream network, will also contribute toward PCB load reductions and meeting PCB water quality goals. Other BMPs that focus on PCB source tracking and elimination at the source rather than end-of-pipe controls are also warranted. Due to this known relationship between TSS and PCB concentrations, implementation of the existing TMDLs for sediments and nutrients in the Anacostia River watershed will further progress towards achieving the NPDES Regulated Stormwater WLAs, and additionally the nonpoint source LAs.

Where necessary, the source characterization efforts will be followed with pollution minimization and reduction measures that will include BMPs for reducing runoff from urban areas, identification and termination of ongoing sources (e.g., industrial uses of equipment that contain PCBs), etc. The identified NPDES regulated WWTP and stormwater control agency permits will be expected to be consistent with the WLAs presented in this report. Both WWTPs in the watersheds are owned and operated by the United States Department of Agriculture. Numerous stormwater dischargers are located in the NEB and NWB of the nontidal Anacostia River watershed including two Municipal Phase I MS4s (Montgomery and Prince George's counties), the State Highway Administration Phase I MS4, 40 industrial facilities, 14 Phase II Municipal MS4s, State and Federal Phase II MS4s, and any construction activities on area greater than 1 acre (see Appendix C of this document to view the current list of known NPDES stormwater dischargers). The current Montgomery County Phase I MS4 permit already requires that the jurisdiction develops an implementation plan to meet its assigned NPDES Regulated Stormwater WLAs. Similar requirements are expected to be put in place in the future Prince George's County and Maryland State Highway Administration Phase I MS4 permits. Additionally, the appropriate Washington, DC agencies will also need to investigate and eliminate possible sources of PCBs in the DC portion of the NWB drainage basin due to their influence on PCB conditions in NWB and tidal Anacostia River.

Private, public, and governmental properties known by the state to be contaminated or have the potential for contamination are identified on the State Master List, otherwise known as the list of State Superfund sites. Newly identified sites can be added to the State Master List via the federal Superfund cleanup process, which begins with site discovery or notification to EPA of possible releases of hazardous substances. Sites can be discovered by various parties including citizens, state agencies, and EPA Regional offices. Once discovered, sites are entered into EPA's computerized inventory of potential hazardous substance release sites [i.e., Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)], which are then evaluated by EPA through the Superfund cleanup process (US EPA 2010a). The Clean Water State Revolving Loan Fund administered by MDE provides low interest loans for cleanup costs to complete approved cleanup plans for sites on the State Master List or in the Voluntary Cleanup Program (VCP), where water quality is an issue.

Given that a number of contaminated sites have already undergone remediation and their baseline loads constitute a relatively small percentage of the Total Baseline Load (i.e., 0.38%), these sites are not intended to be targeted during the initial stages of implementation and thus at this point were not subjected to any reductions. However, if in the future it becomes clear that the TMDL goals cannot be achieved without load reductions from these sites, additional reduction measures might need to be considered.

Given the persistent nature of PCBs, the difficulty in removing them from the environment, and the significant reductions necessary in order to achieve water quality goals in the NEB and NWB, effectiveness of the implementation effort will need to be reevaluated throughout the process to ensure progress is being made towards reaching the TMDLs. As part of Maryland's Watershed Cycling Strategy, follow-up monitoring and assessment will be routinely conducted to evaluate the implementation status in the NEB and NWB. MDE also periodically monitors and evaluates concentrations of contaminants in recreationally caught fish, shellfish, and crabs throughout Maryland. MDE will use these monitoring programs to evaluate progress towards meeting the "fishing" designated use in NEB and NWB.

REFERENCES

Ashley, J. T. F., and J. E. Baker. 1999. Hydrophobic Organic Contaminants in Surficial Sediments of Baltimore Harbor: Inventories and Sources. *Environmental Toxicology and Chemistry* 18 (5): 838-849.

CFR (Code of Federal Regulations). 2010a. *40 CFR 130.2*. http://www.gpo.gov/nara/cfr/waisidx_98/40cfr130_98.html (Accessed February, 2010).

____________. 2010b. *40 CFR 130.7*. http://www.gpo.gov/nara/cfr/waisidx_98/40cfr130_98.html (Accessed February, 2010).

____________. 2010c. *40 CFR 122.44(k)*. http://www.access.gpo.gov/nara/cfr/waisidx_98/40cfr122_98.html (Accessed February, 2010)

COMAR (Code of Maryland Regulations). 2010a. *26.08.02.07*. http://www.dsd.state.md.us/comar/searchall.aspx (Accessed February, 2010).

____________. 2010b. *26.08.02.08 O(3)(a)*. http://www.dsd.state.md.us/comar/searchall.aspx (Accessed February, 2010).

____________. 2010c. *26.08.02.08 O(5)(b)*. http://www.dsd.state.md.us/comar/searchall.aspx (Accessed February, 2010).

____________. 2010d. *26.08.02.02*. http://www.dsd.state.md.us/comar/searchall.aspx (Accessed February, 2010).

____________. 2010e. *26.08.02.03-2G(4)*. http://www.dsd.state.md.us/comar/searchall.aspx (Accessed February, 2010).

____________. 2010f. *26.08.02.04 & 26.08.02.04-1*. http://www.dsd.state.md.us/comar/searchall.aspx (Accessed February, 2010).

Foster, G. D., K. A. Lippa, and C. V. Miller. 2000. Seasonal Concentrations of Organic Contaminants at the Fall Line of the Susquehanna River Basin and Estimated Fluxes to Northern Chesapeake Bay, USA. *Environmental Toxicology and Chemistry* 19: 992–1001.

Hwang, H. M. and G. D. Foster. 2004. Polychlorinated biphenyls in stormwater runoff entering the tidal Anacostia River, Washington, DC, through small urban catchments and combined sewer outfalls. *Journal of Environmental Science and Health* 43: 567-575.

LWA (Larry Walker Associates). 2010. *Calleguas Creek Watershed OC Pesticides and PCBs TMDL Technical Report – April 25 2005*. http://www.epa.gov/waters/tmdldocs/calleguastoxicsalldocs.pdf (Accessed January, 2010).

MDE (Maryland Department of the Environment). 2007. *Total Maximum Daily Loads of Polychlorinated Biphenyls (PCBs) for Tidal Portions of the Potomac and Anacostia Rivers in the District of Columbia, Maryland, and Virginia*. Rockville, MD: Interstate Commission on the Potomac River Basin. Also available at http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/ApprovedFinalTMDL/TMDL_final_Potomac_PCBs.asp#PCBs_TMDL_Potomac_River__Middle_Tidal.

