Model Report for the Revised Polychlorinated Biphenyl (PCB) TMDLs for Small Tributaries in the Rock Creek Watershed in the District of Columbia

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Table of Contents

Table of Contents ..... **i**

List of Figures ..... **iii**

List of Tables ..... **vi**

List of Abbreviations ..... **viii**

Executive Summary ..... **x**

1 Introduction **1**

1.1 Background 1

1.2 Brief Overview of the Tributary Watersheds 3

1.3 Overview of PCBs 5

1.3.1. Use and Regulation of PCBs 5

1.3.2. Fate, Transport, and Environmental Persistence 6

1.3.3. Potential Sources of PCBs in the District's Rock Creek Tributaries 7

1.4 Applicable Water Quality Standards 8

2 Small Tributary Pesticide Model (STPM) **9**

2.1 Model Outline 9

2.2 Watershed Delineation and Land Use Acreage 11

2.2.1 DC Watershed Delineation and Land Use Acreage 11

2.2.2 MD Watershed Delineation and Land Use Acreage 12

2.3 Daily Runoff, Interflow, and Baseflow by Land Cover 12

2.3.1 CSOs 15

2.4 Monitoring Data Analysis and Model Input Concentrations 16

2.4.1 Classification of PCBs 17

2.4.2 Analysis of Instream Monitoring Data 18

2.4.2 Determination of Total PCB Concentration in Storm Flow 20

2.4.4 Uncertainty in Concentration Estimations 25

3 Application of STPM to Revise PCB TMDLs in Rock Creek Watersheds **27**

3.1 Scoping Scenarios 27

3.2 TMDL Scenario 28

3.2.1 Critical Conditions 30
3.2.2 Seasonality 30
3.2.3 Conservative Assumptions 31
3.2.4 Allocations 31
4 Results for Individual Small Tributaries 32
4.1 Broad Branch 33
4.2 Dumbarton Oaks 38
4.3 Fenwick Branch 43
4.4 Klingle Valley Creek 48
4.5 Luzon Branch 53
4.6 Melvin Hazen Valley Branch 58
4.7 Normanstone Creek 63
4.8 Pinehurst Branch 68
4.9 Piney Branch 73
4.10 Portal Branch 80
4.11 Soapstone Creek 85
5 Conclusion 90
References 91

List of Figures

Figure 1.1: Location of Small Tributary Watersheds in the District of Columbia's Portion of the Rock Creek Watershed 4
Figure 1.2: General Structure of PCB Molecule (from ATSDR, 2000) 5
Figure 2.1: Simplified Structure of HSPF Hydrology 14
Figure 2.2: Regression Model relating PCB3+ Concentrations to TSS Concentrations for DC Urban Monitoring Data, Tidal Potomac/Anacostia PCB TMDL 23
Figure 2.3: The Fitted Values of PCB3+ in the DC Urban Regression Model and the 95% Convidence Interval on the Fitted Values 25
Figure 3.1: Simulated Total PCB Concentration (μg/l), TMDL Scenario, and PCB Human Health Criterion and Chronic Aquatic Life Criterion 30
Figure 4.1: Broad Branch and its Watershed 33
Figure 4.2: Simulated Average Daily Flow (cfs), Broad Branch 34
Figure 4.3: Simulated Daily PCB Concentrations (μg/l), Broad Branch, Baseline Conditions, 2005 36
Figure 4.4: Simulated 30-Day Average PCB Concentrations (μg/l), Broad Branch, Baseline Conditions 36
Figure 4.5: Simulated Daily PCB Loads (lbs/d), Broad Branch, Baseline Conditions and TMDL Scenario 37
Figure 4.6: Dumbarton Oaks and its Watershed 38
Figure 4.7: Simulated Average Daily Flow (cfs), Dumbarton Oaks 39
Figure 4.8: Simulated Daily PCB Concentrations (μg/l), Dumbarton Oaks, Baseline Conditions, 2005 41
Figure 4.9: Simulated 30-Day Average PCB Concentrations (μg/l), Dumbarton Oaks, Baseline Conditions 41
Figure 4.10: Simulated Daily PCB Loads (lbs/d), Dumbarton Oaks, Baseline Conditions and TMDL Scenario 42
Figure 4.11: Fenwick Branch and its Watershed 43
Figure 4.12: Simulated Average Daily Flow (cfs), Fenwick Branch 44
Figure 4.13: Simulated Daily PCB Concentrations (μg/l), Fenwick Branch, Baseline Conditions, 2005 46
Figure 4.14: Simulated 30-Day Average PCB Concentrations (μg/l), Fenwick Branch, Baseline Conditions 46
Figure 4.15: Simulated Daily PCB Loads (lbs/d), Fenwick Branch, Baseline Conditions and TMDL Scenario 47
Figure 4.16: Klingle Valley Creek and its Watershed 48
Figure 4.17: Simulated Average Daily Flow (cfs), Klingle Valley Creek 49
Figure 4.18: Simulated Daily PCB Concentrations (μg/l), Klingle Valley Creek, Baseline Conditions, 2005 51
Figure 4.19: Simulated 30-Day Average PCB Concentrations (μg/l), Klingle Valley Creek, Baseline Conditions 51
Figure 4.20: Simulated Daily PCB Loads (lbs/d), Klingle Valley Creek, Baseline Conditions and TMDL Scenario 52
Figure 4.21: Luzon Branch and its Watershed 53
Figure 4.22: Simulated Average Daily Flow (cfs), Luzon Branch 54

Figure 4.23: Simulated Daily PCB Concentrations (µg/l), Luzon Branch, Baseline Conditions, 2005 56
Figure 4.24: Simulated 30-Day Average PCB Concentrations (µg/l), Luzon Branch, Baseline Conditions. 56
Figure 4.25: Simulated Daily PCB Loads (lbs/d), Luzon Branch, Baseline Conditions and TMDL Scenario 57
Figure 4.26: Melvin Hazen Valley Branch and its Watershed 59
Figure 4.27: Simulated Average Daily Flow (cfs), Melvin Hazen Valley Branch 59
Figure 4.28: Simulated Daily PCB Concentrations (µg/l), Melvin Hazen Valley Branch, Baseline Conditions, 2005 61
Figure 4.29: Simulated 30-Day Average PCB Concentrations (µg/l), Melvin Hazen Valley Branch, Baseline Conditions 61
Figure 4.30: Simulated Daily PCB Loads (lbs/d), Melvin Hazen Valley Branch, Baseline Conditions and TMDL Scenario 62
Figure 4.31: Normanstone Creek and its Watershed 63
Figure 4.32: Simulated Average Daily Flow (cfs), Normanstone Creek 64
Figure 4.33: Simulated Daily PCB Concentrations (µg/l), Normanstone Creek, Baseline Conditions, 2005 66
Figure 4.34: Simulated 30-Day Average PCB Concentrations (µg/l), Normanstone Creek, Baseline Conditions 66
Figure 4.35: Simulated Daily PCB Loads (lbs/d), Normanstone Creek, Baseline Conditions and TMDL Scenario 67
Figure 4.36: Pinehurst Branch and its Watershed 68
Figure 4.37: Simulated Average Daily Flow (cfs), Pinehurst Branch 69
Figure 4.38: Simulated Daily PCB Concentrations (µg/l), Pinehurst Branch, Baseline Conditions, 2005 .. 71
Figure 4.39: Simulated 30-Day Average PCB Concentrations (µg/l), Pinehurst Branch, Baseline Conditions 71
Figure 4.40: Simulated Daily PCB Loads (lbs/d), Pinehurst Branch, Baseline Conditions and TMDL Scenario 72
Figure 4.41: Piney Branch and its Watershed 74
Figure 4.42: Piney Branch and its Watershed, Excluding CSS Area 75
Figure 4.43: Simulated Average Daily Flow (cfs), Piney Branch 76
Figure 4.44: Simulated Daily PCB Concentrations (µg/l), Piney Branch, Baseline Conditions, 2005 78
Figure 4.45: Simulated 30-Day Average PCB Concentrations (µg/l), Piney Branch, Baseline Conditions . 78
Figure 4.46: Simulated Daily PCB Loads (lbs/d), Piney Branch, Baseline Conditions and TMDL Scenario. 79
Figure 4.47: Portal Branch and its Watershed 80
Figure 4.48: Simulated Average Daily Flow (cfs), Portal Branch 81
Figure 4.49: Simulated Daily PCB Concentrations (µg/l), Portal Branch, Baseline Conditions, 2005 83
Figure 4.50: Simulated 30-Day Average PCB Concentrations (µg/l), Portal Branch, Baseline Conditions. 83
Figure 4.51: Simulated Daily PCB Loads (lbs/d), Portal Branch, Baseline Conditions and TMDL Scenario 84
Figure 4.52: Soapstone Creek and its Watershed 85
Figure 4.53: Simulated Average Daily Flow (cfs), Soapstone Creek 86
Figure 4.54: Simulated Daily PCB Concentrations (µg/l), Soapstone Creek, Baseline Conditions, 2005 ... 88
Figure 4.55: Simulated 30-Day Average PCB Concentrations (µg/l), Soapstone Creek, Baseline Conditions 88

Figure 4.56: Simulated Daily PCB Loads (lbs/d), Soapstone Creek, Baseline Conditions and TMDL Scenario..89

List of Tables

Table ES.1: Land Use Acreage (acres) in the Rock Creek Watershed Tributaries xii
Table ES.2: Average Annual Baseline Total PCB Loads (lbs/yr) xii
Table ES.3: Percent Reductions Required to Meet Current Class D Human Health Criteria, TMDL Scenario xiii
Table ES.4: Total PCB Average Annual TMDL Load Allocations (lbs/yr)..xiii
Table ES.5: Total PCB Maximum Daily Load Allocations (lbs/d) xiv
Table 1.1: 2004 and 2016 Numerical Water Quality Criteria for Total PCBs (µg/l) 8
Table 2.1: Calibration Statistics for P5.4 Watershed Model, 2001-2012.. 14
Table 2.2: Summary of Simulated CSO Events and Volume, 1998-1990 15
Table 2.3: Simulated CSO Flows and 24-hour Antecedent Precipitation, Long Term Control Plan........... 16
Table 2.4: Congeners Selected for NOAA Status and Trend Program 18
Table 2.6: Classification of Instream Monitoring Locations by Group.. 19
Table 2.7: Sum of Congeners Measured (ng/l) at Piedmont Monitoring Sites in Dry Weather Sampling, October 29, 2013 20
Table 2.8: Regression Equations Relating PCB3+ to TSS by Region 22
Table 2.9: Elements in the Calculation of the Total PCB Concentration in Storm Flow in the STPM 23
Table 2.10: Elements in the Calculation of the Total PCB Concentration in CSO Flow in the STPM 25
Table 3.1: Classification of Sources in Scenarios.. 27
Table 3.2: Percent Reductions Required to Meet Human Health Criteria, Scoping Scenarios................. 28
Table 3.5: Percent Reductions Required to Meet Current Class D Human Health Criteria, TMDL Scenario 29
Table 4.1: Broad Branch Land Use (acres) 34
Table 4.2: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Broad Branch................ 35
Table 4.3: PCB Average Daily Loads (lbs/d), Broad Branch... 35
Table 4.4: PCB Maximum Daily Loads (lbs/d), Broad Branch.. 35
Table 4.5: Dumbarton Oaks Land Use (acres).. 39
Table 4.6: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Dumbarton Oaks 40
Table 4.7: PCB Average Daily Loads (lbs/d), Dumbarton Oaks 40
Table 4.8: PCB Maximum Daily Loads (lbs/d), Dumbarton Oaks 40
Table 4.9: Fenwick Branch Land Use (acres).. 44
Table 4.10: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Fenwick Branch 45
Table 4.11: PCB Average Daily Loads (lbs/d), Fenwick Branch 45
Table 4.12: PCB Maximum Daily Loads (lbs/d), Fenwick Branch 45
Table 4.13: Klingle Valley Creek Land Use (acres).. 49
Table 4.14: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Klingle Valley Creek..... 50
Table 4.15: PCB Average Daily Loads (lbs/d), Klingle Valley Creek... 50
Table 4.16: PCB Maximum Daily Loads (lbs/d), Klingle Valley Creek.. 50
Table 4.17: Luzon Branch Land Use (acres) 54
Table 4.18: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Luzon Branch............... 55
Table 4.19: PCB Average Daily Loads (lbs/d), Luzon Branch... 55

Table 4.20: PCB Maximum Daily Loads (lbs/d), Luzon Branch 55
Table 4.21: Melvin Hazen Valley Branch Land Use (acres) 59
Table 4.22: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Melvin Hazen Valley Branch 60
Table 4.23: PCB Average Daily Loads (lbs/d), Melvin Hazen Valley Branch 60
Table 4.24: PCB Maximum Daily Loads (lbs/d), Melvin Hazen Valley Branch 60
Table 4.25: Normanstone Creek Land Use (acres) 64
Table 4.26: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Normanstone Creek 65
Table 4.27: PCB Average Daily Loads (lbs/d), Normanstone Creek 65
Table 4.28: PCB Maximum Daily Loads (lbs/d), Normanstone Creek 65
Table 4.29: Pinehurst Branch Land Use (acres) 69
Table 4.30: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Pinehurst Branch 70
Table 4.31: PCB Average Daily Loads (lbs/d), Pinehurst Branch 70
Table 4.32: PCB Maximum Daily Loads (lbs/d), Pinehurst Branch 70
Table 4.33: Piney Branch Land Use (acres) 73
Table 4.34: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Piney Branch 77
Table 4.35: PCB Average Daily Loads (lbs/d), Piney Branch 77
Table 4.36: PCB Maximum Daily Loads (lbs/d), Piney Branch 77
Table 4.37: Portal Branch Land Use (acres) 81
Table 4.38: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Portal Branch 82
Table 4.39: PCB Average Daily Loads (lbs/d), Portal Branch 82
Table 4.40: PCB Maximum Daily Loads (lbs/d), Portal Branch 82
Table 4.41: Soapstone Creek Land Use (acres) 86
Table 4.42: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Soapstone Creek 87
Table 4.43: PCB Average Daily Loads (lbs/d), Soapstone Creek 87
Table 4.44: PCB Maximum Daily Loads (lbs/d), Soapstone Creek 87

List of Abbreviations

ac	acres
ANPRM	Advanced Notice of Proposed Rulemaking
ATSDR	Agency for Toxic Substances and Disease Registry
CBP	Chesapeake Bay Program
CBPO	Chesapeake Bay Program Office
CCC	Criteria Continuous Concentration
cfs	cubic feet per second
CMC	Criteria Maximum Concentration
COG	Council of Governments
CSO	Combined Sewer Overflow
CSS	Combined Sewer System
d	days
DC	District of Columbia
DCSTM	DC Small Tributary TMDL Model
DC Water	District of Columbia Water and Sewer Authority
DDOE	District of Columbia Department of Environment
DOEE	District of Columbia Department of Energy and Environment
DDOH	District of Columbia Department of Health
DDT	Dichlorodiphenyltrichloroethane
DEQ	Virginia Department of Environmental Quality
DL	Detection Limit
EMC	Event Mean Concentration
EOP	End-of-Pipe
EOS	Edge-of-Stream
EPA	U. S. Environmental Protection Agency
g	grams
GWLF	Generalized Watershed Loading Functions
HSPF	Hydrological Simulation Program-Fortran
ICPRB	Interstate Commission on the Potomac River Basin
IP	Implementation Plan
in	inch
km	kilometer
l	liters
LA	Load Allocation
lbs	pounds
LTCP	Long-term Control Plan
m	meter

MD	Maryland
MDE	Maryland Department of the Environment
MDP	Maryland Department of Planning
mg	milligrams
MG	million gallons
MGD	million gallons per day
µg	micrograms
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
MSGP	Multi-Sector General Permit
ng	nanograms
NHD	National Hydrography Dataset
NLDAS	North American Land Data Assimilation System
NOAA	National Oceanic and Atmospheric Administration
NPS	Nonpoint Source
P5	Phase 5 Watershed Model
P54	Phase 5.4 Watershed Model
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCB3+	PCBs homolog 3 or greater
POP	Persistent Organic Pollutant
RCRA	Resource Conservation and Recovery Act
STPM	Small Tributary Pesticide Model
TMDL	Total Maximum Daily Load
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
USGS	U. S. Geological Survey
WLA	Wasteload Allocation
WQLS	Water Quality Limited Segments
yr	year

Executive Summary

This report documents the development of revised Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) for the following eleven small tributaries to Rock Creek in the District of Columbia (DC):

1. Broad Branch
2. Dumbarton Oaks
3. Fenwick Branch
4. Klingle Valley Creek
5. Luzon Branch
6. Melvin Hazen Valley Branch
7. Normanstone Creek
8. Pinehurst Branch
9. Piney Branch
10. Portal Branch
11. Soapstone Creek

Instream water quality monitoring collected in 2013 (Tetra Tech, 2014) has confirmed the presence of PCBs in these eleven tributaries.

The original TMDLs were documented in *District of Columbia Final Total Maximum Daily Loads for Organics and Metals in Broad Branch, Dumbarton Oaks, Fenwick Branch, Klingle Valley Creek, Luzon Branch, Melvin Hazen Valley Branch, Normanstone Creek, Pinehurst Branch, Piney Branch, Portal Branch, and Soapstone Creek* (DDOH, 2004a), and approved in 2004. The original TMDLs were developed before TMDLs were required to be expressed as daily loads. Subsequently, the 2006 court case, *Friends of the Earth vs. the Environmental Protection Agency, 446 F.3d 140, 144* , required establishment of a daily loading expression in TMDLs in addition to any annual or seasonal loading expressions established in the TMDLs. On January 15, 2009, Anacostia Riverkeepers, Friends of the Earth, and Potomac Riverkeepers filed a complaint (Case No.: 1:09-cv-00098-JDB), because certain DC TMDLs, including the PCB TMDLs for Rock Creek tributaries, did not have a daily load expression established. The U.S. Environmental Protection Agency (EPA) settled the complaint by agreeing to an established schedule approved by both the court and the plaintiffs to the case. According to the current schedule, the original TMDLs are set to vacate by January 1, 2017.