____________. 2008. *The 2008 Integrated Report of Surface Water Quality in Maryland*. Baltimore, MD: Maryland Department of the Environment. Also available at http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/Maryland%20303%20dlist/2008_Final_303d_list.asp.

___________. 2009a. *Maryland Tier II Dataset.* Baltimore, MD: Maryland Department of the Environment.

___________. 2009b. *Statewide Fish Consumption Guidelines for All Ages: Table (July 2007).* http://www.mde.state.md.us/CitizensInfoCenter/FishandShellfish/index.asp (Accessed December 2009).

___________. 2009c. *2005 Caged Clam Study to Characterize PCB Bioavailability in the Impaired Watersheds Throughout the State of Maryland*. Annapolis, MD: Maryland Department of the Environment. Also available at http://www.mde.state.md.us/assets/document/2005_Corbicula_Study_final.pdf.

___________. 2009d. *Total Maximum Daily Loads of Polychlorinated Biphenyls in Northeast River, Tidal Fresh Segment, Cecil County, Maryland – FINAL DRAFT*. Baltimore, MD: Maryland Department of the Environment. Also available at http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/Pub_Notice/TMDL_PN_NortheastRiver_PCBs.asp.

___________. 2010. *Land Restoration Program's Geospatial Database (LRP-MAP).* Baltimore, MD: Maryland Department of the Environment. http://167.102.241.76/mde_lrp (Accessed January, 2010).

MWCOG (Metropolitan Washington Council of Governments). 2008. *Anacostia Watershed Environmental Baseline Conditions and Restoration Report - Final Draft*. Also available at: http://www.anacostia.net/Restoration_Plan/download/Appendix%20A_Anacostia%20Baseline%20Conditions.pdf

QEA (Quantitative Environmental Analysis, LLC). 1999. *PCBs in the Upper Hudson River – Volume I, Historical Perspective and Model Overview*. Albany, NY: Quantitative Environmental Analysis, LLC – Prepared for General Electric Company.

RETEC (The RETEC Group, Inc.). 2002. *Remedial Investigation Report Lower Fox River and Green Bay, Wisconsin - Prepared for Wisconsin Department of Natural Resources*. Also Available at http://www.dnr.state.wi.us/org/water/wm/foxriver/remedialinvestigation.html.

SFBRWQCB (San Francisco Bay Regional Water Quality Control Board). 2009. *Total Maximum Daily Load for PCBs in San Francisco Bay Staff Report for Proposed Basin Plan Amendment – February 6, 2008*. San Francisco Bay Regional Water Quality Control Board, Oakland, California. http://www.swrcb.ca.gov/water_issues/programs/tmdl/#rb2 (Accessed December 2009).

SMRC (Stormwater Manager's Resource Center). 2009. *The Simple Method to Calculate Urban Stormwater Loads*. http://www.stormwatercenter.net/monitoring%20and%20assessment/simple%20meth/simple.htm (Accessed December 2009).

US Census Bureau. 2000. *2000 Census*. Washington, DC: US Census Bureau.

US EPA (U.S. Environmental Protection Agency). 1991. *Technical Support Document (TSD) for Water Quality-based Toxics Control*. Washington, DC: U.S. Environmental Protection Agency. Also available at http://www.epa.gov/npdes/pubs/owm0264.pdf.

___________. 2002. *Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs*. Washington, DC: U.S. Environmental Protection Agency.

___________. 2006. *National Recommended Water Quality Criteria*. Washington, DC: U.S. Environmental Protection Agency, Office of Science and Technology.

___________. 2007. *Options for the Expression of Daily Loads in TMDLs (DRAFT 6/22/07)*. Washington, DC: U.S. Environmental Protection Agency, Office of Wetlands, Oceans & Watersheds. Also available at www.epa.gov/owow/tmdl/draft_daily_loads_tech.pdf.

___________. 2010a. *Superfund Cleanup Process*. http://www.epa.gov/superfund/cleanup/index.htm) (Accessed May, 2010).

___________. 2010b. *Superfund Site Information Database*. http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm (Accessed January, 2010).

USDA (United States Department of Agriculture). 1983. Sediment Sources, Yields, and Delivery Ratios. In *National Engineering Handbook, Section 3, Sedimentation*. Washington, D.C: United States Department of Agriculture, Natural Resources Conservation Service.

USGS (United States Geological Survey). 2009. 2006 National Land Cover Dataset Chesapeake Bay Area, Modified Version 1.0. Annapolis, MD: United States Geological Survey, Chesapeake Bay Program Office.

Appendix A. List of Individual tPCB Measurements

The NEB and NWB tPCB water column data presented in Table A-1 were collected and analyzed by the Department of Chemistry and Biochemistry at GMU (for a description of analytical methods used, please see Appendix E).

Table A-1: Water Column tPCB Concentrations

Northeast Branch					Northwest Branch				
Date	**Partic. tPCB (ng/L)[1]**	**Diss. tPCB (ng/L)[2]**	**Partic. + Diss. tPCB (ng/L)**	**Flow (cfs)[3]**	**Date**	**Partic. tPCB (ng/L)**	**Diss. tPCB (ng/L)**	**Partic. + Diss. tPCB (ng/L)**	**Flow (cfs)**
4/21/2004	0.565	0.190	0.755	60	4/21/2004	0.679	0.163	0.843	46
5/26/2004	0.383	1.035	1.417	45	5/26/2004	0.583	1.541	2.125	43
6/23/2004	0.546	0.252	0.799	34	6/23/2004	0.345	0.248	0.592	19
7/14/2004	0.717	0.445	1.161	66	7/14/2004	0.193	0.347	0.541	28
12/7/2004	0.997	0.706	1.703	115	1/11/2005	0.098	0.928	1.026	28
1/11/2005	0.328	0.430	0.757	115	2/8/2005	0.221	0.522	0.743	41
2/8/2005	0.143	0.541	0.683	69	6/15/2005	0.010	0.333	0.344	20
6/15/2005	0.017	0.201	0.218	25	9/20/2005	0.026	0.213	0.238	7
9/20/2005	0.045	0.049	0.095	11	6/23/2004	0.305	0.514	0.819	19
6/23/2004	0.375	0.581	0.956	34	7/14/2004	0.456	0.589	1.046	28
7/14/2004	0.849	0.452	1.301	66	8/18/2004	0.121	1.252	1.373	26
8/18/2004	0.717	0.339	1.055	48	1/11/2005	0.477	0.373	0.851	28
1/11/2005	0.107	0.706	0.813	48	2/8/2005	0.203	0.443	0.647	41
2/8/2005	0.216	0.611	0.827	69	4/13/2004	3.727	1.741	5.468	310
4/13/2004	3.283	2.905	6.188	557	4/23/2004	9.219	0.798	10.017	73
4/23/2004	8.587	1.094	9.680	117	5/7/2004	2.359	2.359	4.718	61
4/26/2004	1.564	0.524	2.088	162	6/11/2004	10.361	1.183	11.543	97
5/2/2004	2.964	1.219	4.183	251	6/17/2004	11.241	0.651	11.892	222
5/5/2004	0.497	0.508	1.005	73	6/25/2004	4.966	0.634	5.600	117
5/15/2004	1.794	0.950	2.744	38	7/7/2004	1.417	0.476	1.894	1010
5/27/2004	1.199	1.042	2.240	119	7/22/2004	3.212	0.627	3.839	67
6/5/2004	2.020	0.876	2.896	214	8/11/2004	0.000	1.328	1.328	605
6/11/2004	3.928	2.144	6.072	140	8/12/2004	5.819	2.483	8.302	605
6/17/2004	3.153	1.958	5.112	354	9/8/2004	1.936	0.827	2.762	20
6/25/2004	3.462	1.447	4.909	158	9/28/2004	9.263	0.760	10.023	375
7/7/2004	2.281	1.249	3.531	118	12/3/2004	0.727	0.472	1.199	134
7/22/2004	2.253	1.205	3.457	416	12/23/2004	10.115	2.051	12.166	401
8/11/2004	5.091	1.466	6.557	504	1/14/2005	3.065	0.978	4.043	1370
9/8/2004	1.760	0.672	2.432	100	3/23/2005	4.492	1.210	5.702	808
12/23/2004	14.449	1.222	15.671	509	4/2/2005	5.558	3.957	9.515	1210
1/14/2005	3.704	1.741	5.445	2110	5/20/2005	3.774	2.571	6.345	521
7/8/2005	4.500	1.392	5.893	975	7/8/2005	3.133	0.410	3.543	80
8/8/2005	1.595	0.478	2.073	145	7/15/2005	11.937	0.576	12.513	28
8/19/2005	2.571	0.476	3.047	90	10/7/2005	1.920	0.666	2.585	3810
10/7/2005	9.102	0.317	9.420	4320					

Notes: [1] Partic. = particulate.
[2] Diss. = dissolved.
[3] CFS = cubic feet per second.

On February 25, 2010 and March 30, 2010 MDE collected 24-hour-composite samples from USDA East and West WWTPs (NPDES: MD0020842 and MD0020851). These samples were analyzed by UMCES (for a description of analytical methods used, please see Appendix E). Data presented in Table A-2 have been adjusted based on levels detected in the blank samples and by excluding values for congeners with possible interferences (i.e., cong. 1, 3, and on one occasion cong. 40).

Table A-2: Adjusted WWTP tPCB Concentrations

USDA East				USDA West			
Date	**Partic. tPCB (ng/L)[1]**	**Diss. tPCB (ng/L)[2]**	**Partic. + Diss. tPCB (ng/L)**	**Date**	**Partic. tPCB (ng/L)**	**Diss. tPCB (ng/L)**	**Partic. + Diss. tPCB (ng/L)**
2/25/2010	0.073	2.397	2.470	2/25/2010	0.594	0.460	1.053
3/30/2010	0.173	2.160	2.333	3/30/2010	0.411	0.653	1.064

Notes: [1] Partic. = particulate.
[2] Diss. = dissolved.

Appendix B. Technical Approach Used to Generate Maximum Daily Load

Summary

This appendix documents the technical approach used to define the MDLs of tPCBs consistent with the average annual TMDLs, which are protective of the "fishing" designated use in the NEB and NWB of the Anacostia River watershed. The approach builds upon the analysis that was conducted to determine the average annual NEB and NWB PCB TMDLs and can be summarized as follows:

- The approach defines an MDL for each of the source categories;
- The approach builds upon the TMDL analysis that was conducted to ensure that the average annual TMDL results in compliance with water quality standards;
- The approach considers a daily load level of a resolution based on the specific data that exists for each source category.

Introduction

This appendix documents the development and application of the approach used to present the average annual PCB TMDL allocations in terms of daily loads. It is divided into sections discussing:

- Basis for approach;
- Options considered;
- Selected approach;
- Results of approach.

Basis for Approach

The overall approach for the development of daily loads was based upon the following factors:

- **Average Annual TMDL:** The basis of the average annual PCB TMDL is that the NEB and NWB Baseline Loads result in water column concentrations that exceed the tPCB criterion protective of the "fishing" designated use. Thus, the average annual PCB TMDL was calculated to be protective of this designated use.
- **Draft US EPA guidance document entitled *Options for the Expression of Daily Loads in TMDLs*** (US EPA 2007).

The rationale for developing TMDLs expressed as daily loads was to accept the existing average annual TMDLs, but then develop a method for converting these numbers to their corresponding MDLs – in a manner consistent with US EPA guidance and available information.

Options Considered

The draft US EPA guidance document for developing daily loads does not specify a single approach that must be adhered to, but rather it contains a range of acceptable options (US EPA 2007). The selection of a specific method for translating a time-series of allowable loads into the expression of an MDL requires decisions regarding both the level of resolution (e.g., single daily load for all conditions vs. loads that vary with environmental conditions) and level of probability associated with the exceedance of the TMDL. This section describes the options that were considered when developing methods to calculate the NEB and NWB MDLs.

Level of Resolution

The level of resolution pertains to the amount of detail used in specifying the MDL. The draft US EPA guidance on daily loads (US EPA 2007) provides three categories of options for level of resolution, all of which are potentially applicable to the NEB and NWB:

1. **Representative daily load:** In this option, a single daily load (or multiple representative daily loads) is specified that covers all time periods and environmental conditions.
2. **Flow-variable daily load:** This option allows the MDL to vary based upon the observed flow conditions.
3. **Temporally-variable daily load:** This option allows the MDL to vary based upon seasons or times of varying source or water body behavior (US EPA 2007).