The District's water quality standards for PCBs were revised in 2005, after the original TMDLs were established, and EPA and the District of Columbia's Department of Energy and Environment (DOEE) decided to revise the TMDLs rather than submit daily loads based on the original TMDLs. The original TMDLs had been developed using the DC Small Tributary TMDL Model (DCSTM) (ICPRB, 2003). DCSTM was a simple model. It calculated constituent loads in small tributaries based on (1) simulating storm flow and base flow in a tributary from the land uses in a watershed, and (2) associating a constituent concentration with storm flow or base flow from each land use. EPA and DOEE decided to update the model used to develop the TMDLs. A revised model, the Small Tributary Pesticide Model (STPM), has been developed and used to revise 30 pesticide TMDLs for small tributaries in the District's portion of the Rock Creek and Potomac River watersheds (Mandel and Nagel, 2016). The same model was also used to revise the eleven PCB TMDLs for the Rock Creek tributaries. STPM has the same structure as DCSTM, but the model elements have been updated using the best information currently available. In particular, STPM incorporates the following new information:

- The simulation of daily flows is based on a recent version of the Chesapeake Bay Program's (CBP's) Watershed Model, which allows the simulation period to be updated to 2001-2012;
- Land use classes and acreage in DC have been taken from the DC Consolidated TMDL Implementation Plan for its MS4; and
- Model input concentrations associated with land uses and flow paths have been estimated based on instream monitoring data and monitoring data collected in the District to estimate PCB loads for the tidal Potomac/Anacostia PCB TMDL.

Land use was classified by land cover (impervious, pervious developed or turf, and forest) and regulatory status (municipal separate storm water system (MS4), combined sewer system (CSS), and direct drainage). Land use acreage for the small tributaries is shown in Table ES.1. Piney Branch is the only tributary with combined sewer overflow (CSO) outfalls. Portions of Fenwick Branch, Pinehurst Branch, and Portal Branch watersheds lie in Maryland.

Table ES.2 gives the average annual total PCB baseline loads (lbs/yr) from STPM in the small tributaries over the 2001-2012 simulation period. Baseline loads represent PCB loads under current conditions over the twelve-year STPM simulation period. TMDLs for the small tributaries were developed by assigning the most stringent water quality criteria, the Class D 30-day average human health criterion, as the model input concentration for both storm flow and base flow from all sources. Since all sources discharge at the human health criterion, simulated concentrations in the tributaries are held at constant values equal to the human health criterion. The human health criterion is less than the four-day average chronic aquatic life criterion, and this ensures that the latter criterion is also met over the four day averaging period.

The TMDLs generally require reductions greater than 99% from all sources. Sources can be divided into end-of-pipe (EOP) discharges, like DC's MS4 and CSS, and nonpoint sources (NPS), which include base flow discharges and all flows in DC outside either the MS4 or CSS. Surface flows from developed land in the portion of tributaries in Maryland were also assumed to be EOP sources. Table ES.3 shows the reduction required under the TMDL Scenario from EOP sources and nonpoint sources.

Table ES.1: Land Use Acreage (acres) in the Rock Creek Watershed Tributaries

	MS4			Direct Drainage				Maryland			
Tributary	Impervious	Turf	Forest	Impervious	Turf	Forest	CSS	Impervious	Turf	Forest	Total
Broad Branch	367	495	39	22	46	176	-	-	-	-	1,145
Dumbarton Oaks	8	3	1	25	52	47	-	-	-	-	136
Fenwick Branch	60	93	9	11	25	22	-	150	243	0	612
Klingle Valley Creek	55	57	14	7	13	26	-	-	-	-	172
Luzon Branch	300	277	13	5	22	25	-	-	-	-	643
Melvin Hazen Valley Branch	43	60	6	9	9	47	-	-	-	-	174
Normanstone Creek	70	88	8	6	12	34	-	-	-	-	217
Pinehurst Branch	89	151	6	12	28	160	-	59	160	0	664
Piney Branch	18	18	9	2	7	46	2,406	-	-	-	2,506
Portal Branch	22	37	2	0	1	7	-	80	50	0	201
Soapstone Creek	202	202	7	22	30	52	-	-	-	-	514

Sources: DOEE (MS4 and Direct Drainage) and MDE (Maryland)

Table ES.2: Average Annual Baseline Total PCB Loads (lbs/yr)

Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Broad Branch	1.69E-01	-	2.21E-02	-	1.91E-01
Dumbarton Oaks	3.23E-03	-	1.46E-02	-	1.78E-02
Fenwick Branch	2.86E-02	-	7.59E-03	7.20E-02	1.08E-01
Klingle Valley Creek	2.39E-02	-	5.26E-03	-	2.92E-02
Luzon Branch	1.29E-01	-	7.51E-03	-	1.37E-01
Melvin Hazen Valley Branch	1.99E-02	-	5.99E-03	-	2.59E-02
Normanstone Creek	3.17E-02	-	5.03E-03	-	3.67E-02
Pinehurst Branch	4.31E-02	-	1.23E-02	3.28E-02	8.82E-02
Piney Branch	7.72E-03	4.01E-02	2.84E-03	-	5.07E-02
Portal Branch	1.08E-02	-	7.39E-04	3.25E-02	4.41E-02
Soapstone Creek	8.78E-02	-	1.38E-02	-	1.02E-01

Table ES.3: Percent Reductions Required to Meet Current Class D Human Health Criteria, TMDL Scenario

Tributary	EOP	NPS
Broad Branch	99.87%	99.36%
Dumbarton Oaks	99.87%	99.36%
Fenwick Branch	99.87%	99.36%
Klingle Valley Creek	99.87%	99.36%
Luzon Branch	99.87%	99.36%
Melvin Hazen Valley Branch	99.87%	99.36%
Normanstone Creek	99.87%	99.36%
Pinehurst Branch	99.87%	99.36%
Piney Branch[1]	99.87%	99.36%
Portal Branch	99.87%	99.36%
Soapstone Creek	99.87%	99.36%

[1] The CSOs in Piney Branch will require a 99.998% reduction in load under the TMDL Scenario

The TMDLs used an implicit margin of safety (MOS) that was justified by the conservative assumptions incorporated into STPM. The twelve-year simulation period (2001-2012) ensures that the TMDLs covered a variety of hydrological conditions and critical conditions, including seasonal variations. Moreover, it is assumed that all categories of sources discharge at the most stringent applicable water quality criteria, and that no category of sources relies on dilution from another category of sources, in order that water quality standards be met.

The PCB TMDLs are expressed as average annual loads, average daily loads, and maximum daily loads. Table ES.4 gives the average annual TMDL load allocations (lbs/yr). Average daily loads are the average annual loads divided by 365. Tables ES.5 gives the maximum daily load allocations (lbs/d). The maximum daily load for each allocation source category is the maximum daily load for that source in the 12-year simulation period that can be discharged and still achieve the water quality standards.

Table ES.4: Total PCB Average Annual TMDL Load Allocations (lbs/yr)

Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Broad Branch	2.20E-04	-	8.37E-05	-	3.04E-04
Dumbarton Oaks	4.22E-06	-	2.77E-05	-	3.19E-05
Fenwick Branch	3.73E-05	-	1.99E-05	1.14E-04	1.71E-04
Klingle Valley Creek	3.12E-05	-	1.54E-05	-	4.66E-05
Luzon Branch	1.69E-04	-	3.05E-05	-	1.99E-04
Melvin Hazen Valley Branch	2.60E-05	-	1.79E-05	-	4.39E-05
Normanstone Creek	4.14E-05	-	1.69E-05		5.83E-05
Pinehurst Branch	5.62E-05	-	4.55E-05	5.58E-05	1.58E-04
Piney Branch	1.01E-05	8.37E-07	1.16E-05	-	2.25E-05
Portal Branch	1.41E-05	-	4.20E-06	4.65E-05	6.48E-05
Soapstone Creek	1.15E-04	-	3.76E-05	-	1.52E-04

Table ES.5: Total PCB Maximum Daily Load Allocations (lbs/d)

Tributary	DC Regulated Stormwater	DC Combined Sewer	DC Nonpoint Source	Maryland	Total
Broad Branch	4.09E-05	-	7.10E-06	-	4.80E-05
Dumbarton Oaks	6.60E-07	-	4.29E-06	-	4.95E-06
Fenwick Branch	7.09E-06	-	2.11E-06	1.08E-05	2.00E-05
Klingle Valley Creek	5.56E-06	-	1.67E-06	-	7.23E-06
Luzon Branch	2.94E-05	-	1.82E-06	-	3.12E-05
Melvin Hazen Valley Branch	4.85E-06	-	1.93E-06	-	6.78E-06
Normanstone Creek	7.59E-06	-	1.57E-06		9.16E-06
Pinehurst Branch	1.09E-05	-	4.89E-06	4.64E-06	2.04E-05
Piney Branch	1.79E-06	2.09E-06	1.40E-06	-	5.29E-06
Portal Branch	2.73E-06	-	2.31E-07	5.21E-06	8.17E-06
Soapstone Creek	2.02E-05	-	3.57E-06	-	2.38E-05

1 Introduction

1.1 Background

In 2004, the District of Columbia Department of Health (DDOH) developed Total Maximum Daily Loads (TMDLs) for toxic organic chemicals, including Polychlorinated Biphenyls (PCBs), in eleven small tributaries to Rock Creek (DDOH, 2004a). These TMDLs were documented in *District of Columbia Final Total Maximum Daily Loads for Organics and Metals in Broad Branch, Dumbarton Oaks, Fenwick Branch, Klingle Valley Creek, Luzon Branch, Melvin Hazen Valley Branch, Normanstone Creek, Pinehurst Branch, Piney Branch, Portal Branch, and Soapstone Creek*, and the TMDLs were approved in 2004. Subsequently, the 2006 court case, *Friends of the Earth vs. the Environmental Protection Agency, 446 F.3d 140, 144* , required establishment of a daily loading expression in TMDLs in addition to any annual or seasonal loading expressions previously established in the TMDLs. On January 15, 2009, Anacostia Riverkeepers, Friends of the Earth, and Potomac Riverkeepers filed a complaint (Case No.: 1:09-cv-00098-JDB), because certain District of Columbia (DC) TMDLs did not have a daily load expression established. The U.S. Environmental Protection Agency (EPA) settled the complaint by agreeing to an established schedule approved by both the court and the plaintiffs to the case. The organic chemical TMDLs for small tributaries in the Rock Creek were developed without daily loading expressions and were included in the 2009 complaint. According to the current schedule, the small tributary organic chemical TMDLs are scheduled to vacate by January 1, 2017.

Almost all of the Rock Creek small tributaries were first placed on the District of Columbia's (DC's) 303(d) List of Impaired Waters because of toxics in 1996. At the time, nearly all waters in the District were listed as impaired by toxics, based on fish tissue and sediment samples collected in the Anacostia River (DDOH, 2004a). Before developing daily load expressions for the TMDLs, EPA and the District of Columbia Department of Energy and Environment (DOEE) reviewed the available monitoring data and collected additional data to clarify and identify the current impairments for each of the tributaries. On behalf of EPA, Tetra Tech collected samples in the listed tributaries on October 29, 2013 as part of a larger effort to confirm the listings for metals and toxics across the District. The samples were analyzed for metals, pesticides, Polycyclic Aromatic Hydrocarbons (PAHs), and PCBs. For more information, please refer to the District's 2014 Integrated Report (DDOE, 2014).

PCBs were detected in the following eleven Rock Creek tributaries for which PCB TMDLs were developed in 2004:

1. Broad Branch
2. Dumbarton Oaks
3. Fenwick Branch
4. Klingle Valley Creek
5. Luzon Branch

6. Melvin Hazen Valley Branch
7. Normanstone Creek
8. Pinehurst Branch
9. Piney Branch
10. Portal Branch
11. Soapstone Creek

For each of these tributaries, DOEE will revise its PCB TMDL and include a daily load expression[1]. Rather than base the daily loads on the original TMDLs, EPA and DOEE decided to revise the PCB TMDLs for the following reasons:

First, after the original TMDLs had been established in 2004, the water quality standards changed for PCBs in 2005. These changes are described in Section 1.4.

Second, additional monitoring data had been collected under DC's municipal separate storm sewer system (MS4) permit and in DC's non-tidal waters in support of the development of the tidal Potomac/Anacostia PCB TMDL. This data could be used for modeling PCBs in the Rock Creek tributaries.

Third, EPA and DOEE wanted to update the model used to develop the TMDLs. The original TMDLs had been developed using the District of Columbia Small Tributary TMDL Model (DCSTM) (ICPRB, 2003). DCSTM was a simple model. It calculated constituent loads in small tributaries based on (1) simulating storm flow and base flow in a tributary from the land uses in a watershed, and (2) associating a constituent concentration with storm flow or base flow from each land use. Simulated flows were taken from a calibrated Hydrological Simulation Program Fortran (HSPF) model of the Watts Branch. The simulation period was 1988-1990. It was decided that all of the elements of the model could be updated, including

- Changing the underlying hydrology model to allow a more recent simulation period;
- Updating the land use and acreage; and
- Revising the constituent concentrations used in the model by incorporating all monitoring data currently available.

A revised model, the Small Tributary Pesticide Model (STPM), has been developed and used to revise 30 pesticide TMDLs for small tributaries in the District's portion of the Rock Creek and Potomac River watersheds (Mandel and Nagel, 2016). The same model was also used to revise the eleven PCB TMDLs for the Rock Creek tributaries. Section 2 describes the structure of STPM and inputs to the model. Section 3 discusses the general application of the model in scoping scenarios and in the TMDL scenario. Section 4 provides results for individual tributaries.

[1] PCB TMDLs for other small tributaries in the Potomac River watershed (DDOH, 2004b) and Oxon Run (2004c) were superseded by the tidal Potomac/Anacostia PCB TMDL(Haywood and Buchanan, 2007), which assigned allocations on an average annual and daily basis to the sources draining directly to the tidal Potomac River.

In the remainder of this Introduction, Section 1.2 briefly describes the tributary watersheds, Section 1.3 provides background on PCBs, and Section 1.4 presents the water quality standards applicable to the PCBs.

1.2 Brief Overview of the Tributary Watersheds

All of the small tributary watersheds in the Rock Creek watershed are located in the Northwest Quadrant of DC. Figure 1.1 shows the location of the watersheds of these tributaries. A portion of Portal Branch, Fenwick Branch, and Pinehurst Branch lies in Montgomery County, Maryland (MD). Figure 1 also shows DC Combined Sewer System (CSS). Piney Branch is the only watershed with combined sewer overflow (CSO) outfalls in it.

All the tributary watersheds are highly developed, although substantial sections of some of the watershed are in parkland. Section 4 provides additional description of the individual small tributary watersheds.

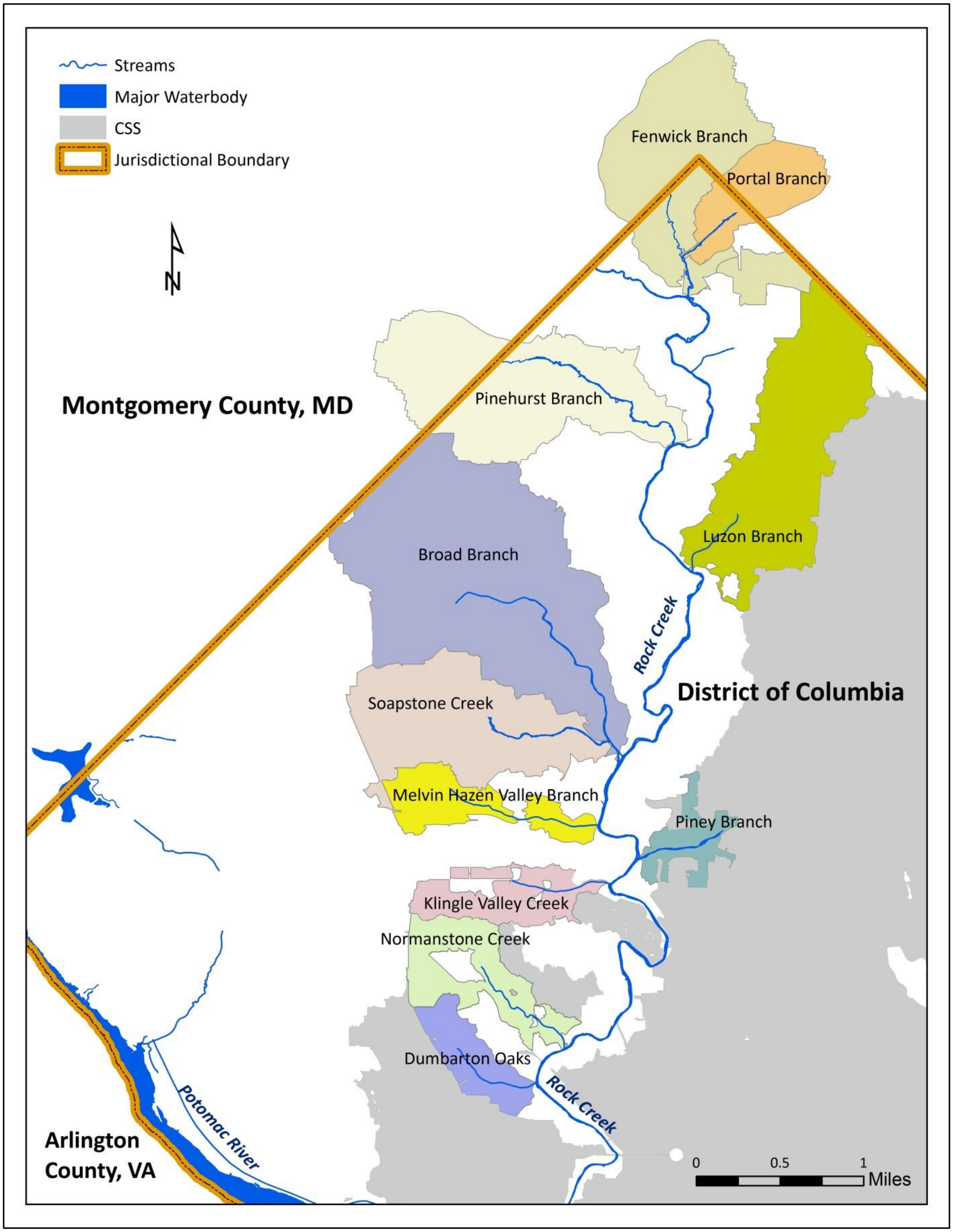

Figure 1.1: Location of Small Tributary Watersheds in the District of Columbia's Portion of the Rock Creek Watershed

1.3 Overview of PCBs

PCBs are a group of 209 different compounds. These compounds differ in the number and location of chlorine atoms attached to the two benzene rings that make up the biphenyl molecule. Up to ten chlorine atoms can attach to biphenyl. Figure 1.2 shows the general structure of a PCB molecule.