Probability Level

All TMDLs have some probability of being exceeded, with the specific probability being explicitly specified or implicitly assumed. This level of probability directly or indirectly reflects two separate phenomena:

1. Water quality criteria consist of components describing acceptable magnitude, duration, and frequency. The frequency component addresses how often conditions can allowably surpass the combined magnitude and duration components.
2. Pollutant loads, especially from wet weather sources, typically exhibit a large degree of variability over time. It is rarely practical to specify a "never to be exceeded value" for a daily load, as essentially any loading value has some finite probability of being exceeded.

The draft daily load guidance document states that the probability component of the MDL should be "based on a representative statistical measure" that is dependent upon the specific TMDL and best professional judgment of the developers (US EPA 2007). This statistical measure represents how often the MDL is expected/allowed to be exceeded. The primary options for selecting this level of protection would be:

1. **The MDL reflects some central tendency:** In this option, the MDL is based upon the mean or median value of the range of loads expected to occur. The variability in the actual loads is not addressed.

2. **The MDL reflects a level of protection implicitly provided by the selection of some "critical" period**: In this option, the MDL is based upon the allowable load that is predicted to occur during some critical period examined during the analysis. The developer does not explicitly specify the probability of occurrence.
3. **The MDL is a value that will be exceeded with a pre-defined probability:** In this option, a "reasonable" upper bound percentile is selected for the MDL based upon a characterization of the variability of daily loads. For example, selection of the 95^{th} percentile value would result in an MDL that would be exceeded 5% of the time.

Selected Approach

The level of resolution selected for the NEB and NWB MDLs was a representative daily load, expressed as a single daily load for each loading source category. This approach was chosen due to the nature of PCBs and the TMDL endpoint that is protective of the "fishing" designated use. Occasional daily load exeedances are not expected to affect the long-term fish PCB bioaccumulation rate. An allocation at these levels of resolution is thus unwarranted. However, EPA recommends that all future TMDLs and associated LAs and WLAs be expressed in terms of daily time increments.

The approach selected for defining NEB and NWB MDLs was based upon the specific data that exists for each source category. The approach consists of unique methods for each of the following categories of sources:

- Approach for Nonpoint Sources and NPDES Regulated Stormwater Point Sources within the NEB and NWB watersheds;
- Approach for NPDES permitted WWTP Point Sources within the NEB watershed; and
- Approach for Upstream Sources.

Approach for Nonpoint Sources and NPDES Regulated Stormwater Point Sources within the NEB and NWB Watersheds

The Nonpoint Source and NPDES Regulated Stormwater Point Source MDLs were estimated based on three factors: a specified probability level, the average annual PCB TMDL allocations, and the coefficient of variation (CV) of the baseline conditions for ambient water column concentrations in the NEB and NWB. The probability level (or exceedance frequency) is based upon guidance from US EPA (1991) where examples suggest that when converting from a long-term average to a daily value, the z-score corresponding to the 99^{th} percentile of the log-normal probability distribution should be used.

The CVs of 0.985 and 0.945 were calculated for the NEB and NWB, respectively using the arithmetic mean and standard deviation of the baseline ambient water column concentrations in these watersheds (see Equation B1).

$$CV = \frac{\beta}{\alpha} \qquad \text{(Equation B1)}$$

Where:
CV = coefficient of variation
α = mean (arithmetic)
β = standard deviation (arithmetic)

The MDL for each contributing source is estimated as the appropriate average annual load allocation for that source category multiplied by a conversion factor that accounts for expected variability of daily loading values. The equation is as follows:

$$MDL = LTA * e^{(z\sigma - 0.5\sigma^2)} \qquad \text{(Equation B2)}$$

Where:
MDL = Maximum daily load
LTA = Long-term average (average annual load allocation)
Z = z-score associated with target probability level
$\sigma^2 = \ln(CV^2+1)$
CV = Coefficient of variation based on arithmetic mean and standard deviation

Using a z-score of 2.326 associated with the 99th percentile probability, CVs of 0.985 (NEB) and 0.945 (NWB), and an appropriate unit conversion (i.e., from long-term average load (g/yr) to an MDL (mg/day)) results in a conversion factor of 13.253 and 12.764 for NEB and NWB Nonpoint Sources and NPDES Regulated Stormwater Point Source average annual loads, respectively.

Approach for WWTP Point Sources within the NEB Watershed

The TMDL also considers contributions from NPDES permitted WWTP point sources that discharge quantifiable concentrations of PCBs in the NEB watershed. The MDL was calculated based on the guidance provided in the Technical Support Document (TSD) for Water Quality-based Toxics Control (US EPA 1991). The average annual TMDL allocation was converted to maximum daily limits using Table 5-2 of the TSD assuming a CV of 0.6, a z-score of 2.326 associated with the 99th percentile probability, and an appropriate unit conversion (i.e., from long-term average load (g/yr) to an MDL (mg/day)). This results in a conversion factor of 8.533.

Approach for Upstream Sources

For the purpose of this analysis, only the Washington, DC portion of the NWB watershed is classified as an Upstream Source. The DC Upstream Watershed MDL was calculated based on the same approach as was used for nonpoint sources and NPDES regulated stormwater point sources within the NWB watershed (see above).

Results of Approach

This section lists the results of the selected approaches to define the NEB and NWB MDLs.

- Calculation Approach for Nonpoint Sources (i.e., Contaminated Sites within the Maryland portion of the watershed, Unregulated Watershed Runoff within the Maryland portion of the watershed, and DC Upstream Watershed Sources) and NPDES Regulated Stormwater Point Sources within the NEB and NWB watersheds:

  NEB
  - Nonpoint Source MDL (mg/day) = Average Annual Nonpoint Source LA (g/yr) × 13.253
  - NPDES Regulated Stormwater MDL (mg/day) = Average Annual NPDES Regulated Stormwater WLA (g/yr) × 13.253

  NWB
  - Nonpoint Source MDL (mg/day) = Average Annual Nonpoint Source LA (g/yr) × 12.764

- NPDES Regulated Stormwater MDL (mg/day) =
  Average Annual NPDES Regulated Stormwater WLA (g/yr) × 12.764

- Calculation Approach for WWTP Point Source within NEB watershed:
  - WWTP MDL (mg/day) = Average Annual WWTP WLA (g/yr) × 8.533

- Calculation Approach for Upstream Sources in NWB watershed:
  - DC Upstream Watershed MDL (mg/day) =
    Average Annual DC Upstream Watershed LA (g/yr) × 12.764