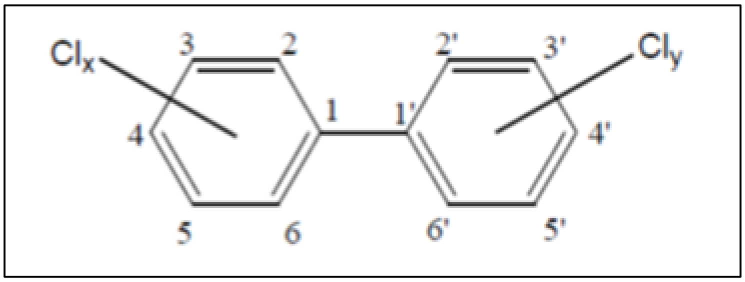

Figure 1.2: General Structure of PCB Molecule (from ATSDR, 2000)

1.3.1. Use and Regulation of PCBs

Commercial production and use of PCBs began in 1929. In the United States, PCBs were manufactured by Monsanto, who marketed a suite of mixtures of PCBs under the name of Aroclor. PCBs were used in a wide variety of applications, including the following:

- Transformers, capacitors, and other electrical equipment;
- Hydraulic fluids and lubricants;
- Plasticizers;
- Fire-retarding paint, tiles, textiles;
- Carbonless copy paper and printing inks.

As the list indicates, PCBs could be used in closed systems like transformers or other electrical equipment, which are not open to the environment in normal use, or open systems, such as fire-retarding materials. Hydraulic systems that used PCBs could be either open or closed. Keeler *et al.* (1993) stated that approximately 60% of PCBs were used in closed electrical and hydraulic systems, 10% were used in open hydraulic systems, 25% as plasticizers, and 5% in other uses.

The key property of PCBs that made them useful commercially is their stability. They do not readily react with acids or bases and they do not break down easily with increasing temperature. This made them ideal for use as insulators or as fire-retarding additives to plastics or other materials. They are also good dielectrics, which explains their widespread use in electrical equipment.

The toxicity of PCBs to birds, mammals, fish and aquatic organisms have been well-documented in laboratory studies. Exposure to PCBs limits the growth of diatoms and freshwater algae. Negative impacts on reproduction and development in fish and other aquatic organisms have been observed

(Eisler, 1986). PCBs have also been linked to disruption of reproductive functions and birth defects in humans. ATSDR (2000) documents many adverse impacts on human health from exposure to PCBs. EPA (2016) has classified PCBs as class B2 probable human carcinogens.

The EPA was given the authority to regulate PCBs under the 1976 Toxic Substances Control Act (TSCA). In 1979 the, the EPA banned the production, import, and distribution of PCBs, as well as their use outside of closed systems, with a few exceptions. TSCA also established regulations for the disposal of PCBs or PCB-contaminated waste.

The EPA also placed the suite of PCB Aroclors on the Clean Water Act's Priority Pollutant List, and has recommended the adoption of water quality criteria for PCBs to protect aquatic life and human health. Section 1.4 discusses the water quality criteria adopted by DC for PCBs.

PCBs are among the persistent organic pollutants (POPs) regulated by the 2001 Stockholm Convention, a treaty sponsored by the United Nations and signed by 90 countries[2]. The treaty aims to eliminate, or greatly reduce, the production and use of POPs. One goal of the treaty is to phase out electrical equipment with high concentrations of PCBs by 2025. The EPA has issued an Advanced Notice of Proposed Rulemaking (ANPRM) to solicit comments on the phase-out of any equipment which contains PCBs in concentrations greater than 50 ppm[3].

1.3.2. Fate, Transport, and Environmental Persistence

Keeler *et al*. (1993) estimated that in 1982, 54% of the PCBs produced in the United States were still in use, 11% had been exported, 3% had been destroyed, 21% were buried in landfills, and 11% were circulating in the environment. PCBs continue to enter the environment through leaks from transformers and other closed applications; export from manufacturing or disposal sites contaminated with PCBs; or released from landfills or scrapyards where products containing PCBs have been disposed of improperly.

The stability of PCBs, which made them useful commercially, is also responsible for their persistence in the environment. According to Smith *et al*. (1988), PCBs are characterized by:

- Slow degradation rates in soils and sediment;
- Very limited solubility in water;
- Limited volatility;
- Strong adherence to soils or sediments;
- Dissolved readily in non-polar organic solvents and fats; and
- Strong tendency to bioaccumulate in fish, plants, and animals.

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[2] EPA. Persistent Organic Pollutants: A Global Issue, A Global Response. http://www2.epa.gov/international-cooperation/persistent-organic-pollutants-global-issue-global-response#thedirtydozen

[3] https://www.federalregister.gov/articles/2010/04/07/2010-7751/polychlorinated-biphenyls-pcbs-reassessment-of-use-authorizations#h-12

Despite the stability of PCBs, PCB concentrations in lake and reservoir sediments indicate a declining trend in PCB concentrations in their influent streams and rivers. Van Metre and Mahler (2005) studied sediment cores in 28 urban reservoirs and 10 natural lakes. They found exponential declines in PCB concentrations over time, and estimated that concentrations of total PCBs in sediment had a median half-life of 19.7 years. Van Metre *et al*. (1997) found similar rates of decline in concentrations of cesium, Dichlorodiphenyltrichloroethane (DDT), and PCBs in sediment cores from reservoirs, and they speculated that the rate of exponential decline was controlled by soil erosion, transport, and deposition, rather than specific attributes of the constituent. As van Metre (2006) points out, half-life, as used here, does not refer to one specific process, but to the overall effect of all the processes which govern the fate and transport of the constituent.

Air deposition is an important source of PCBs. Although they generally have low volatility, because of their very low solubility in water, significant volatilization of PCBs can occur (Smith *et al*., 1988). PCBs also can be transported attached to particulates in air. PCB concentrations in the atmosphere and PCB deposition rates tend to be higher in urban areas (Offenberg and Baker, 1997; Offenberg and Baker, 1999).

1.3.3. Potential Sources of PCBs in the District's Rock Creek Tributaries

Sites with known PCB releases or soils contaminated with PCBs were identified for the tidal Potomac/Anacostia PCB TMDL (Haywood and Buchanan, 2007). No such sites were identified in the Rock Creek watershed. Current EPA databases identify no sites in the Rock Creek watershed contaminated by PCBs on (1) the National Priorities List of the Superfund Program[4]; (2) sites undergoing corrective actions under the Resource Conservation and Recovery Act (RCRA)[5]; or (3) properties slated to undergo redevelopment under the Brownfields program[6].

PCBs have been detected in bed sediment in the Rock Creek watershed. Anderson *et al*. (2002) monitored PCBs and other organic contaminants in the Rock Creek watershed 1999-2000. Bed sediment samples were collected at three sites in February 1999. One of the bed sediment samples was from Portal Branch, and the other two samples were from the mainstem of Rock Creek. PCBs were detected in the two samples from mainstem Rock Creek, but not in the sediment sample from Portal Branch.

On the other hand, PCBs were not detected in shallow groundwater in the District. Korterba *et al*. (2010) analyzed PCB concentrations in samples collected from 13 wells in the District in 2008. None of the wells were deeper than 100 feet. Three of the wells sampled were in the Rock Creek watershed. PCBs were not detected in any of the 13 samples, though it should be noted, however, that the detection limit was 1 µg/l.

[4] https://www.epa.gov/superfund/search-superfund-sites-where-you-live
[5] https://www3.epa.gov/reg3wcmd/ca/dc.htm
[6] https://www.epa.gov/cleanups/cleanups-my-community

Baker (1999) estimated wet and dry deposition of PCBs for the Chesapeake Bay Program's (CBP's) Chesapeake Bay Basin Toxics Loading and Release Inventory (CBP, 1999). Based on a study of atmospheric deposition of PCB's in Baltimore, MD (Offenberg and Baker, 1999), Baker estimated that PCB deposition rates over urban areas were ten times the regional background deposition rates, as measured at three rural stations in the basin. The urban rate for wet deposition was 8.3 µg/m^2/yr, and the rate for dry deposition was 8.0 µg/m^2/yr. These deposition rates were used to represent PCB deposition in the District in both the original PCB TMDLs for the Rock Creek tributaries (DDOH, 2004) and the tidal Potomac/Anacostia PCB TMDL (Haywood and Buchanan, 2007).

1.4 Applicable Water Quality Standards

The District has water quality criteria for total PCBs to support both the Aquatic Life Use (Class C) and Human Health Use (Consumption of Fish and Shellfish) (Class D). All of the small Rock Creek tributaries are Class C and Class D waters. Table 1.1 presents the current (2016) water quality standards. Many metals and organic pollutants have two criteria to support the Aquatic Life Use: the Criteria Maximum Concentration (CMC) and the Criteria Continuous Concentration (CCC), which protect for acute and chronic exposure, respectively. There is no CMC for PCBs, however. The CCC applies to a four-day average concentration. The criterion for the Fish Consumption Use applies to a 30-day average concentration. It is established to protect human health. It represents the maximum 30-day average water column concentration of a pollutant that would result in a fish tissue pollutant concentration that would not raise an individual's lifetime risk of contracting cancer from the consumption of fish by more than one in one million. It is based on average body weight, fish consumption rates, and bioaccumulation rates of the pollutant in the food chain.

Table 1.1: 2004 and 2016 Numerical Water Quality Criteria for Total PCBs (µg/l)

	Class C: Aquatic Life Use		**Class D: Fish and Shellfish Consumption Use**
Year	**CCC (four-day average)**	**CMC (one-hour average)**	**Human Health (30-day average)**
2004	0.014	--	0.000045
Current	0.014	--	0.000064

Table 1.1 also shows the criteria that were in effect when the original TMDLs were developed. Since the original TMDLs were established, the 30-day human health criteria for total PCBs became less stringent, while the CCC for total PCBs remained unchanged.

2 Small Tributary Pesticide Model (STPM)

This section describes the elements of the Small Tributary Pesticide Model (STPM), which will be used to develop the revised PCB TMDLs for the small tributaries in DC's portion of the Rock Creek watershed. STPM is similar in structure to the DCSTM, but the model elements have been updated using the best information currently available. In particular, STPM incorporates the following new information:

- The simulation of daily flows is based on a recent version of the Chesapeake Bay Program's (CBP's) Watershed Model, which allows the simulation period to be updated to 2001-2012;
- Land use classes and acreage in DC have been taken from the DC Consolidated TMDL Implementation Plan for its MS4; and
- Model input concentrations associated with land uses and flow paths have been estimated based on recent instream monitoring data and monitoring data collected in support of the tidal Potomac/Anacostia PCB TMDL (Haywood and Buchanan, 2007).

Section 2.1 presents an outline of the model structure. Section 2.2 discusses watershed delineation; land use and land cover; and acreages. Section 2.3 describes the flow component of STPM, including how the CSOs in Piney Branch were simulated. Section 2.4 describes the determination of model input concentrations.

2.1 Model Outline

The model used to develop the revised TMDLs is a version of a loading function model (McElroy *et al.*, 1976), which can be described as follows: A watershed is divided into land uses; daily simulated runoff, interflow, and baseflow are determined for each land use on a per acre basis; daily storm flow (runoff and interflow), and total flow at the outlet of the watershed are then calculated from the daily per acre simulated flow for each land use and the land use acreage; finally, the daily load of a constituent at the watershed outlet is then calculated by associating a concentration with each land use and flow path. This approach differs from more complex loading function models, such as the Generalized Watershed Loading Functions (GWLF) (Haith and Shoemaker, 1987) because sediment and the transport of a constituent attached to sediment are not explicitly simulated; the constituent concentration associated with each flow path includes both the dissolved and solid-phase of the constituent.

To express the modeling approach more precisely, let Q_i be the daily flow (cfs) from the watershed on day i. Q_i is calculated as follows:

$$Q_i = 0.042 \sum_{j=1}^{NLU} (S_{i,j} + B_{i,j}) * A_j$$

where

$S_{i,j}$ = storm flow (in/day) from land use j on day i

$B_{i,j}$ = baseflow (in/day) from land use j on day i

A_j = area (acres) of land use j

0.042 = conversion factor (ac-in/d to cfs)

NLU = number of land uses

Runoff and interflow are components of storm flow:

$$S_{i,j} = R_{i,j} + I_{i,j}$$

where

$R_{i,j}$ = runoff (in/day) from land use j on day i

$I_{i,j}$ = interflow (in/day) from land use j on day i

The daily load of a constituent on day i, L_i (lbs/d), is given by:

$$L_i = 0.000227 * \sum_{j=1}^{NLU} (C_{S,j} * S_{i,j} + C_{B,j} * B_{i,j}) * A_j$$

where

$C_{S,j}$ = surface concentration of constituent (µg/l) for land use j

$C_{B,j}$ = baseflow concentration of constituent (µg/l) for land use j

0.000227 = conversion factor from µg/l*in/d*ac to lbs/d

The daily constituent concentration, C_i is determined from the daily load and flow:

$$C_i = 185.40 * \frac{L_i}{Q_i}$$

where

185.40 = conversion factor from lbs/cfs/d to µg/l

If there are discharges from a CSS (as in Piney Branch), the contribution of the CSOs must be included in the calculation of daily flow and daily load. Let CSO_i be the CSO flow rate (acre-in/d) and C_{cso} be the constituent concentration (µg/l) associated with the CSOs. Then

$$Q_i = 0.042 * (CSO_i + \sum_{j=1}^{NLU} (S_{i,j} + B_{i,j}) * A_j)$$

and

$$L_i = 0.000227 * (C_{cso} * CSO_i + \sum_{j=1}^{NLU} (C_{S,j} * S_{i,j} + C_{B,j} * B_{i,j}) * A_j)$$

The Small Tributary Model used to develop the original TMDLs has the same structure, but all of the model inputs have been updated. The model requires three types of inputs:

1. Land use acreage;
2. Simulated daily storm and baseflow by land use on a per acre basis; and
3. Constituent concentrations in storm flow and base flow by land use.

The land use, flows, and constituent concentrations used in the revised TMDLs will be discussed in more detail in the following sections.

2.2 Watershed Delineation and Land Use Acreage

Locally-developed land use information was used to determine land use acreage. Portions of Fenwick Branch, Pinehurst Branch, and Portal Branch lie in Montgomery County, MD. The delineation of the tributary watersheds and the calculation of land use acreage for each jurisdiction are discussed in the following sections.

2.2.1 DC Watershed Delineation and Land Use Acreage

Under its MS4 permit, DOEE was required to develop a Consolidated TMDL Implementation Plan (Limno Tech, 2015). The Consolidated Plan describes the strategy for implementing pollution control measures to meet the almost 400 wasteload allocations (WLAs) for MS4 areas under 26 different TMDLs. As part of the Consolidated Plan, the watersheds for the DC portion of all of the Rock Creek tributaries were redelineated. The areas served by DC's separate storm sewer system were also redelineated, taking into account the most up-to-date information on storm sewer lines and inlets. Watershed area was divided into four categories by regulatory status: (1) MS4 areas contributing to open channels; (2) direct drainage to open channels; (3) CSS areas; and (4) MS4 areas that drain directly to Rock Creek, the Anacostia River, or the Potomac River. Areas in the fourth category represents closed channels with respect to the small tributaries and are not included in the small tributary watersheds.

As part of the Consolidated Plan, an Implementation Plan (IP) Modeling Tool was developed to simulate baseline conditions and management scenarios for pollution control measures in a consistent manner. The IP Modeling Tool is based on a modified version of the Simple Method (Schueler, 1987). Land cover was determined for each regulatory category for each TMDL watershed. Three basic land cover types were used: impervious surface, forest, and turf (including yards, fields, grassed areas, and rights-of-way). Forest and turf were further divided by soil hydrological group.

Land use for the revised PCB TMDLs was taken directly from the Consolidated Plan. Land uses were defined by regulatory category and land cover. DOEE provided acreage by land use and land cover for each of the tributaries[7]. Only two regulatory categories were used: MS4 and direct drainage. CSO flows are input as a flow rate and the area in CSS is not needed to calculate flow or loads. Hydrologic soil group is not used in the revised toxic TMDLs, so only the total area in forest or turf is used in the revised TMDLs. Since DOEE provided the acreage for tributary watersheds directly, the revised delineations were used primarily for documentation and to help delineate the Maryland portions of the tributary watersheds.

2.2.2 MD Watershed Delineation and Land Use Acreage

The MD portions of the small tributary watersheds were delineated from the catchment boundaries in National Hydrography Dataset (NHD) Plus version 2. Small adjustments were made in the catchment boundaries to match the delineation of the DC portions of the watersheds.

The Maryland Department of the Environment (MDE) provided the Maryland Office of Planning's (MDP's) 2010 land use data and impervious cover data for Montgomery County[8]. Forest and water acreage were calculated directly from the land use data, and impervious acreage was calculated from the impervious cover data. Pervious developed (turf) acreage was calculated as the difference between total watershed acreage and forest, water, and impervious acreage. This same method was used to calculate turf acreage in the DC Consolidated Plan (Limno Tech, 2015).

2.3 Daily Runoff, Interflow, and Baseflow by Land Cover

Daily flows by land cover type were taken from the Chesapeake Bay Program's Watershed Model. There is a sequence of versions or phases of the Watershed Model. The phase used for this project is 5.4, Scenario NLDc8414Hyd (P5.4). This is an intermediate phase between Phase 5 and Phase 6, which is

[7] Martin Hurd (DOEE). 2015. Personal communication.
[8] Jeff White (MDE). 2015. Personal communication.

currently under development. The Phase P5.4 uses P5 land segments and land uses, but uses hourly meteorological inputs from the North American Land Data Assimilation System (NLDAS), with a simulation period from 1985-2014. The Watershed Model runs on an hourly time step, with hourly meteorological inputs, but flows, loads, and concentrations are reported on a daily basis. The Phase P5.4 was chosen for use in this project so a more recent simulation period could be used for modeling the tributaries. The period, 2001 through 2012, was chosen for the model simulation period.

The Watershed Model is basically an adaptation of the Hydrological Simulation Program FORTRAN (HSPF) model for use in the Chesapeake Bay basin. Its primary purposes are: (1) to determine the sources of nitrogen, phosphorus, and sediment to the Chesapeake Bay, (2) to calculate nutrient and sediment loads to the Chesapeake Bay for use in the CBP model of water quality in the bay, and (3) to facilitate estimation of nutrient and sediment load allocations under the Chesapeake Bay TMDL. Two types of processes are simulated, land simulations and river simulations. Land simulations are performed by land use and by land segment on a per acre basis. Thirty land uses are represented. Each land use is simulated on over 360 land segments, which generally follow county boundaries. A land segment is a section of the Chesapeake Bay watershed in which it is assumed that each land use type is relatively homogeneous and can be simulated by one land simulation per type. The P5 land segments are generally at the county level. The output from land use simulations are input into a river network of over 1,100 river reaches. This includes all rivers in the Chesapeake Bay watershed with greater than 100 cubic feet per second (cfs) average annual flow, and some smaller rivers, mainly in the Coastal Plain, where there are flow or monitoring data available to calibrate the model. EPA (2010) documents in more detail the development of the Phase 5 Watershed Model.

Figure 2.1 provides a simplified picture of the HSPF hydrological simulation for a land use. Each land simulation represents all phases of the hydrological cycle, including precipitation, runoff, infiltration, interflow, percolation and groundwater discharge. Bicknell *et al*. (2000) discusses the HSPF model in more detail.

Washington DC is represented by a single land segment in P5.4 (A11001). Montgomery County (A24031) is also represented by a single land segment. P5.4 (and the Phase 5 Watershed Model in general) uses an automated calibration procedure to set key land simulation parameters, such as the infiltration rate or baseflow recession rate, by comparing simulated flow in river reaches to flows observed at U. S. Geological Survey (USGS) gauges. EPA (2010) provides a full description of the automated calibration procedure for hydrology. The DC land segment was calibrated primarily against the USGS gauges on Rock Creek at Sherrill Drive (01648000) and the Northwest Branch of the Anacostia River (01650500). Table 2.1 presents the key flow statistics for the P5.4 simulation at those gauges.

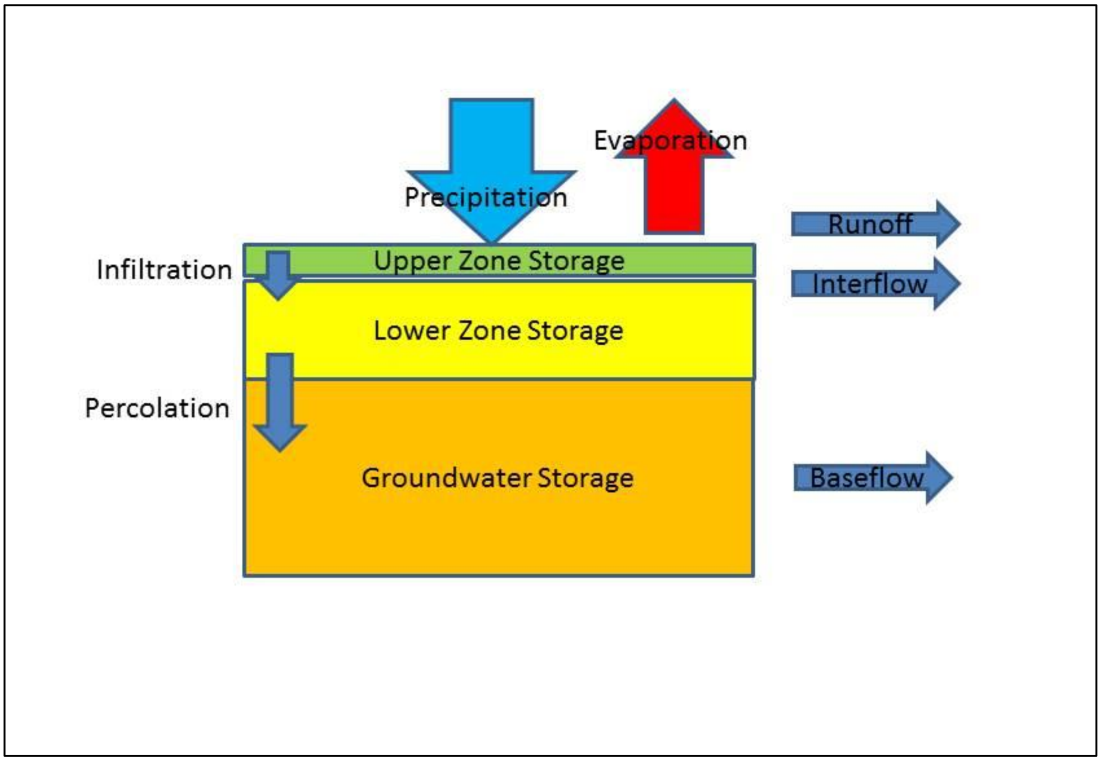

Figure 2.1: Simplified Structure of HSPF Hydrology

Table 2.1: Calibration Statistics for P5.4 Watershed Model, 2001-2012

Statistic	Rock Creek	NW Branch Anacostia River
Percent Bias[1] Total Flow	+9%	+10%
Percent Bias[1] Less than 50th Percentile Flow Volume	-1%	-7%
Percent Bias[1] Greater than 10th Percentile Flow Volume	+13%	+3%
Coefficient of Determination (R^2)	0.79	0.71
Nash-Sutcliff Efficiency[2]	0.76	0.70

[1] Percent Bias: 100 * (simulated–observed)/observed
[2] Nash-Sutcliff Efficiency: 1 – variance (errors)/variance (observations)

There is good agreement between observed and simulated daily flows, as shown by the Nash-Sutcliff efficiencies[9]. Simulated total flow volume, low flow (<50th percentile) volume, and high flow (>90th percentile) volume are within 10% of the observed volumes except for high flows on Rock Creek, which are 13% higher than observed volume.

[9] The value of the Nash-Sutcliff efficiency ranges from -∞ to 1. The larger the value, the better the agreement between the model and the observed data. A value of 1 represents perfect agreement between the model and the observed data; a value of 0 means the model simulates the observations no better than the average value of the observations; and a value less than 0 means that the average value of the observations is a better predictor than the model.

For each jurisdiction, the daily time series of runoff, interflow, and baseflow (in/d) were extracted for the following land uses from the model output:

- Forest
- Regulated impervious land
- Regulated pervious land

Developed land was represented by the regulated impervious land and regulated pervious land, whereas forest was used primarily to represent forested parkland.

2.3.1 CSOs

The District of Columbia Water and Sewer Authority (DC Water) provided simulated CSO flows from their MIKE URBAN model for the outfalls in the Piney Branch watershed[10]. Simulated CSO flows were provided for both baseline conditions and the implementation of DC Water's Long-term Control Plan (LTCP). Model output was at 15 minute intervals. Simulated CSO volumes were only available for the years 1988-1990. Table 2.2 summarizes the differences between baseline conditions and the LTCP. Under the LTCP, there is a dramatic decrease in CSO volume, and CSO events are predicted to occur only about twice a year in Piney Branch.

Table 2.2: Summary of Simulated CSO Events and Volume, 1988-1990

Statistic	Baseline	Long-Term Control Plan
Number of Events	84	6
Total Volume (MG)	841	18.8

The simulation period for the revised TMDLs is 2001-2012. The MIKE URBAN model output was analyzed in an attempt to determine a relation between precipitation, on the one hand, and the occurrence and magnitude of CSO flows, on the other, that could be used to estimate CSO flows during the simulation period. No such predictive relation could be found. Table 2.3 shows the predicted CSO flow from the MIKE URBAN model under the LTCP, aggregated from all Piney Branch outfalls, the precipitation that occurred 24-hours before the CSO event at Reagan Airport, and the precipitation from the NLDAS-based precipitation for the DC land segment in the Watershed Model. There is little relation between the total precipitation 24-hours preceding the event and its magnitude. All six events were above 0.76 in, the 90th percentile 24-hour antecedent precipitation for Reagan Airport for the period 1988-1990 (including days when there was no rain), but so were over one hundred other storm events during which no simulated CSO flow occurred.

[10] John Cassidy (DC Water). 2005. Personal communication.

Table 2.3: Simulated CSO Flows and 24-hour Antecedent Precipitation, Long Term Control Plan

Date	CSO Flow (MGD)	Reagan Airport (in/d)	NLDAS (in/d)
11/16/1989	2.60	0.77	0.82
5/6/1989	15.69	2.28	2.23
7/4/1989	0.05	0.81	1.28
10/18/1990	0.30	0.95	1.3
7/13/1990	0.07	1.24	0.68
8/6/1990	0.11	1.72	1.92

In the light of the failure to find a predictive relation between precipitation and simulated CSO flows, it was decided to keep the same rate and distribution of CSO flows as simulated by the MIKE URBAN model, but to assign CSO flows to the largest precipitation events by size. If the MIKE URBAN model predicts six CSO events in a three-year period under the LTCP, then it was assumed that 24 CSO events would occur in the period 2001-2012: four of the same size as the largest event, four of the size of the next largest, etc. In other words, a time series of daily CSO volumes under the LTCP was constructed as follows:

- For each hour in the simulation period 2001-2012, calculate precipitation in previous 24 hours;
- For each day, find maximum 24-hour precipitation; and
- Assign simulated LTCP flows on a daily basis to the 24 largest daily maximum 24-hour precipitation totals by size (largest flow to the 4 largest precipitation events, next largest flow to the next 4, etc.).

The same method was used for baseline conditions. MIKE URBAN estimates that 84 CSO events occur over three years under baseline conditions, so it was assumed that four times that number, or 336 CSO events, would occur over the twelve-year simulation period. CSO events were assigned to the 336 days with largest 24-hour precipitation totals, according to the same distribution of volumes in the MIKE URBAN 1988-1990 simulation of baseline conditions.

For all model scenarios except baseline conditions, the time series constructed from LTCP output was used to represent CSO flows.

2.4 Monitoring Data Analysis and Model Input Concentrations

The STPM needs to assign input concentrations for storm flow and base flow for each land use. Base flow concentrations were determined from in-stream baseflow monitoring data collected by Tetra-Tech on behalf of EPA. As discussed below, there was insufficient data to estimate storm flow concentrations from the wet-weather monitoring data collected under the District's MS4 permit, so the storm flow input concentration was based on the analysis of PCB concentrations performed for the tidal

Potomac/Anacostia PCB TMDLs. These analyses are discussed in more detail in the following sections, after a discussion of the classification of PCBs used in analyzing and reporting PCB monitoring data.

2.4.1 Classification of PCBs

As described in Section 1.3, PCBs are a group of 209 different compounds, which differ in the number and location of chlorine atoms attached to the biphenyl molecule. Up to ten chlorine atoms can attach to biphenyl. PCB congeners are individual compounds specified by the number and location of the chlorine atoms. Congeners differ in their physical and chemical properties, as well as their effects on the environment and human health. Homologs are groups of congeners with the same number of chlorine atoms.

PCBs are also analyzed and reported as Aroclors. Aroclor is the trade name PCBs were marketed under by Monsanto, the only American manufacturer of PCBs. Aroclors are mixtures of congeners. Aroclors were identified by four-digit numbers. The last two digits represent the percent of chlorine by mass in the mixture; the first two numbers is usually a “12” which designates the number of carbon atoms in the biphenyl structure. An exception to this naming convention is Aroclor 1016, which is a mixture of mono- through hexachlorinated homologues which is 41% chorine by mass.

The total PCBs in a sample would represent the sum of all of the congeners in a sample. Total PCBs are not measured directly, but are calculated based on a laboratory analysis of Aroclors, homologs, or congeners (Battelle *et al*., 2012). National Oceanic and Atmospheric Administration’s (NOAA) Status and Trends Program has identified a set of 20 congeners that can be used to estimate total PCBs (Lauenstein and Cantillo, 1993). Table 2.4 shows the congener name and number, as well as the homolog number for these 20 congeners.

Table 2.4: Congeners Selected for NOAA Status and Trend Program

Congener Number	Congener Name	Homolog Number
8	2-4'-Dichlorobiphenyl	2
18	2,2',5-Trichlorobiphenyl	3
28	2,4,4'-Trichlorobiphenyl	3
44	2,2',3,5'-Tetrachlorobiphenyl	4
52	2,2',5,5'-Tetrachlorobiphenyl	4
66	2,3',4,4'-Tetrachlorobiphenyl	4
77	3,3',4,4'-Tetrachlorobiphenyl	4
101	2,2',4,5,5'-Pentachlorobiphenyl	5
105	2,3,3',4,4'-Pentachlorobiphenyl	5
118	2,3',4,4',5-Pentachlorobiphenyl	5
126	3,3',4,4',5-Pentachlorobiphenyl	5
128	2,2',3,3',4,4'-Hexachlorobiphenyl	6
138	2,2',3,4,4',5-Hexachlorobiphenyl	6
153	2,2',4,4',5,5'-Hexachlorobiphenyl	6
170	2,2',3,3',4,4',5-Heptachlorobiphenyl	7
180	2,2',3,,4,4',5,5'-Heptachlorobiphenyl	7
187	2,2',3,4',5,5',6-Heptachlorobiphenyl	7
195	2,2',3,3',4,4',5,6-Octachlorobiphenyl	8
206	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	9
209	Decachlorobiphenyl	10

2.4.2 Analysis of Instream Monitoring Data

As described previously, Tetra Tech (2014) collected dry-weather samples at 29 locations on October 29, 2013. Each of these samples was analyzed for 20 PCB congeners in addition to other parameters. Nineteen of the twenty congeners were from the NOAA Status and Trends list shown in Table 2.4, with congener 169 replacing congener 195.

Observations for the congeners were classified into two groups according to hydrogeomorphic region, as shown in Table 2.5. Samples from the Piedmont Region were used to estimate base flow total PCB concentrations for STPM. Two field duplicates were included in the Piedmont Group.

Table 2.5: Classification of Instream Monitoring Locations by Group

Piedmont	Coastal Plain
Fenwick Branch	Fort Stanton
Portal Branch	Hickey Run
Broad Branch	Nash Run
Soapstone Creek	Popes Branch
Luzon Branch	Watts Branch
Pinehurst Branch	Oxon Run
Piney Branch	Texas Run
Klingle Valley Creek	
Melvin Hazen Valley Branch	
Dalecarlia Tributary	
Normanstone Creek	
Dumbarton Oaks	

Table 2.6 summarizes the analyses of the instream concentrations by station. For each observation at each station, the measured congeners were summed. The sums were calculated in three ways, depending on the treatment of undetected congeners. If a congener was undetected, it was assigned a value (1) equal to the method detection limit, (2) zero, or (3) half of the detection limit. Table 2.7 shows the sums for each observation by each of the three ways.

Detection limits for observations of individual congeners were approximately 0.2 ±0.05 ng/l. Congener 18 was the most frequently detected congener, detected in 86% of the samples. Congeners 28, 52, and 101 were detected in 64% of the samples, and Congeners 8 and 66 were detected in 57% of the samples. The remaining congeners were detected in less than 50% of the samples. Five congeners—128, 153, 180, 206, and 209—were never detected.

Using the rule of thumb for the set of congeners from NOAA's Status and Trend Program, total PCBs can be estimated from the sum of the congeners by multiplying by a factor of two. For each way of calculating sums, the average sum over the samples was calculated and the average of total PCBs estimated by multiplying by a factor of two. Table 2.7 shows the results. EPA's guidance on treating data below the detection limit recommends substituting half the detection limit in calculations where it is known that the constituent is present (Smith, 1991). The total PCB concentration used to model base flow loads was therefore taken from the congener sums substituting half the detection limit, or 10 ng/l (0.01 µg/l).

Table 2.6: Sum of Congeners Measured (ng/l) at Piedmont Monitoring Sites in Dry Weather Sampling, October 29, 2013

Monitoring Site	Number of Congeners Detected	Sum of Measured Congeners (ng/l) Substitution for Observations Below Detection Limit (DL) =		
		DL	0	half DL
Broad Branch	9	7.56	5.51	6.53
Dalecarlia	5	12.90	10.18	11.54
Dumbarton Oaks	4	5.18	2.29	3.73
Dumbarton Oaks (Field Duplicate)	6	5.65	3.05	4.35
Fenwick Branch	7	5.66	3.22	4.44
Klingle Valley	6	3.87	0.56	2.21
Luzon Branch	6	5.68	3.09	4.38
Melvin Hazen	3	4.33	1.20	2.76
Normanstone Creek	6	5.89	3.27	4.58
Pinehurst	1	3.61	0.20	1.90
Piney Branch	5	5.74	3.02	4.38
Portal Branch	7	5.94	3.61	4.78
Portal Branch (Field Duplicate)	5	6.17	3.43	4.80
Soapstone Creek	9	8.13	6.08	7.11
Average Sum of Measured Congeners		6.17	3.48	4.82
Estimated Average Total PCB Concentration		12.33	6.96	9.64

2.4.2 Determination of Total PCB Concentration in Storm Flow

A natural approach to estimating a storm flow total PCB concentration to use in the STPM is to analyze available PCB observations made under wet weather conditions for the MS4 program. DOEE provided a database containing all wet-weather samples collected by the DC MS4 program 2001-2013[11]. No wet weather samples were analyzed for PCBs after 2013. In fact, the latest sample analyzed for PCBs was taken in 2007. The analyses performed 2001-2007 reported PCBs as (1) total PCBs, (2) Aroclors, and (3) individual congeners. The results can be summarized as follows:

- Total PCBs were reported from 90 samples taken between 2001 and 2007. None of the observations were reported above the detection limit. Twenty-six samples were taken in the Rock Creek watershed. The detection limits for the Rock Creek samples were generally around 1 µg/l, 5000 times the detection limit used for the instream dry weather monitoring discussed in the previous section.
- Twenty-three samples taken 2001-2002 were analyzed for Aroclors at eight stations in the Anacostia watershed. No sample had a detectable concentration of any Aroclor.