Table G-1: Summary of PCB Maximum Daily Load

Northeast Branch		
Source	**TMDL (g/yr)**	**MDL (mg/day)**
MD Unregulated Watershed Runoff	0.50	6.66
MD Contaminated Site Runoff	1.61	21.34
Nonpoint Source Baseline Loads / LAs	***2.11***	***27.99***
MD WWTPs	0.725	6.19
MO Co. NPDES Regulated Stormwater	1.53	20.30
PG Co. NPDES Regulated Stormwater	3.77	49.98
Point Source Baseline Loads / WLAs	***6.03***	***76.46***
Margin of Safety (5%)	***0.43***	***5.50***
Total	**8.57**	**109.96**

Northwest Branch		
Source	**TMDL (g/yr)**	**MDL (mg/day)**
MD Unregulated Watershed Runoff	0.39	4.97
DC Upstream Watershed[1]	0.95	12.11
Nonpoint Source Baseline Loads / LAs	***1.34***	***17.08***
MO Co. NPDES Regulated Stormwater	2.56	32.62
PG Co. NPDES Regulated Stormwater	1.77	22.57
Point Source Baseline Loads / WLAs	***4.32***	***55.19***
Margin of Safety (5%)	**0.30**	**3.80**
Total	**5.96**	**76.07**

Note: [1] Point sources in the Washington, DC portion of the watershed have not been characterized.

Appendix C. MDE Permit Information

This appendix provides a summary of all of the relevant NPDES regulated point sources in the NEB and NWB of the nontidal Anacostia River watershed mentioned in Sections 2.3 and 4.4.1of the main report.

Table C-1: Permit Summary for the NEB and NWB of the nontidal Anacostia River Watershed[1]

MD Permit	NPDES	Facility	City	County	Type	TMDL
05DP2525	MD0020842	USDA EAST-SIDE WWTP	BELTSVILLE	PRINCE GEORGE'S	WMA2	WWTP WLA
05DP2787	MD0020851	USDA WEST-SIDE WWTP	BELTSVILLE	PRINCE GEORGE'S		
02SW0621	MD0003425	LAUREL SAND & GRAVEL, INC.	LAUREL	PRINCE GEORGE'S	WMA5SW	Stormwater WLA
02SW1234		COCA-COLA BOTTLING CO. - SILVER SPRING	SILVER SPRING	MONTGOMERY		
02SW1052		FEDERAL EXPRESS - BELTSVILLE	BELTSVILLE	PRINCE GEORGE'S		
02SW1242		WMATA - GREENBELT METRORAIL YARD	COLLEGE PARK	PRINCE GEORGE'S		
02SW1241		WMATA - GLENMONT METRORAIL YARD	SILVER SPRING	MONTGOMERY		
02SW0522		MONTGOMERY COUNTY PUBLIC SCHOOLS -	SILVER SPRING	MONTGOMERY		
02SW1258		MONTGOMERY COUNTY SCHOOLS - WEST FARM	COLESVILLE	MONTGOMERY		
02SW1621		EARL CENTER LUMBER COMPANY	LAUREL	PRINCE GEORGE'S		
02SW0344		M-NCPPC - LAYHILL/BONIFANT RUBBLE FILL	SILVER SPRING	MONTGOMERY		
02SW1103		UNITED STATES POSTAL SERVICE - RIVERDALE VMF	RIVERDALE	PRINCE GEORGE'S		
02SW1276		NAZARIO CONSTRUCTION COMPANY, INC.	BELTSVILLE	PRINCE GEORGE'S		
02SW0466		SHERWIN-WILLIAMS COMPANY - BELTSVILLE	BELTSVILLE	PRINCE GEORGE'S		
02SW1745		D.C. MATERIALS	HYATTSVILLE	PRINCE GEORGE'S		
02SW1926		ROCKWOOD PIGMENTS, N.A., INC.	BELTSVILLE	PRINCE GEORGE'S		
02SW1754		THE RECYCLING CENTER	LAUREL	PRINCE GEORGE'S		
02SW1320		SHA - FAIRLAND SHOP	SILVER SPRING	MONTGOMERY		
02SW1931		PEPSI BOTTLING GROUP	SILVER SPRING	MONTGOMERY		
02SW0316		EATON CORPORATION - FLUID CONVEYANCE	BELTSVILLE	PRINCE GEORGE'S		
02SW0338		M-NCPPC - MARTIN LUTHER KING, JR. PARK	WHITE OAK	MONTGOMERY		
02SW0341		M-NCPPC - OLNEY MANOR PARK MAINTENANCE	OLNEY	MONTGOMERY		
02SW0343		M-NCPPC - WHEATON REGIONAL PARK	WHEATON	MONTGOMERY		
02SW0389		M-NCPPC - BROOKSIDE GARDENS MAINTENANCE	WHEATON	MONTGOMERY		
02SW0648		PRINCE GEORGE'S SCRAP, INC.	COLLEGE PARK	PRINCE GEORGE'S		