[11] Martin Hurd (DOEE). 2015. Personal communication.

- Forty-three samples taken between 2001 and 2005 were analyzed for individual congeners. Twenty-five of those samples were collected at nine locations in the Rock Creek watershed. The number of congeners reported per sample ranged from one to 35. Thirty of the 43 samples were analyzed for ten or fewer congeners. The order of magnitude of the detection limits was 1 ng/l or less; and the frequency of detection of individual congeners was over 90%. No sample, however, had a sufficient number of the congeners used in NOAA's Status and Trends Program to estimate total PCBs in the sample.
- Seven samples collected at six stations in the Potomac River watershed in 2005 were also analyzed for individual congeners. The detection limit, however, was 20 ng/l, and no congener was detected in any sample.

Since the District's wet-weather monitoring data is not useful for estimating total PCB concentrations, the best available estimate of total PCBs in the District's storm water can be derived from the analysis of PCB monitoring data collected for the tidal Potomac/Anacostia PCB TMDL (Haywood and Buchanan, 2007). The tidal Potomac/Anacostia PCB TMDL was a joint effort of the District's Department of the Environment (DDOE), the Maryland Department of the Environment (MDE), the Virginia Department of Environmental Quality (DEQ), the Interstate Commission on the Potomac River Basin (ICPRB), Limno-Tech, the Metropolitan Washington Council of Governments (COG), and EPA Region III. Under this effort, five water quality limited segments (WQLS) in the District, four WQLS in Maryland, and 19 WQLS in Virginia tributaries have explicit TMDLs for PCBs. Impairments addressed by TMDLs cover the length of the tidal Potomac River, from the fall line at Chain Bridge to Smith Point, as well as the tidal Anacostia River.

To determine TMDLs for these impaired tidal segments, Limno-Tech developed a computer simulation model (POTPCB) of the fate and transport of PCBs and organic carbon in the tidal Potomac River. The model actually simulates PCB homologs 3 through 10 (PCB3+), which is converted to total PCBs during model post-processing. Haywood and Buchanan (2007) and Limno-Tech (2007) provided additional details on POTPCB. Simulated flows and total suspended solids (TSS) loads from the Phase 5 Watershed Model were used to develop PCB3+ input loads for POTPCB for tributaries and direct drainage to the tidal Potomac River. Tributaries are watersheds represented by a river reach in the Watershed Model, while direct drainage, on the other hand, are areas which have no river reach associated with them and drain directly to tidal waters.

ICPRB analyzed monitoring data collected in the Potomac River basin and developed three regression equations relating observed PCB3+ concentrations to observed TSS concentrations. Based on the fact that the highest concentrations of PCBs in non-tidal waters were observed in the District's tributaries to the Anacostia River and the lowest concentrations in Virginia tributaries more than 20 km from the District (Haywood and Buchanan (2007), p.A-15), each regression equation covered a different area of the tidal Potomac drainage: (1) DC and surrounding urban areas; (2) near DC; and (3) remaining areas (Elsewhere). Table 2.7 gives the regression equation used for each area. The DC Urban equation was applied to direct drainage to the tidal Anacostia River, Washington Ship Channel, and Potomac River downstream of Rock Creek, while the Near DC equation was applied to other areas within 20 km of the District, including the Rock Creek watershed. The Elsewhere equation was applied to the remainder of the tidal Potomac drainage. A fourth regression model was developed for PCB loads from the non-tidal Potomac River above the fall line at Chain Bridge.

Table 2.7: Regression Equations Relating PCB3+ to TSS by Region

Region	Equation	Coefficient of Determination (R^2)
DC Urban	$[PCB3+] = 0.855*[TSS]^{0.9702}$	0.61
Near DC	$[PCB3+] = 0.3290*[TSS]^{0.5059}$	0.63
Elsewhere	$[PCB3+] = 0.0458*[TSS]^{0.5008}$	0.52

Although in the tidal Potomac/Anacostia PCB TMDL, the District's Rock Creek tributaries are included in the simulation of the Rock Creek watershed, which uses the Near DC Equation to relate PCB concentrations to TSS concentrations, the monitoring stations used in the DC Urban Equation are closer to DC's Rock Creek tributaries and therefore most likely more representative of PCB concentrations in those tributaries. The DC Urban Equation was based on monitoring data from 31 samples collected at four locations in the District and one in Prince George's County, MD. All sampling locations are in the Anacostia watershed. Figure 2.2 shows the data collected at each station and the resulting regression line relating PCB3+ concentrations to TSS concentrations. In contrast, the Near DC Equation is based on monitoring data collected in streams in Northern Virginia or in the Northwest and Northeast Branches of the Anacostia River in Maryland. This monitoring data is probably more representative of the Rock Creek watershed as a whole, 87% of which is in suburban Maryland, than the more highly urbanized Rock Creek tributaries in the District.

The DC Urban Equation was also used to estimate PCB loads from the District's CSOs for the tidal Potomac/Anacostia PCB TMDL. Two samples were taken from CSOs and analyzed for PCBs and TSS. The results are shown in Figure 2.2. As the figure shows, the PCB3+ concentrations predicted by the DC Urban Equation match the observed values. Haywood and Buchanan (2007) used the event mean concentration (EMC) of TSS in CSO flows, estimated from monitoring data collected for the DC LTCP (DC Water, 2002), to estimate the PCB3+ concentration in CSO flows. The EMCs are flow-weighted averages of pollutant concentrations, and when multiplied by flows, yield estimates of the pollutant load, in much the same manner as STPM. The TSS EMC for CSOs, 156 mg/l, was used in the DC Urban Equation to obtain a representative PCB3+ concentration in CSO flow of 115 ng/l. The PCB3+ loads were converted to total PCBs load by dividing by a conversion factor of 0.96, which was derived from an analysis of the two samples taken from the CSOs.

The same method can be adapted to set the storm flow concentrations in STPM. As part of the Consolidated TMDL Implementation Plan (Limno Tech, 2015), EMCs were estimated for TMDL pollutants in storm water to use in the IP Modeling Tool. For TSS, the Consolidated Plan estimated a watershed-specific EMC of 60 mg/l for Rock Creek, based on the District's MS4 monitoring data. This EMC concentration can be used in the DC Urban Equation to obtain a representative concentration of PCB3+ in storm flow. In the tidal Potomac/Anacostia PCB TMDL, the PCB3+ loads were converted to total PCBs loads by dividing by the conversion factor of 0.92, which was derived from an analysis of the monitoring data collected in non-tidal waters for the tidal Potomac/Anacostia PCB TMDL. Applying this conversion factor to the representative PCB3+ concentration from the DC Urban Equation results in total PCB concentration of 49 ng/l (0.049 µg/l), rounded to the nearest ng/l. Table 2.8 summarizes the elements in the calculation of the input total PCB concentration for storm flow in STPM.

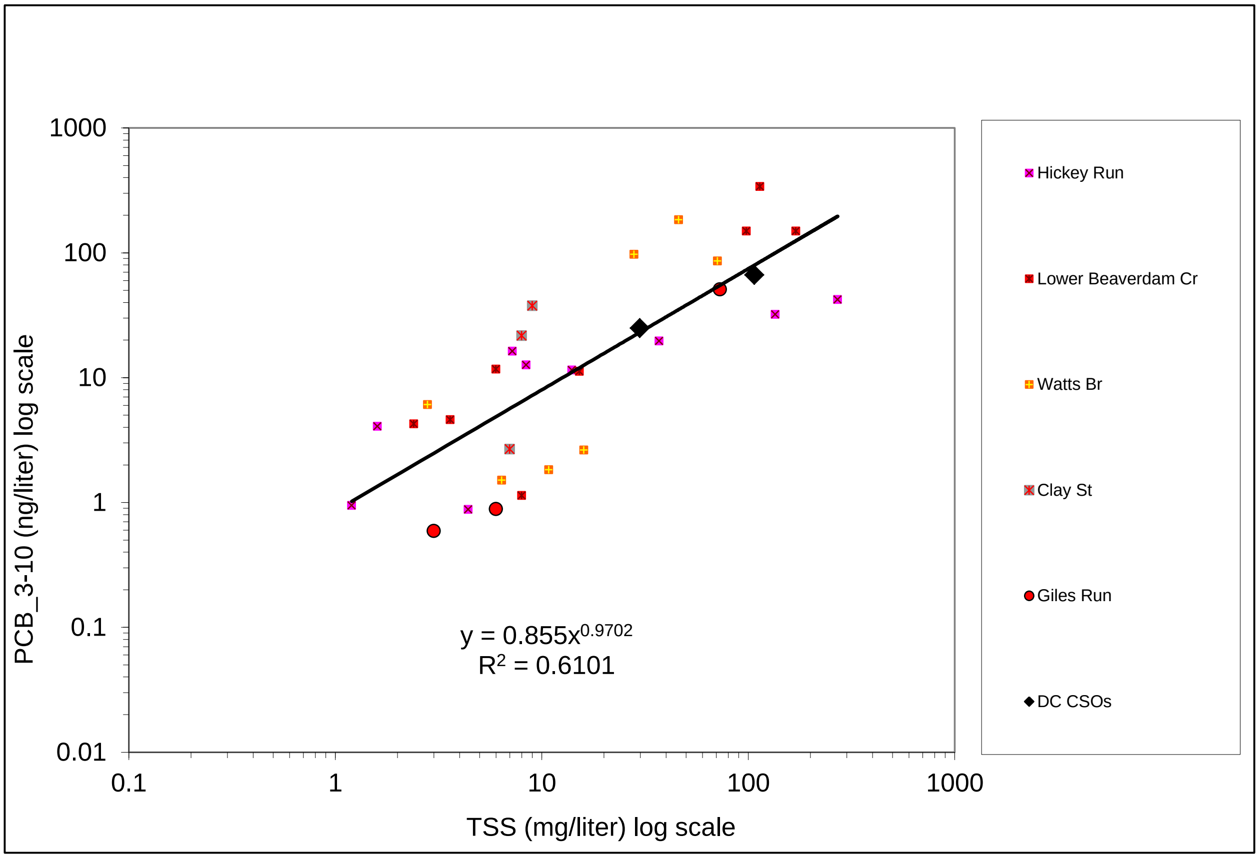

Figure 2.2: Regression Model relating PCB3+ Concentrations to TSS Concentrations for DC Urban Monitoring Data, Tidal Potomac/Anacostia PCB TMDL

Table 2.9: Elements in the Calculation of the Total PCB Concentration in Storm Flow in the STPM

Element	Value	Source
DC Urban Regression Model	$[PCB3+] = 0.855*[TSS]^{0.9702}$	Tidal Potomac/Anacostia PCB TMDL
Rock Creek EMC TSS Concentration	60 mg/l	DC Consolidated Implementation Plan
Conversion to Total PCBs	1/0.92	Tidal Potomac/Anacostia PCB TMDL
Input STPM Storm Flow PCB Concentration		49 ng/l

The estimated STPM storm water total PCB concentration was used to represent the concentration of PCBs in storm water from all land uses in STPM, with the exception of forest. Since forest represents minimally disturbed conditions, the concentration of PCBs in forest surface flow was set at the instream concentration (10 ng/l) used to represent base flow PCB concentrations.

For CSOs, the representative PCB3+ concentration of 115 ng/l was divided by the 0.92 conversion factor, resulting in a representative total PCB concentration of 120 ng/l. Table 2.10 summarizes the elements in the calculation of the input total PCB concentration for CSO flow in STPM.

Table 2.10: Elements in the Calculation of the Total PCB Concentration in CSO Flow in the STPM

Element	Value	Source
DC Urban Regression Model	$[PCB3+] = 0.855*[TSS]^{0.9702}$	Tidal Potomac/Anacostia PCB TMDL
Rock Creek EMC TSS Concentration	156 mg/l	DC Long-Term Control Plan
Conversion to Total PCBs	1/0.96	Tidal Potomac/Anacostia PCB TMDL
Input STPM CSO Flow PCB Concentration		120 ng/l

2.4.4 Uncertainty in Concentration Estimations

There are a number of sources of uncertainty in the estimates of the input concentrations used in STPM. First, there is the familiar uncertainty introduced whenever statistics is used to estimate parameters of a population from a sample. For example, Figure 2.3 shows the fitted values of the DC Urban regression model and the 95% confidence interval in the estimate of the fitted values. The model indicates that the concentration of PCB3+ at a TSS concentration of 60 mg/l is between 25 and 84 ng/l at the 95% confidence level. This implies that the range of total PCB concentrations at that confidence level lies between 27 and 91 ng/l, i.e. between 54% and 187% of the 49 ng/l used to characterize the concentration of total PCBs in storm flow.

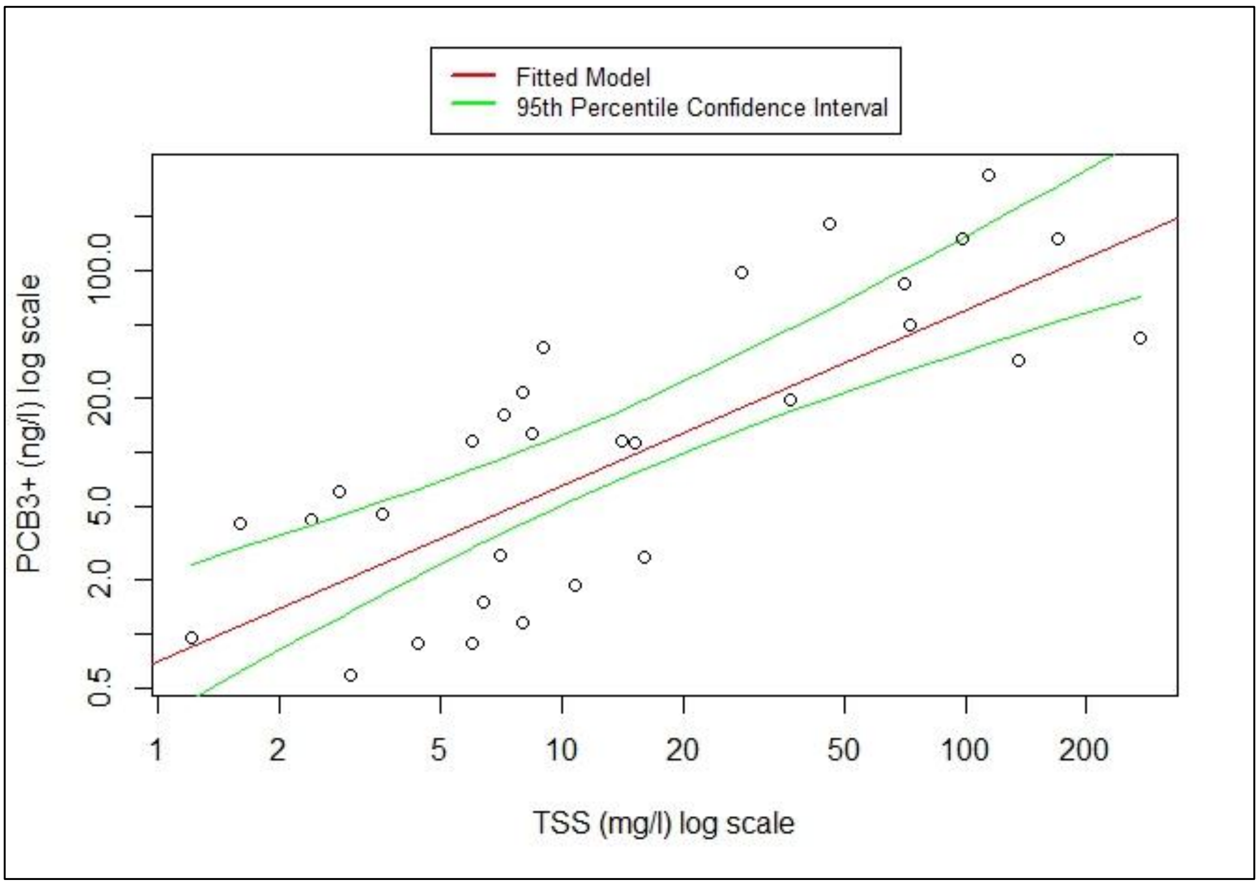

Figure 2.3: The Fitted Values of PCB3+ in the DC Urban Regression Model and the 95% Convidence Interval on the Fitted Values

Second, there is additional uncertainty introduced by the large number of observations of PCBs reported below the laboratory detection limit. Based on these laboratory analyses, the resulting concentrations estimated from these observations could be anywhere between zero and the detection limit. Table 2.6 shows the minimum value of average total PCBs, 7 ng/l, calculated by assuming all observations below the detection limit are zero, and the maximum value of average total PCBs, 12 ng/l, calculated by assuming that all observations below the detection limit have a concentration equal to the detection limit. Possible values of the average total PCB concentration in instream monitoring data range from 70% to 120% of the 10 ng/l used to represent total PCB concentrations in base flow in STPM.

Finally, there are unquantifiable sources of uncertainty, such as the extent to which the monitoring stations used in the DC Urban model, which are all in the Anacostia River watershed, are representative of PCB concentrations across the District. This can only be determined by additional monitoring and laboratory analysis. All of these sources of uncertainty introduce uncertainty into the estimate of baseline total PCB loads under current conditions. However, as will be explained in the next section, the conservative approach adopted to determine load and wasteload allocations under the TMDLs decouples those allocations from the uncertainty in estimates of baseline PCB loads.

3 Application of STPM to Revise PCB TMDLs in Rock Creek Watersheds

This section discusses the application of STPM to revise the PCB TMDLs for the small tributaries in the District's portion of the Rock Creek watershed. Section 3.1 discusses scoping scenarios used to determine the levels of reductions necessary to meet DC's aquatic life and human health criteria for PCBs. Section 3.2 discusses the TMDL Scenario required to meet current criteria. It includes a discussion of seasonality, critical conditions, and the conservative assumptions incorporated into the TMDL. Generally, in this section, only the percent reduction required to meet water quality standards is reported. Baseline loads and load allocations for individual tributaries are presented in Section 4.

In these scenarios, sources that discharge at storm sewer outlets are distinguished from diffuse sources. The former are referred to as "end-of-pipe" (EOP) sources, while the latter are referred to as "nonpoint sources" (NPS). Table 3-1 shows the classification of sources. The classification of sources is supposed to capture the degree to which source loads are controllable. EOP sources are more controllable than NPS. EOP sources include all surface discharges within the DC MS4 boundaries as well as surface discharges from developed land in Maryland. All other sources are considered NPS, including base flow discharges from the DC MS4 and surface discharges from developed land outside of the DC MS4 boundaries. The EOP/NPS distinction, therefore, does not fully match how input concentrations were assigned in STPM.

Table 3.1: Classification of Sources in Scenarios

Land Cover	Flow Type	MS4	Direct Drainage	Maryland
Impervious	Storm	EOP	NPS	EOP
Turf	Storm	EOP	NPS	EOP
	Base	NPS	NPS	NPS
Forest	Storm	EOP	NPS	NPS
	Base	NPS	NPS	NPS

According to STPM, the CCC aquatic life criterion and the Class D human health criteria are never met under baseline or current conditions. As demonstrated in Section 3.2, although the TMDL was developed explicitly to meet the Class D human health criteria, it also ensures that the chronic aquatic life criterion is met.

3.1 Scoping Scenarios

Three scoping scenarios were simulated with the STPM: (1) equal reduction to all sources; (2) 100% reduction in EOP loads; and (3) 100% reduction in NPS loads. Table 3.2 shows the percent reduction required from EOP and NPS sources to meet water quality standards under the three scoping scenarios. Since the minimum reduction in NPS loads occurs when the maximum reduction from EOP loads is taken, the second scenario also represents the minimum reduction in NPS loads. Similarly, a 100% reduction in NPS loads represents the minimum reduction in EOP loads.

Table 3.2: Percent Reductions Required to Meet Human Health Criteria, Scoping Scenarios

	Equal Percent Reduction		Minimum NPS		Minimum EOP	
Tributary	**EOP**	**NPS**	**EOP**	**NPS**	**EOP**	**NPS**
Broad Branch	99.81%	99.81%	100.00%	99.36%	99.77%	100.00%
Dumbarton Oaks	99.80%	99.80%	100.00%	99.76%	98.65%	100.00%
Fenwick Branch	99.83%	99.83%	100.00%	99.36%	99.80%	100.00%
Klingle Valley Creek	99.81%	99.81%	100.00%	99.36%	99.74%	100.00%
Luzon Branch	99.83%	99.83%	100.00%	99.36%	99.80%	100.00%
Melvin Hazen Valley Branch	99.80%	99.80%	100.00%	99.36%	99.72%	100.00%
Normanstone Creek	99.81%	99.81%	100.00%	99.36%	99.76%	100.00%
Pinehurst Branch	99.80%	99.80%	100.00%	99.36%	99.75%	100.00%
Piney Branch	99.78%	99.78%	100.00%	99.37%	99.67%	100.00%
Portal Branch	99.80%	99.80%	100.00%	99.56%	99.65%	100.00%
Soapstone Creek	99.82%	99.82%	100.00%	99.36%	99.77%	100.00%

The percent reduction required to meet water quality standards for both edge of stream (EOS) and NPS sources is greater than 99% in all three scenarios, with the single exception of the reduction of EOP sources in Dumbarton Oaks under the Minimum EOP Scenario. With this exception, a greater percent reduction is required for the Minimum EOP Scenario than the Minimum NPS Scenario, reflecting the fact that STPM stormflow concentrations are nearly five times greater than baseflow concentrations. Even if base flow contained no PCBs, substantial reductions in PCBs in storm flow would have to occur to meet the 30-day human health criterion. On the other hand, the reductions required in base flow to meet the criterion under dry weather conditions are almost as great as the storm water reductions. Even if storm water discharged no PCBs, the reductions in PCBs in base flow would need to be greater than 99% to meet the 30-day human health criterion under dry weather conditions. The reductions required on EOP sources under the Equal Percent Reduction Scenario are only slightly greater than the reductions in the Minimum EOP Scenario, which indicates that wet weather conditions are dictating the overall level of reduction. It requires a 99.36% reduction from the 10 ng/l concentration assigned to base flow and a 99.87% reduction from the 49 ng/l concentration assigned to storm flow for these sources to discharge at the human health criterion. Therefore, under the Equal Percent Reduction Scenario, base flow discharges at a concentration below the human health criterion, while EOP sources discharge above it.

3.2 TMDL Scenario

The Equal Reduction Scenario may appear to be the most equitable allocation of loads under a TMDL, because it seems to imply an equal level of effort. However, if EOP sources discharge above the Class D criteria, the other sources must discharge below it and provide the dilution capacity to meet water quality standards. Another complicating factor is the uncertainty associated with the input concentrations used in STPM, previously discussed in Section 2.4. Since baseline concentrations and loads are uncertain, an equal percent reduction measured with respect to those loads may not in fact be equitable, if actual loads turn out to be very different from their estimates.

An equitable allocation, which is not affected by the uncertainty in baseline loads, is to require all sources to discharge at the most stringent current water quality criterion, the Class D human health criterion. This allocation was chosen as the TMDL Scenario. Table 3.5 shows the reductions necessary under the TMDL Scenario. The required reductions are all greater than 99%.

Table 3.5: Percent Reductions Required to Meet Current Class D Human Health Criteria, TMDL Scenario

Tributary	EOP	NPS
Broad Branch	99.87%	99.36%
Dumbarton Oaks	99.87%	99.36%
Fenwick Branch	99.87%	99.36%
Klingle Valley Creek	99.87%	99.36%
Luzon Branch	99.87%	99.36%
Melvin Hazen Valley Branch	99.87%	99.36%
Normanstone Creek	99.87%	99.36%
Pinehurst Branch	99.87%	99.36%
Piney Branch	99.87%	99.36%
Portal Branch	99.87%	99.36%
Soapstone Creek	99.87%	99.36%

Under the TMDL Scenario, each source discharges at the Class D human health criterion. Consequently, the total PCB concentration in a tributary is a constant value equal to the human health criterion. Moreover, the four-day average and 30-day average concentrations are also constant values equal to the human health criterion. Since the 30-day average human health criterion is less than 4-day average chronic aquatic life use criterion, the chronic aquatic life use criterion will also be met under the TMDL Scenario. Figure 3.1 shows these relationships. The relationships hold for each tributary modeled, and therefore Figure 3-1 could represent any tributary. A single constant time series at the 30-day human health criterion simultaneously represents (1) the criterion; (2) the hourly or instantaneous total PCB concentration; (3) the four-day average concentration; and (4) the 30-day average concentration. By design, under the TMDL Scenario, the 30-day human health criterion is met. Figure 3.1 also demonstrates that the TMDL Scenario meets the chronic aquatic life use criterion.

The remainder of this section discusses how the TMDL Scenario meets the requirements of TMDLs.

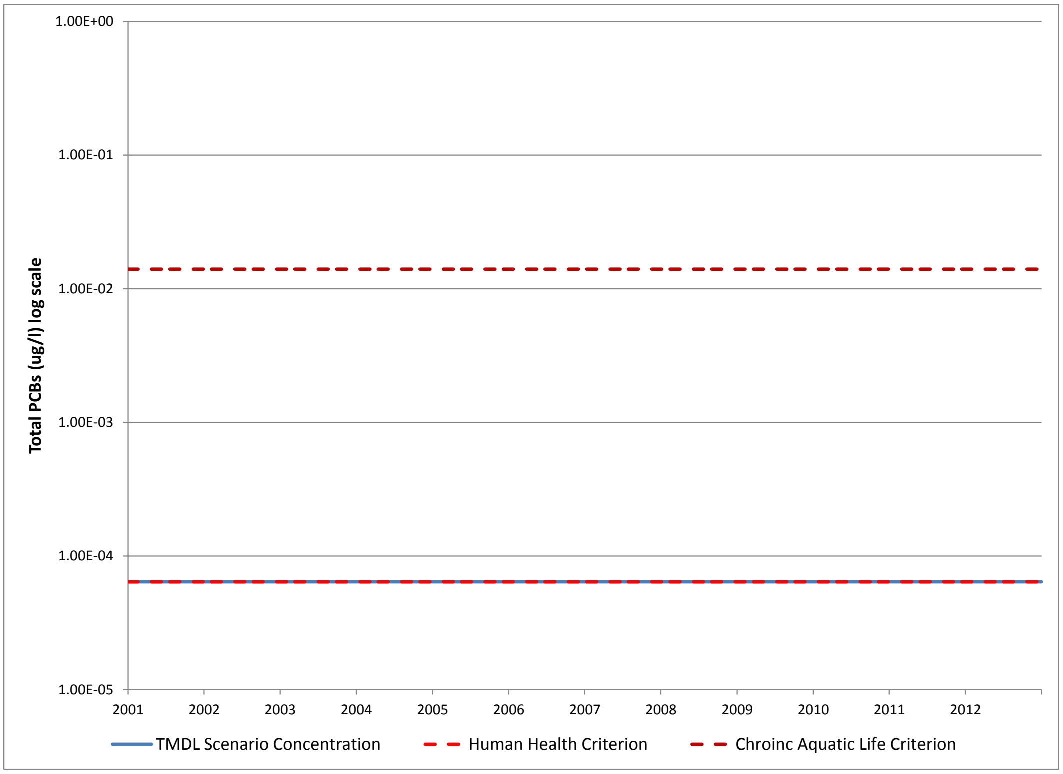

Figure 3.1: Simulated Total PCB Concentration (µg/l), TMDL Scenario, and PCB Human Health Criterion and Chronic Aquatic Life Criterion

3.2.1 Critical Conditions

EPA's regulations require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters (40 CFR 130.7 (c) (1)). The intent of this requirement is to ensure that the water quality of the waterbody is protected during times when it is most vulnerable. The STPM simulates a variety of hydrological conditions over a 12-year simulation period, including periods of dry weather (2002) and periods of frequent storm flow events (2003). The Minimum EOP and Minimum NPS Scenarios demonstrate that violations of water quality criteria take place both during dry conditions and periods of frequent storm events, requiring substantial reductions in PCB loads both in storm flow and base flow. Loading rates under these conditions are determined directly from the Class D criterion, so critical conditions are taken into account.

3.2.2 Seasonality

EPA regulations also require TMDLs to take into account seasonal environmental variations. Seasonal variation has been incorporated into STPM. STPM uses daily output from HSPF, a continuous simulation model on an hourly time-step to simulate flows over a 12-year simulation period, so the model takes into account hourly variation in precipitation, temperature, and potential evapotranspiration. Model parameters representing crop cover and surface roughness also vary monthly (EPA, 2010).

3.2.3 Conservative Assumptions

TMDLs require a margin of safety (MOS) to account for uncertainty in the relation between loading rates and water quality. The MOS can be explicit or implicit. If it is implicit, it must be justified by showing that conservative assumptions were incorporated into the development of TMDLs.

The use of STPM to revise the PCB TMDLs for the Rock Creek watersheds incorporates the following conservative assumptions. First, a 12-year simulation period, 2001-2012, was used in STPM. This simulation period includes a variety of hydrological conditions, including a very wet year (2003) and a very dry year (2001). As measured by annual precipitation at Ronald Reagan Washington National Airport, 2003 was the wettest year in the last 50 years while 2001 was the fourth-driest year in the last 50 years and the second-driest in the last 35 years[12]. The longer simulation period ensures that the TMDLs covered a variety of hydrological conditions and critical conditions, including seasonal variations. Second, although there is considerable uncertainty in baseline load estimates, the uncertainty in baseline concentrations and loads has no impact on the relation between the loads under the TMDL Scenario and water quality standards. The loads under the TMDL scenario were not determined from baseline loads, but directly from the most stringent applicable water quality criteria. Third, it is assumed that all categories of sources discharge at the most stringent applicable water quality criteria, and that no category of sources relies on dilution from another category of sources, in order that water quality standards be met. Therefore, the use of an implicit MOS is justified on the basis of the methodology used to develop the revised PCB TMDLs.

3.2.4 Allocations

The PCB TMDL for each tributary is divided into a wasteload allocation (WLA) and a load allocation (LA). The sources included in the WLA are (1) the District's regulated stormwater and (2) CSS in Piney Branch. The sources included in the LA are (1) nonpoint sources from the District's direct drainage and (2) upstream loads from Maryland.

TMDLs and their allocations were expressed as (1) average annual loads, (2) average daily loads, and (3) maximum daily loads. The average annual load allocated for each source is the average load attributed to the source under the TMDL over the 12-year (2001-2012) simulation period. The allocation for a source is expressed as average daily load by dividing the average annual load allocation by 365. The maximum daily load for each allocation source category is the maximum daily load for that source in the 12-year simulation period that can be discharged and still achieve the applicable water quality standard. For each method of expressing the TMDL, the MOS is implicit and the TMDL is the sum of the allocations of the sources.

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[12] National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI). http://www.ncdc.noaa.gov/

4 Results for Individual Small Tributaries

In this section, the results of the application of STPM to develop PCB TMDLs for each small tributary will be discussed individually. Each section below will present results for an individual tributary, including:

- A brief description of the tributary and its watershed;
- Map of the tributary watershed;
- Land use acreage;
- Time series of simulated daily flows;
- Average annual baseline conditions and TMDL Scenario loads;
- Average daily loads for baseline conditions and TMDL Scenario;
- Maximum daily loads for baseline conditions and TMDL Scenario;
- Time series of simulated daily concentrations for 2005;
- 30-day average simulated concentrations under baseline conditions; and
- Daily loads for each pesticide under baseline conditions and TMDL Scenario.

Daily simulated concentrations are shown for 2005 only to better display the variability in concentrations. The year 2005 was chosen because, according to Haywood and Buchanan (2007), the distribution of flows on the Potomac River at Little Falls in calendar year 2005 is similar to the long-term distribution of flows, and so provides typical variety of flow conditions seen in this region.

4.1 Broad Branch

Broad Branch is about a two-mile long western tributary of Rock Creek. Figure 4.1 shows the location of Broad Branch and its watershed. It is joined by Soapstone Creek about 800 feet before it discharges into Rock Creek. Broad Branch begins near Nebraska and Connecticut Avenues. For half of its length, Broad Branch is bordered on one side by National Park Service parkland and on the other side by Broad Branch Road which directly abuts it. The lower reach of the stream travels through Rock Creek Park and is bordered by an approximately 200-feet buffer of tree and shrubs. The stream is about 25 feet wide (DDOH, 2004a).

Table 4.1 gives the land use acreage in the Broad Branch watershed. The watershed encompasses 1,145 acres. The watershed is 34% impervious and 79% lies within the DC MS4. About 15% percent of the watershed is parkland, while the remaining area is residential and retail commercial. There is one Multi-Sector General Permit (MSGP) in the watershed, 5333 Connecticut Avenue NW (DCR05AA17), as shown in Figure 4.1. The loading from this MSGP is aggregated under the MS4 WLA.

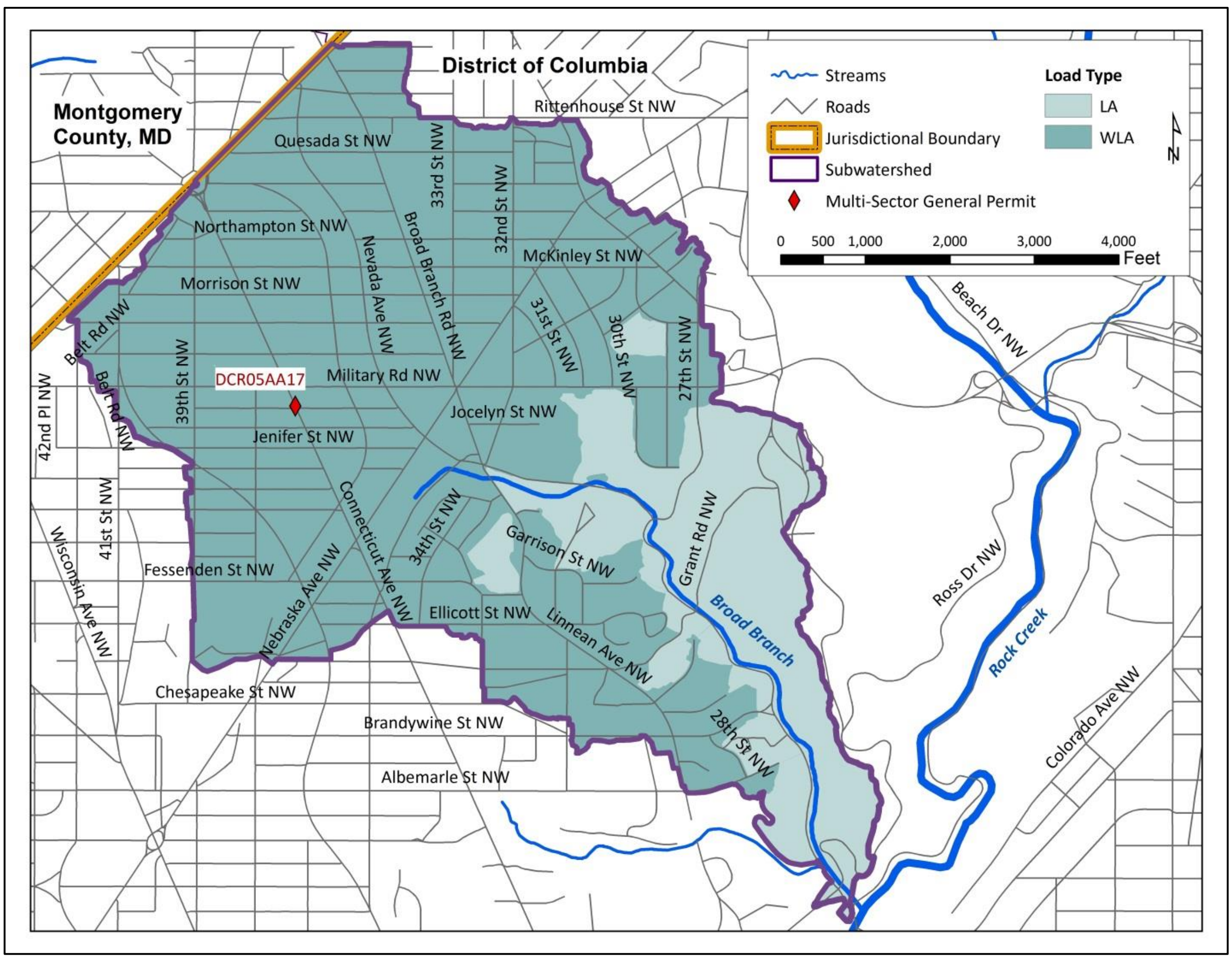

Figure 4.1: Broad Branch and its Watershed

Table 4.1: Broad Branch Land Use (acres)

Type	Impervious	Pervious	Forest	Total
DC MS4	367	495	39	900
DC Non-MS4	22	46	176	245
Maryland	-	-	-	-
Total	389	541	215	1,145

Figure 4.2 shows simulated daily average flow over the 2001-2012 year period Simulated flows range from 0.06 cfs to 139 cfs. The average daily flow is 2.4 cfs and the median flow is 0.57 cfs.