MD Permit	NPDES	Facility	City	County	Type	TMDL
02SW0007		STONE INDUSTRIAL PRECISION PRODUCTS	COLLEGE PARK	PRINCE GEORGE'S		
02SW0267		MONTGOMERY COUNTY - COLESVILLE DEPOT	SILVER SPRING	MONTGOMERY		
02SW1077		INTERSTATE BRANDS CORP. - BELTSVILLE	BELTSVILLE	PRINCE GEORGE'S		
02SW0289		MONTGOMERY COLLEGE - TAKOMA PARK	TAKOMA PARK	MONTGOMERY		
02SW1763		STRITTMATTER LAND, LLC	LAUREL	PRINCE GEORGE'S		
02SW1662		BARDON, INC. - LAUREL VEHICLE MAINTENANCE	LAUREL	PRINCE GEORGE'S		
02SW1661		BAXTER MARYLAND VACCINES - BLDG 5	BELTSVILLE	PRINCE GEORGE'S		
02SW1659		BAXTER HEALTHCARE CORPORATION - BLDG. 1	BELTSVILLE	PRINCE GEORGE'S		
02SW1721		BELTSVILLE AUTO RECYCLERS, INC.	BELTSVILLE	PRINCE GEORGE'S		
02SW1724		EAST-WEST MOTORS, INC.	LAUREL	PRINCE GEORGE'S		
02SW1741		ATLANTIC TRANSPORTATION EQUIPMENT, LTD	BELTSVILLE	PRINCE GEORGE'S		
02SW1136		ALLSTAR USED AUTO PARTS, INC.	BELTSVILLE	PRINCE GEORGE'S		
02SW1779		ATMAN CORPORATION	LAUREL	PRINCE GEORGE'S		
02SW1829		HALLE ENTERPRISES, INC.	BELTSVILLE	PRINCE GEORGE'S		
02SW1856		BATES TRUCKING COMPANY	BLADENSBURG	PRINCE GEORGE'S		
02SW1860		TURBO HAUL, INC.	BELTSVILLE	PRINCE GEORGE'S		
02SW1864		ROLLING FRITO-LAY SALES - BELTSVILLE DC	BELTSVILLE	PRINCE GEORGE'S		
03-IM-5500-002		TOWN OF BRENTWOOD MS4	BRENTWOOD	PRINCE GEORGE'S		
03-IM-5500-004		TOWN OF RIVERDALE PARK MS4	RIVERDALE PARK	PRINCE GEORGE'S		
03-IM-5500-005		TOWN OF BERWYN HEIGHTS MS4	BERWYN HEIGHTS	PRINCE GEORGE'S		
03-IM-5500-028		CITY OF TAKOMA PARK MS4	TAKOMA PARK	MONTGOMERY		
03-IM-5500-030		CITY OF COLLEGE PARK MS4	COLLEGE PARK	PRINCE GEORGE'S		
03-IM-5500-032		CITY OF GREENBELT MS4	GREENBELT	PRINCE GEORGE'S		
03-IM-5500-033		CITY OF HYATTSVILLE MS4	HYATTSVILLE	PRINCE GEORGE'S		
03-IM-5500-034	MDR055501	CITY OF LAUREL MS4	LAUREL	PRINCE GEORGE'S	WMA6G	
03-IM-5500-035		CITY OF NEW CARROLTON MS4	NEW	PRINCE GEORGE'S		
03-IM-5500-037		TOWN OF BLADENSBURG MS4	BLADENSBURG	PRINCE GEORGE'S		
03-IM-5500-038		TOWN OF CHEVERLY MS4	CHEVERLY	PRINCE GEORGE'S		
03-IM-5500-040		TOWN OF COTTAGE CITY MS4	COTTAGE CITY	PRINCE GEORGE'S		
03-IM-5500-041		TOWN OF LANDOVER HILLS MS4	LANDOVER HILLS	PRINCE GEORGE'S		
03-IM-5500-043		TOWN OF UNIVERSITY PARK MS4	UNIVERSITY PARK	PRINCE GEORGE'S		

MD Permit	NPDES	Facility	City	County	Type	TMDL
01DP3320	MD0068349	MONTGOMERY COUNTY MS4	COUNTY-WIDE	MONTGOMERY	WMA6	
99DP3314	MD0068284	PRINCE GEORGE'S COUNTY MS4	COUNTY-WIDE	PRINCE GEORGE'S		
99DP3313	MD0068276	STATE HIGHWAY ADMINISTRATION MS4	STATE-WIDE	ALL PHASE I (MONTGOMERY PRINCE GEORGE'S)		
	MDR100000	MDE GENERAL PERMIT TO CONSTRUCT	ALL	ALL		

Note: [1] Although not listed in this table, some individual process water permits for municipal and industrial discharges may also incorporate stormwater requirements. Stormwater PCB loads from such facilities as well as from general Phase II state and federal MS4s (i.e., military bases, hospitals, etc.) are inherently accounted for within the NPDES stormwater WLA presented in this document.

Appendix D. Contaminated Site Load Calculation Methodology

The term contaminated site used throughout this report refers to areas with known PCB soil contamination, as documented by state or federal hazardous waste cleanup programs (i.e., state or federal Superfund programs). When compared against the human health screening criteria for soil and groundwater exposure pathways, PCBs are not necessarily a contaminant of concern at these sites, but have been screened for, reported, and detected during formal site investigations. Initially, three contaminated sites (comprised of multiple sub-sites) located in the NEB drainage basin were identified as part of the Tidal Potomac and Anacostia PCB TMDL effort (MDE 2007), and the EOF PCB baseline loads for these sites were estimated (see Table D-1).

Table D-1: Summary of Contaminated Sites Included in the Tidal Potomac and Anacostia PCB TMDL Tributary Load Characterization

Facility	Location	EOF PCB Loads (g/yr)
United Rigging and Hauling	NEB	0.05
White Oak	NEB	3.05
Beltsville Agricultural Research Center	NEB	3.41

Data Source: MDE 2007

As part of the NEB and NWB Tributary PCB TMDL effort summarized in this report, the 2007 contaminated site list and the associated loadings have been refined. The list of sites has been updated based on information gathered from the US EPA's Superfund and MDE's LRP-MAP databases (US EPA 2010; MDE 2010). A total of 15 sub-sites (see Table D-2) have been identified with PCB soil concentrations at or above method detection levels, as determined via soil sample results contained within MDE LMA's records of contaminated site surveys and investigations. All of the sites are located within the NEB watershed. PCB EOF loads from these sites have been calculated and subsequently converted to EOS loads using methods applied within Maryland's nontidal sediment TMDLs, thirteen of which have been approved by the EPA since 2006. Given that not all of the contaminated site PCB loads are expected to reach the nearby streams, EOS loads are thought to be a more accurate representation of actual PCB loads from these sites in terms of their impact on downstream water quality. The purpose of this appendix is to describe the detailed procedures used to calculate the Contaminated Site PCB Baseline Loads.

I. PCB Soil Concentration Data Processing

The Contaminated Site PCB Baseline Loads were only characterized for those sites and samples where PCB concentrations were found to be at or above method detection limits. When a sample was analyzed for multiple PCB congener mixes and more than one PCB congener mix was detected (e.g., 1242 or 1260), the results were added together to represent tPCB concentrations. Next, the median value of the tPCB concentrations from each sub-site was calculated (see Table D-2).

Table D-2: Median tPCB Soil Concentrations at Contaminated Sites with Measurable PCB Soil Levels in the NEB Drainage Basin

Facility	Site Description	Sub-watershed	Median tPCB (µg/kg)	n[1] [%][2]
United Rigging and Hauling	(post soil remediation)	17	340	5 [63%]
Beltsville Agricultural Research Center	Site 7 (no soil remediation)	17	580	1 [25%]
	Site 9 (no soil remediation)	16	1100	1 [3%]
	Site 32 (post soil remediation)	16	465	4 [100%]
White Oak	Site 47 (post remediation)	3	260	35 [70%]
	Site 8 (post remediation)	3	15	7 [54%]
	Site 28 (post remediation)	3	187	40 [82%]
	Site 4 (post remediation)	3	330	5 [100%]
	Site 3 (post remediation)	3	1450	10 [100%]
Adelphi Laboratory	(no soil remediation)	3	305	8 [38%]
Contee Sand and Gravel Landfill Area	(limited soil remediation)	17	1390	1 [11%]
NASA Goddard Space-Flight Center	Landfill A1 (no soil remediation)	16	8	3 [25%]
	Landfill B (no soil remediation)	16	38	10 [38%]
	Landfill C (no soil remediation)	16	5	2 [50%]
	Building 90 (no soil remediation)	16	12	2 [13%]

Notes: [1] n – number of samples above method detection limits.
[2] % – percent of all samples that are above method detection limits.