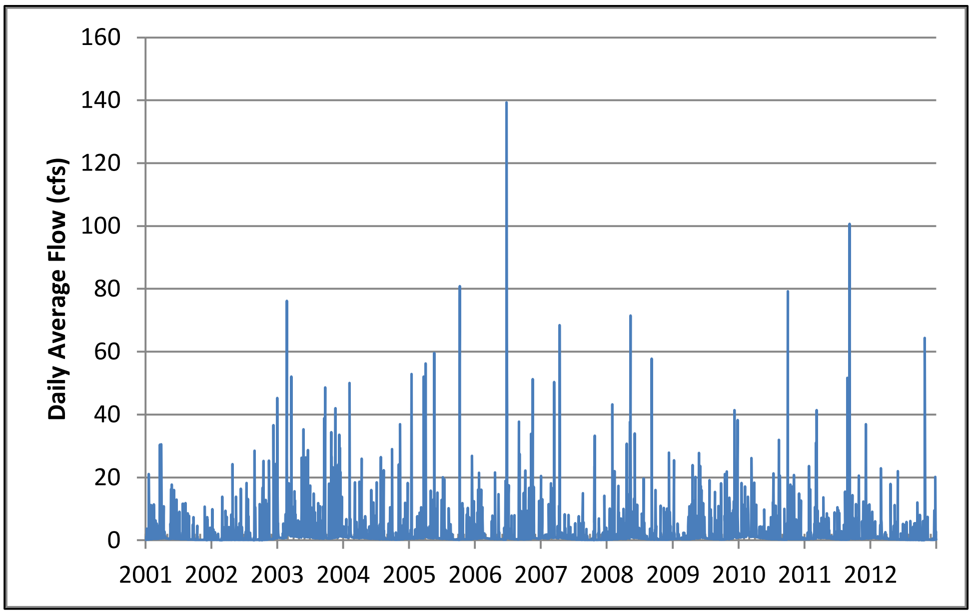

Figure 4.2: Simulated Average Daily Flow (cfs), Broad Branch

Table 4.2 presents the average annual baseline total PCB loads and TMDL allocations. Table 4.3 presents the daily average baseline loads and TMDL allocations, and Table 4.4 presents maximum daily baseline total PCB loads and TMDL allocations. Baseline loads and allocations for multi-sector general permit DCR05AA17 are included in the DC Stormwater baseline loads and allocations. Figure 4.3 shows simulated daily PCB concentrations under baseline conditions in 2005. Since the concentration of PCBs in storm flow is greater than the concentration in base flow, concentrations increase during storm events. Figure 4.4 contrasts the 30-day average total PCB concentration under baseline conditions and the current Class D human health criterion. Figure 4.5 presents simulated daily PCB loads under baseline conditions and under the TMDL.

Table 4.2: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Broad Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.69E-01	2.20E-04	99.87%
	Total	1.69E-01	2.20E-04	99.87%
Load Allocation	Direct Drainage	2.21E-02	8.37E-05	99.62%
	Upstream Maryland	-	-	-
	Total	2.21E-02	8.37E-05	99.62%
Margin of Safety		-	Implicit	-
Total		1.91E-01	3.04E-04	99.84%

Table 4.3: PCB Average Daily Loads (lbs/d), Broad Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	4.62E-04	6.03E-07	99.87%
	Total	4.62E-04	6.03E-07	99.87%
Load Allocation	Direct Drainage	6.06E-05	2.29E-07	99.62%
	Upstream Maryland	-	-	-
	Total	6.06E-05	2.29E-07	99.62%
Margin of Safety		-	Implicit	-
Total		5.23E-04	8.33E-07	99.84%

Table 4.4: PCB Maximum Daily Loads (lbs/d), Broad Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.13E-02	4.09E-05	99.87%
	Total	3.13E-02	4.09E-05	99.87%
Load Allocation	Direct Drainage	2.94E-03	7.10E-06	99.76%
	Upstream Maryland	-	-	-
	Total	2.94E-03	7.10E-06	99.76%
Margin of Safety		-	Implicit	-
Total		3.43E-02	4.80E-05	99.86%

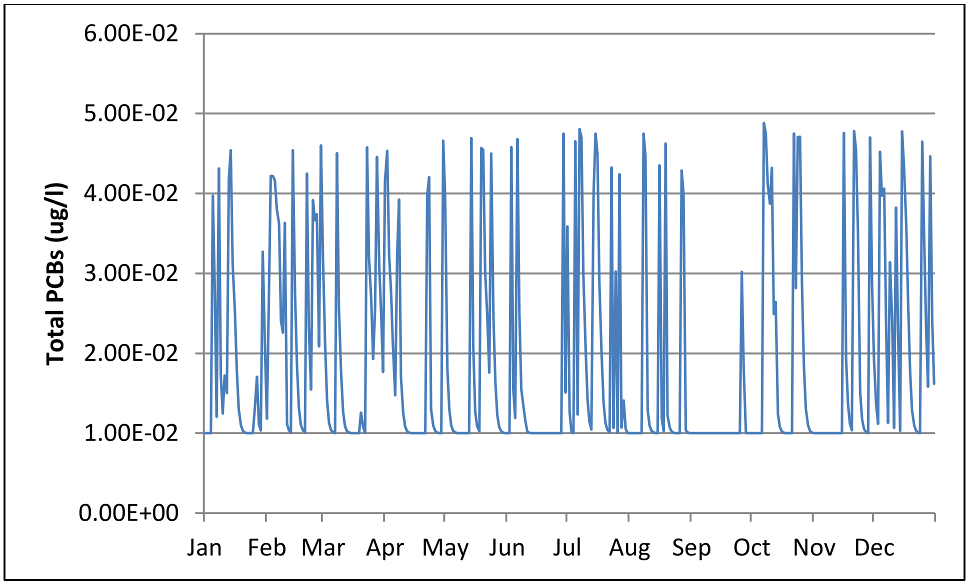

Figure 4.3: Simulated Daily PCB Concentrations (µg/l), Broad Branch, Baseline Conditions, 2005

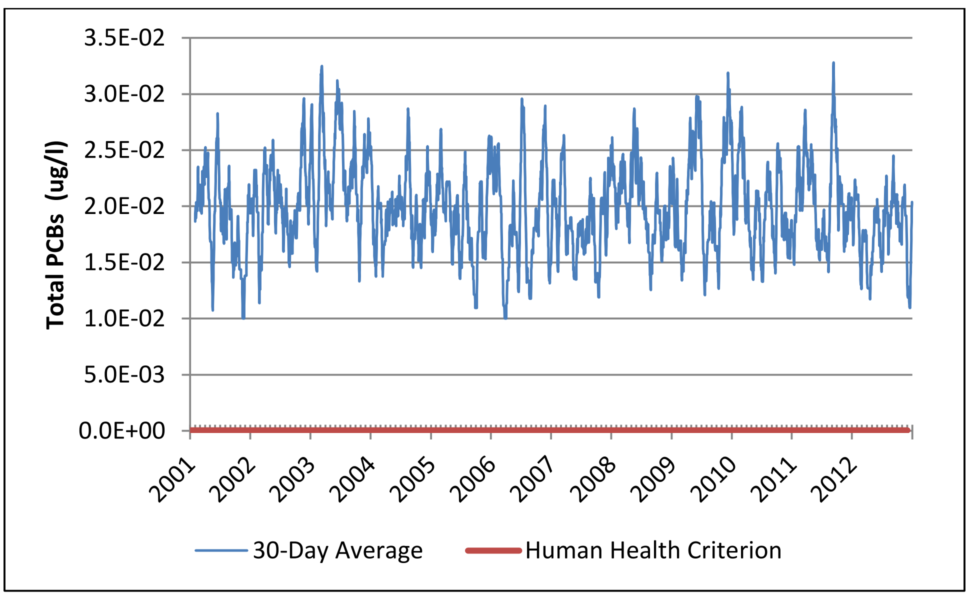

Figure 4.4: Simulated 30-Day Average PCB Concentrations (µg/l), Broad Branch, Baseline Conditions

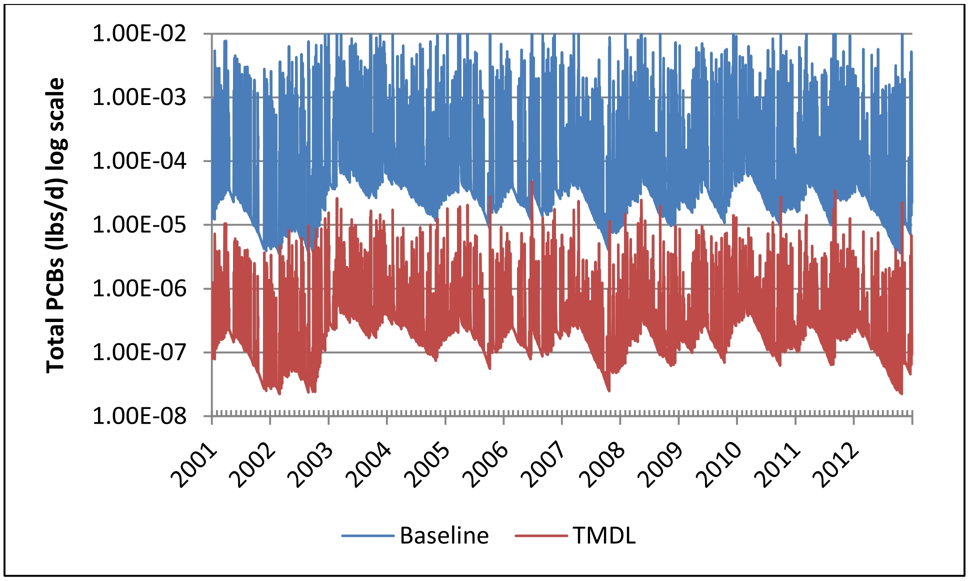

Figure 4.5: Simulated Daily PCB Loads (lbs/d), Broad Branch, Baseline Conditions and TMDL Scenario

4.2 Dumbarton Oaks

Dumbarton Oaks is a minor western tributary whose confluence with Rock Creek is about 100 yards south of Massachusetts Avenue over Rock Creek. Figure 4.6 shows the location of Dumbarton Oaks and its watershed. The Dumbarton Oaks watershed drains mostly National Park Service parkland, including about a quarter of the grounds of the US Naval Observatory and Dumbarton Oaks Gardens. Approximately two-thirds of the watershed is landscaped or forested parkland, with the remainder area as residential. Dumbarton Oaks is a little more than a half-mile long and is buffered with varying widths of landscaped parkland as it flows eastward to Rock Creek. The channel is about 22 feet wide. It is very steep, dropping 200 feet from the head of its watershed to its mouth near Rock Creek (DDOH, 2004a).

Table 4.5 gives the land use acreage in the Dumbarton Oaks watershed. The watershed encompasses 136 acres. The watershed is 25% impervious but only 9% lies within the DC MS4.

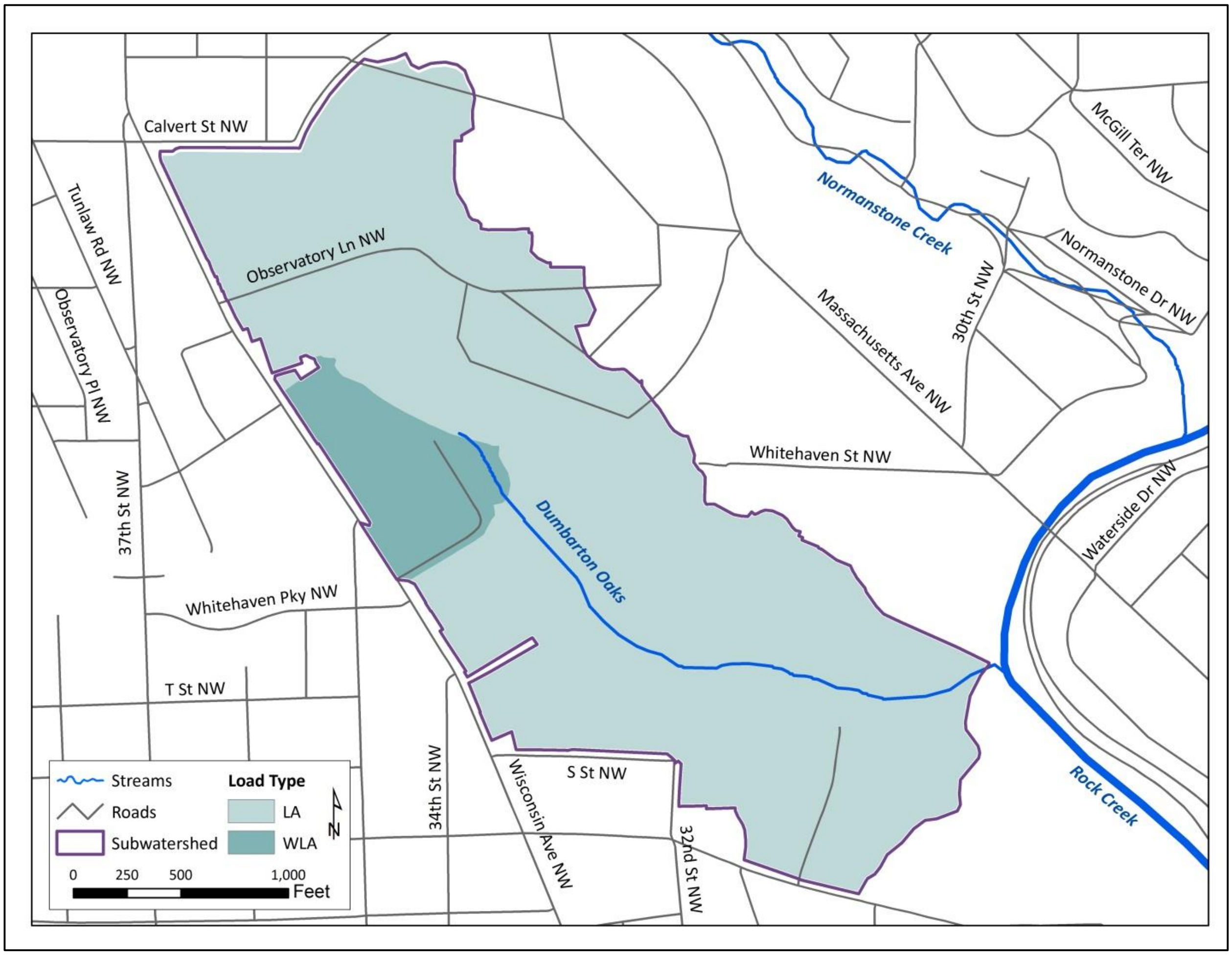

Figure 4.6: Dumbarton Oaks and its Watershed

Table 4.5: Dumbarton Oaks Land Use (acres)

Type	Impervious	Pervious	Forest	Total
DC MS4	8	3	1	12
DC Non-MS4	25	52	47	124
Maryland	-	-	-	-
Total	34	54	48	136

Figure 4.7 shows simulated daily average flow over the 2001-2012 year period. Simulated flows range from 0.01 cfs to 14.4 cfs. The average daily flow is 0.25 cfs and the median flow is 0.08 cfs.