II. Revised Universal Soil Loss Equation Version II Soil Loss Calculation Procedures

The Revised Universal Soil Loss Equation Version II (RUSLE2)[1] was run for each site with the use of the Maryland state climate database, county soil databases, and management databases that can be downloaded from the following website: http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm. The site characteristics (i.e., soil types, land cover, slope, etc.) were selected from drop down menus provided in the RUSLE2 worksheet. Input parameters were selected via the following decision rules:

1. **Location:** The appropriate county name was selected from the Maryland state climate database in the RUSLE2 *location* field. This resulted in an automatic selection of the appropriate climatic factors.

[1] RUSLE2 is an advanced, user-friendly software model developed by the University of Tennessee Biosystems Engineering & Soil Science Department, in cooperation with USDA – Agricultural Research Service (ARS), the National Sedimentation Laboratory, the USDA – Natural Resources Conservation Service (NRCS), and the Bureau of Land Management.

2. **Soil:** Soil type, which was identified from either LMA's site survey and investigation records or via Geographic Information System (GIS) analysis, was selected from the appropriate county's soils database in the RUSLE2 worksheet. Soil type determined from the site investigations and surveys was specifically pulled from site descriptions and soil maps. If subsurface slope was not specified for a particular soil type in the site survey and investigation records, the lowest subsurface slope for the given soil type in the RUSLE2 database was used. Additionally, soil type for some sites was identified via GIS analysis using a digitized site area and soils data acquired from the USDA-NRCS. For sites with multiple soil types, soil loss was first calculated for each soil type based on the site's parameters (e.g. slope and slope length). Then, the soil loss values for each soil type were weighted based on the percentage of the site that the given soil type occupied. Finally, the summation of the weighted soil loss values was calculated to produce a total soil loss for the entire site.

3. **Slope Length:** Slope length (length of the site), which was identified from either LMA's site survey and investigation records or via GIS analysis, was manually inserted into the *slope length* field. Slope length from the site investigation and survey records was calculated based on site descriptions, topographic maps, or other available information. Slope length was also calculated for some sites via GIS analysis using flow direction grids generated from Digital Elevation Models, acquired from the USGS, and/or digital USGS quadrangles (i.e., topographic maps). The maximum slope length permitted by the soil loss equation was 2000 feet. For sites with length greater than 2000 feet, 2000 feet was used.

4. **Percent Slope:** Percent slope, or slope steepness, (the difference between maximum and minimum site elevations/slope length), which was identified from either LMA's site survey and investigation records or via GIS analysis, was manually inserted into the *percent slope* field. Percent slope was calculated via site surveys and investigations from site descriptions and site topographic maps. When information regarding average slope was not provided in the site description and a precise topographic map was not available for the site, slope was calculated based on the slope of the area where the site was located. For the original sites identified as part of the tidal Potomac and Anacostia PCB TMDL effort, if a topographic map of the larger region was not available, or if slope could not be determined because of the flat nature of the site, a minimal slope of 1% was assumed. Also, slope steepness for some sites was calculated via a combination of maximum and minimum site elevations from the site investigations and surveys and the GIS estimated slope length.

5. **Management:** The *management option* field was used to represent a site's land cover (i.e., forest, grass, barren, etc.), which was identified from either LMA's site survey and investigation records or via GIS analysis (i.e., agricultural management options were used to approximate the soil loss characteristics of the land covers present at these non-agricultural sites). For example, for sites covered by grass, the warm season grass – not harvested management option was selected; for wooded sites, the established orchard - full cover option was selected; and for sites with bare soil, the bare ground management

option was selected. Land cover estimates determined from site investigation and survey records were taken from site descriptions and any applicable maps. For other sites, land cover areas were estimated using GIS analysis; specifically, cover areas were digitized using the State of Maryland's 2006 6-inch resolution aerial photography.

III. Calculating EOF PCB loads

The RUSLE2 generated soil loss values, reported in tons/acre/year per soil type, were used in conjunction with adjusted pervious area estimates and median tPCB soil concentrations to determine the EOF contaminated site PCB loads. Pervious area estimates were adjusted for each site based on the percent of PCB samples that were above the method detection limit (e.g., if only 25% of the samples had PCB concentrations above method detection limit, only 25% of the previous area of the site was used in the calculations). To be consistent with the RUSLE2 soil loss units, the median tPCB soil concentrations were converted to pounds of tPCBs per pound of soil (lbs/lb). The EOF contaminated site PCB loads are reported here as g/yr (Table D-3).

Table D-3: Summary of Contaminated Site Soil Loss Values and EOF PCB Loads

Facility	Site Description	Sub-watershed	Median tPCB (µg/kg)	Soli Loss (lbs/yr)	EOF PCB Loads (g/yr)
United Rigging and Hauling	(post soil remediation)	17	340	188	2.89×10^{-2}
Beltsville Agricultural Research Center	Site 7 (no soil remediation)	17	580	15	3.99×10^{-3}
	Site 9 (no soil remediation)	16	1100	55	2.77×10^{-2}
	Site 32 (post soil remediation)	16	465	45	9.46×10^{-3}
White Oak	Site 47 (post remediation)	3	260	329	3.88×10^{-2}
	Site 8 (post remediation)	3	15	0.1	6.52×10^{-7}
	Site 28 (post remediation)	3	187	33,796	2.87
	Site 4 (post remediation)	3	330	94	1.41×10^{-2}
	Site 3 (post remediation)	3	1450	770	5.06×10^{-1}
Adelphi Laboratory	(no soil remediation)	3	305	<0.1	2.69×10^{-7}
Contee Sand and Gravel Landfill Area	(limited soil remediation)	17	1390	9	5.46×10^{-3}
NASA Goddard Space-Flight Center	Landfill A1 (no soil remediation)	16	8	21	7.93×10^{-5}
	Landfill B (no soil remediation)	16	38	942	1.62×10^{-2}
	Landfill C (no soil remediation)	16	5	58	1.35×10^{-4}
	Building 90 (no soil remediation)	16	3	7	3.90×10^{-5}

IV. Calculating EOS PCB loads

Given that not all of the EOF contaminated site PCB loads are expected to reach the nearby streams, EOS loads are thought to be a more accurate representation of the actual PCB loads from these sites in terms of their impact on downstream water quality. EOS values were calculated using methods applied within Maryland's nontidal sediment TMDLs, thirteen of which have been approved by the EPA since 2006. This was done using the following procedures:

EOS Loads = EOF Loads × DF (Equation D1)

$DF = 0.417762 \times A^{-0.134958} - 0.127097$ (USDA 1983) (Equation D2)

Where,
DF (delivery factor) = the sediment delivery ratio
A = drainage area in square miles assumed to be equal to the area of a circle with radius equal to the distance between the center of the sub-site and the closest stream reach.

A summary of the Contaminated Site PCB Baseline Loads is shown in Table D-4.

Table D-4: Summary of Contaminated Site EOS PCB Baseline Loads

Facility	Site Description	Sub-watershed	EOF PCB Loads (g/yr)	DF[1]	EOS PCB Loads (g/yr)
United Rigging and Hauling	(post soil remediation)	17	2.89×10^{-2}	0.47	1.37×10^{-2}
Beltsville Agricultural Research Center	Site 7 (no soil remediation)	17	3.99×10^{-3}	0.35	1.39×10^{-3}
	Site 9 (no soil remediation)	16	2.77×10^{-2}	0.31	8.68×10^{-3}
	Site 32 (post soil remediation)	16	9.46×10^{-3}	0.37	3.51×10^{-3}
White Oak	Site 47 (post remediation)	3	3.88×10^{-2}	0.45	1.76×10^{-2}
	Site 8 (post remediation)	3	6.52×10^{-7}	0.39	2.57×10^{-7}
	Site 28 (post remediation)	3	2.87	0.38	1.09
	Site 4 (post remediation)	3	1.41×10^{-2}	0.38	5.42×10^{-3}
	Site 3 (post remediation)	3	5.06×10^{-1}	0.91	4.60×10^{-1}
Adelphi Laboratory	(no soil remediation)	3	2.69×10^{-7}	0.43	1.16×10^{-7}
Contee Sand and Gravel Landfill Area	(limited soil remediation)	17	5.46×10^{-3}	0.27	1.49×10^{-3}
NASA Goddard Space-Flight Center	Landfill A1 (no soil remediation)	16	7.93×10^{-5}	0.35	2.80×10^{-5}
	Landfill B (no soil remediation)	16	1.62×10^{-2}	0.41	6.69×10^{-3}
	Landfill C (no soil remediation	16	1.35×10^{-4}	0.43	5.82×10^{-5}
	Building 90 (no soil remediation)	16	3.90×10^{-5}	0.73	2.85×10^{-5}
Total Contaminated Site EOS PCB Load (g/yr)					**1.61**

Note: [1] DF = delivery factor.

V. Contaminated Site Baseline Load Summary

The Contaminated Site PCB Baseline Load from the identified sites in the NEB and NWB is estimated to be 1.61 g/yr. This load is the sum of individual PCB loads from 15 contaminated sites within the NEB drainage basin, a number of which have undergone remediation. The average PCB concentrations at the non-remediated sites are below levels detected at the already remediated sites. No contaminated sites have been identified in the NWB drainage basin.

Appendix E. List of Analyzed PCB Congeners

Water column data were collected and analyzed by the Department of Chemistry and Biochemistry at GMU. PCB congeners were identified and quantified by high resolution gas chromatography with electron capture detection. GMU uses a slightly modified version of the PCB congener specific method described in Foster et al. (2000), in which the identities and concentrations of each congener in a mixed Aroclor standard (25:18:18 mixture of Aroclors 1232, 1248, and 1262) are determined based on their chromatographic retention times relative to the internal standards (PCB 30 and PCB 204). Based on this method, 72 chromatographic peaks can be quantified (see Table E-1). Some of the peaks contain one PCB congener, while others are comprised of two or more co-eluting congeners.

Table E-1. List of Analyzed PCB Congeners in the NEB and NWB (Water Column)

8	84	146	157, 202
18, 15	92	153, 132	180
31, 28	90, 101	105, 184, 127	199
33	99	168	191
22	119	141	169
52	97	179	170
49	86, 81	137	190
47	87	138	198
44, 37	115	158	189
42	77, 136	126	203, 196
64	120	166, 178	201
74	110	187, 183	195
70	82	128	208
66	151	167	207
95	135	185	194
80	123	174	205
91	149, 118	177	206
60, 56	114	156, 171	209

Clam tissue and WWTP samples were analyzed by the UMCES. PCB congeners were identified and quantified by high resolution gas chromatography with electron capture detection. UMCES uses a slightly modified version of the PCB congener specific method described in Ashley and Baker (1999), in which the identities and concentrations of each congener in a mixed Aroclor standard (25:18:18 mixture of Aroclors 1232, 1248, and 1262) are determined based on their chromatographic retention times relative to the internal standards (PCB 30 and PCB 204). Based on this method, 86 chromatographic peaks can be quantified (see Table E-1). Some of the peaks contain one PCB congener, while many are comprised of two or more co-eluting congeners.

Table E-2. List of Analyzed PCB Congeners in the NEB and NWB (Clam Tissue and WWTPs)

1*	45	110, 77	177
3*	46	114	180
4, 10	47, 48	118	183
6	49	119	185
7, 9	51	123, 149	187, 182
8, 5	52	128	189
12, 13	56, 60	129, 178	191
16, 32	63	132, 153, 105	193
17	66, 95	134	194
18	70, 76	135, 144	197
19	74	136	198
22	81, 87	137, 130	199
24	82, 151	141	201
25	83	146	202, 171, 156
26	84, 92	157, 200	203, 196
29	89	158	205
31, 28	91	163, 138	206
33, 21, 53	97	167	207
37, 42	99	170, 190	208, 195
40	100	172	209
41, 64, 71	101	174	
44	107	176	

Note: * These congeners have been excluded from the analysis due to possible interference.

The PCB analysis presented in this document is based on tPCB concentrations that are calculated as the sum of the detected PCB congeners/congener groups representing the most common congeners that were historically used in the Aroclor commercial mixtures.