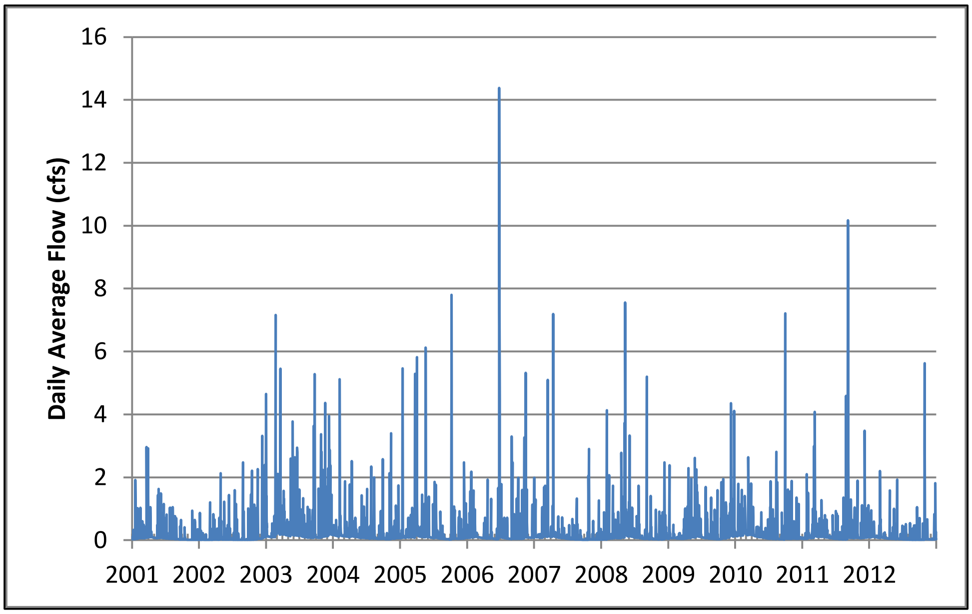

Figure 4.7: Simulated Average Daily Flow (cfs), Dumbarton Oaks

Table 4.6 presents the average annual baseline total PCB loads and TMDL allocations. Table 4.7 presents the daily average baseline loads and TMDL allocations, and Table 4.8 presents maximum daily baseline total PCB loads and TMDL allocations. Figure 4.8 shows simulated daily PCB concentrations under baseline conditions in 2005. Since the concentration of PCBs in storm flow is greater than the concentration in base flow, concentrations increase during storm events. Figure 4.9 contrasts the 30-day average total PCB concentration under baseline conditions and the current Class D human health criterion. Figure 4.10 presents simulated daily PCB loads under baseline conditions and under the TMDL.

Table 4.6: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.23E-03	4.22E-06	99.87%
	Total	3.23E-03	4.22E-06	99.87%
Load Allocation	Direct Drainage	1.46E-02	2.77E-05	99.81%
	Upstream Maryland	-	-	-
	Total	1.46E-02	2.77E-05	99.81%
Margin of Safety		-	Implicit	-
Total		1.78E-02	3.19E-05	99.82%

Table 4.7: PCB Average Daily Loads (lbs/d), Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	8.84E-06	1.16E-08	99.87%
	Total	8.84E-06	1.16E-08	99.87%
Load Allocation	Direct Drainage	4.00E-05	7.59E-08	99.81%
	Upstream Maryland	-	-	-
	Total	4.00E-05	7.59E-08	99.81%
Margin of Safety		-	Implicit	-
Total		4.88E-05	8.75E-08	99.82%

Table 4.8: PCB Maximum Daily Loads (lbs/d), Dumbarton Oaks

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.05E-04	6.60E-07	99.87%
	Total	5.05E-04	6.60E-07	99.87%
Load Allocation	Direct Drainage	2.73E-03	4.29E-06	99.84%
	Upstream Maryland	-	-	-
	Total	2.73E-03	4.29E-06	99.84%
Margin of Safety		-	Implicit	-
Total		3.24E-03	4.95E-06	99.85%

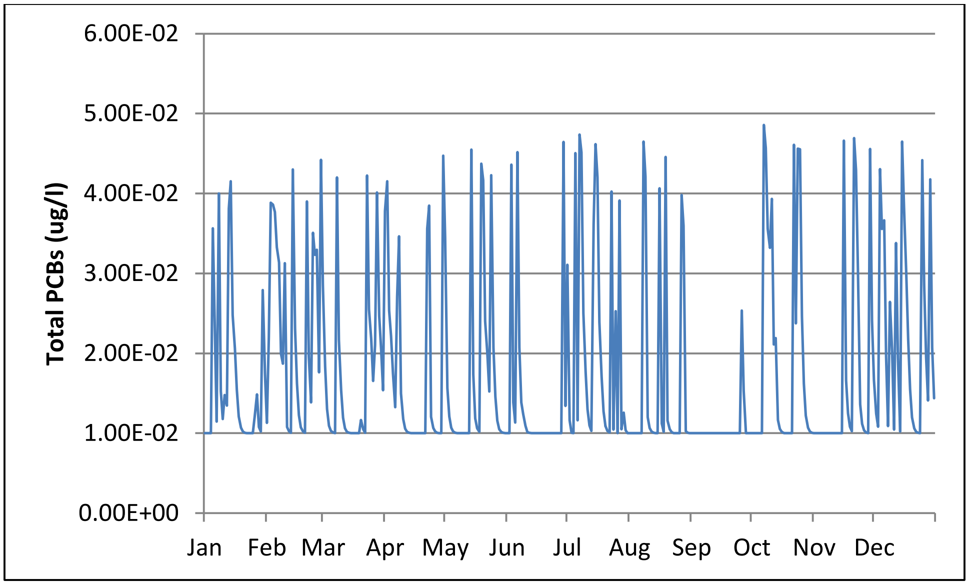

Figure 4.8: Simulated Daily PCB Concentrations (µg/l), Dumbarton Oaks, Baseline Conditions, 2005

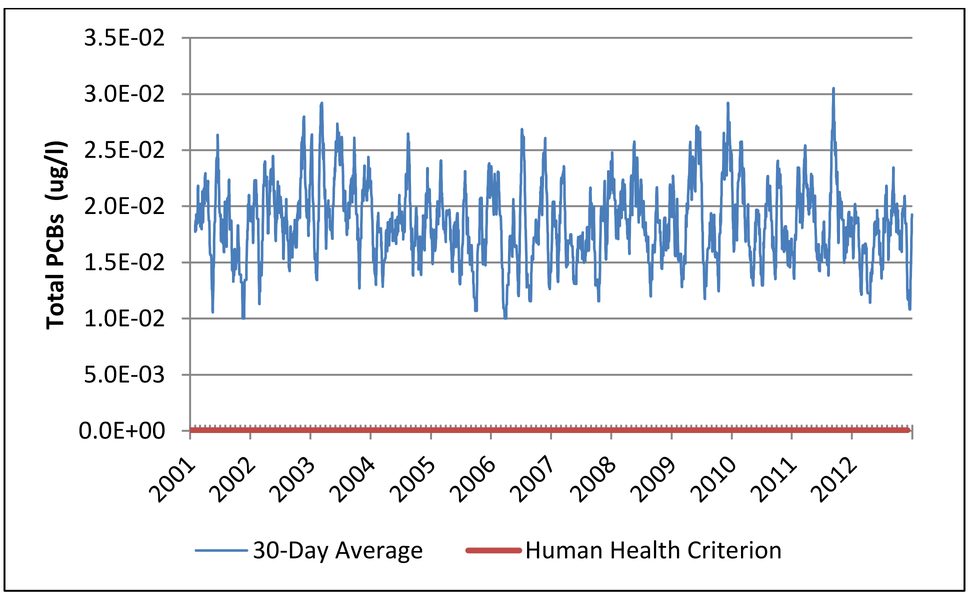

Figure 4.9: Simulated 30-Day Average PCB Concentrations (µg/l), Dumbarton Oaks, Baseline Conditions

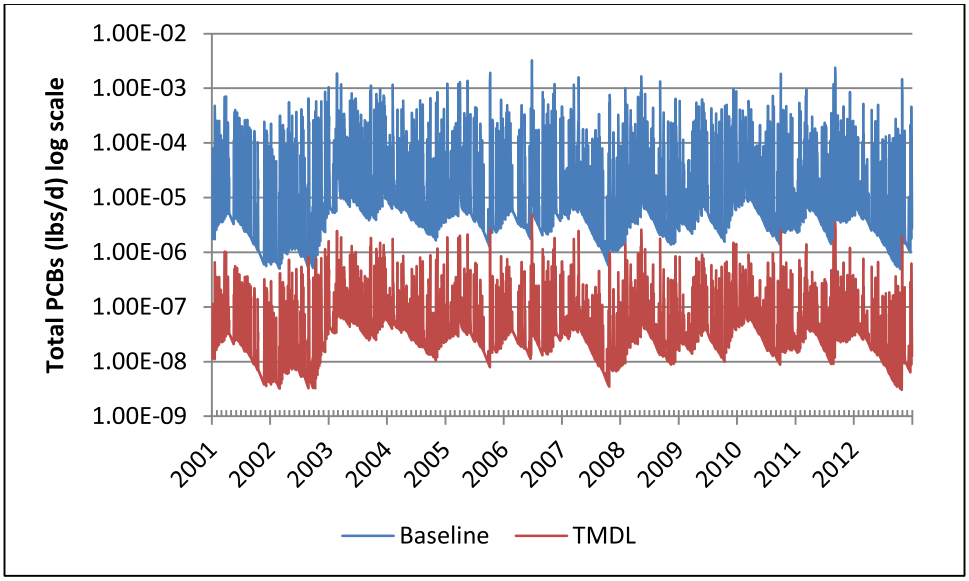

Figure 4.10: Simulated Daily PCB Loads (lbs/d), Dumbarton Oaks, Baseline Conditions and TMDL Scenario

4.3 Fenwick Branch

Fenwick Branch is a second-order eastern tributary of Rock Creek originating in Maryland just outside the Northeastern DC border. Figure 4.11 shows the location of Fenwick Branch and its watershed. Fenwick Branch's watershed measures approximately 612 acres, but only 219 acres are within DC boundaries, the rest being in Montgomery County, MD. The watershed is primarily urbanized, including residential areas inside the District and some commercial and light industrial in MD. The tributary runs a little more than half a mile before joining Portal Branch, approximately 120 feet north of its confluence with Rock Creek. Throughout the length of the stream it is buffered by approximately 100 feet of forested parkland on both sides. The stream channel is about 6 feet wide (DDOH, 2004a).

Table 4.9 gives the land use acreage in the Fenwick Branch watershed. DC's portion of the watershed is 32% impervious and 74% lies within the DC MS4.

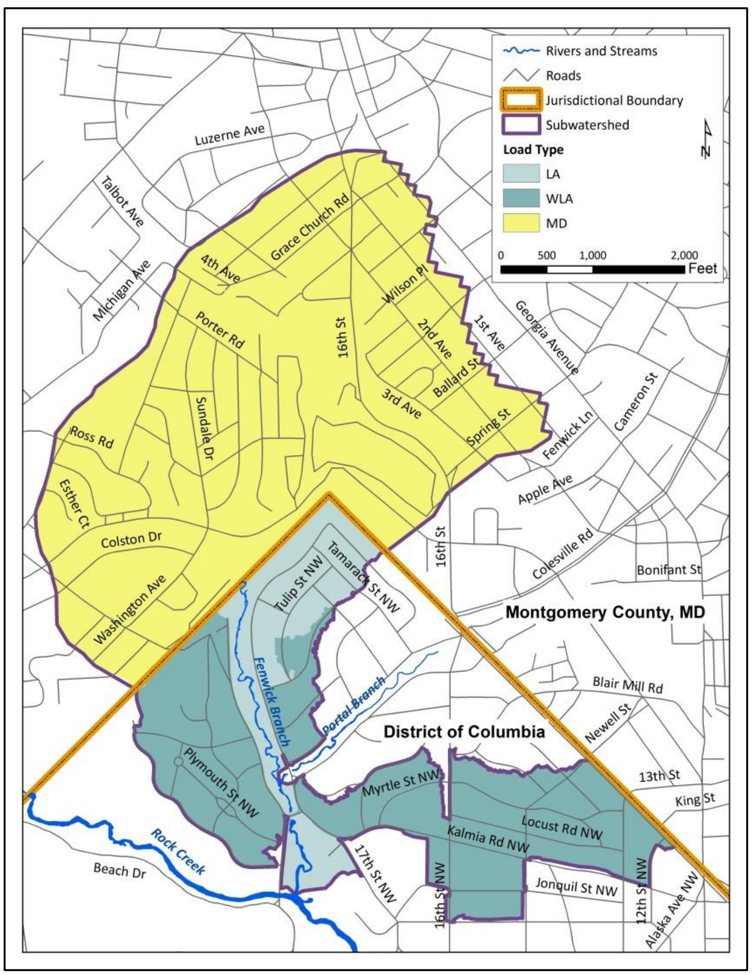

Figure 4.11: Fenwick Branch and its Watershed

Table 4.9: Fenwick Branch Land Use (acres)

Type	Impervious	Pervious	Forest	Total
DC MS4	60	93	9	162
DC Non-MS4	11	25	22	57
Maryland	150	243	0	393
Total	221	361	30	612

Figure 4.12 shows simulated daily average flow over the 2001-2012 year period. Simulated flows range from 0.02 cfs to 55 cfs. The average daily flow is 1.36 cfs and the median flow is 0.37 cfs.

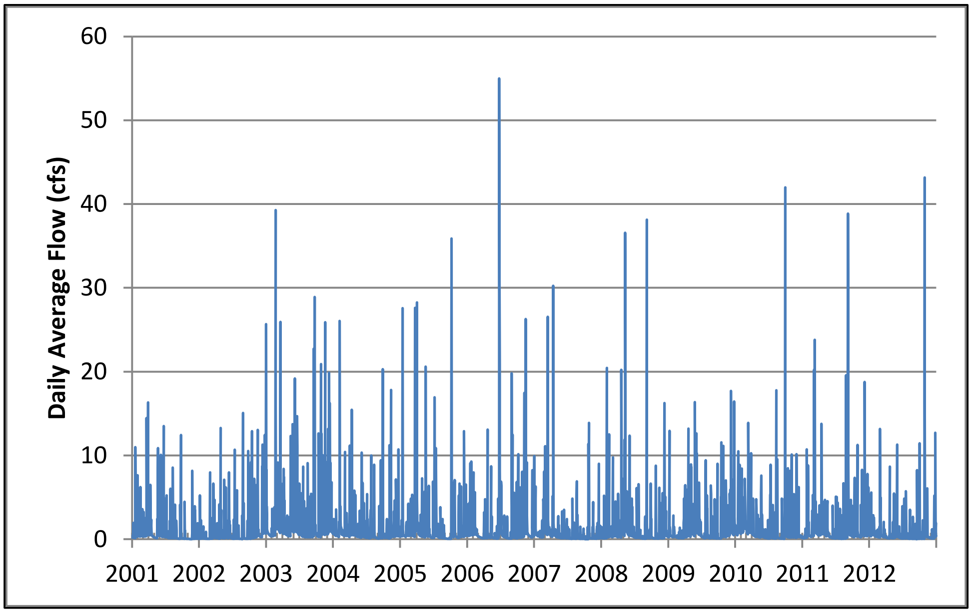

Figure 4.12: Simulated Average Daily Flow (cfs), Fenwick Branch

Table 4.10 presents the average annual baseline total PCB loads and TMDL allocations. Table 4.11 presents the daily average baseline loads and TMDL allocations, and Table 4.12 presents maximum daily baseline total PCB loads and TMDL allocations. Figure 4.13 shows simulated daily PCB concentrations under baseline conditions in 2005. Since the concentration of PCBs in storm flow is greater than the concentration in base flow, concentrations increase during storm events. Figure 4.14 contrasts the 30-day average total PCB concentration under baseline conditions and the current Class D human health criterion. Figure 4.15 presents simulated daily PCB loads under baseline conditions and under the TMDL.

Table 4.10: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Fenwick Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.86E-02	3.73E-05	99.87%
	Total	2.86E-02	3.73E-05	99.87%
Load Allocation	Direct Drainage	7.59E-03	1.99E-05	99.74%
	Upstream Maryland	7.20E-02	1.14E-04	99.84%
	Total	7.96E-02	1.34E-04	99.83%
Margin of Safety		-	Implicit	-
Total		1.08E-01	1.71E-04	99.84%

Table 4.11: PCB Average Daily Loads (lbs/d), Fenwick Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	7.83E-05	1.02E-07	99.87%
	Total	7.83E-05	1.02E-07	99.87%
Load Allocation	Direct Drainage	2.08E-05	5.45E-08	99.74%
	Upstream Maryland	1.97E-04	3.12E-07	99.84%
	Total	2.18E-04	3.66E-07	99.83%
Margin of Safety		-	Implicit	-
Total		2.96E-04	4.69E-07	99.84%

Table 4.12: PCB Maximum Daily Loads (lbs/d), Fenwick Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.43E-03	7.09E-06	99.87%
	Total	5.43E-03	7.09E-06	99.87%
Load Allocation	Direct Drainage	1.26E-03	2.11E-06	99.83%
	Upstream Maryland	8.25E-03	1.08E-05	99.87%
	Total	9.51E-03	1.29E-05	99.86%
Margin of Safety		-	Implicit	-
Total		1.49E-02	2.00E-05	99.87%

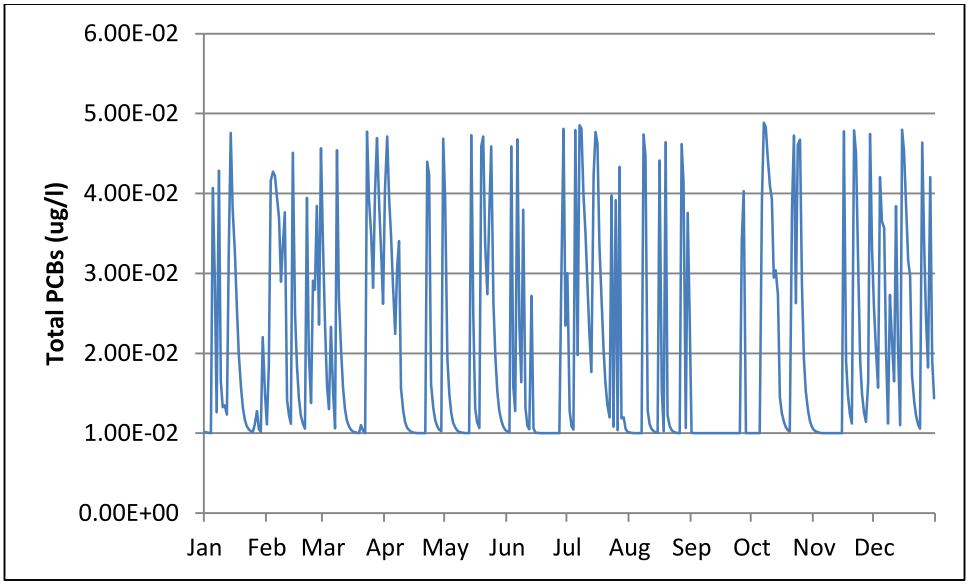

Figure 4.13: Simulated Daily PCB Concentrations (µg/l), Fenwick Branch, Baseline Conditions, 2005

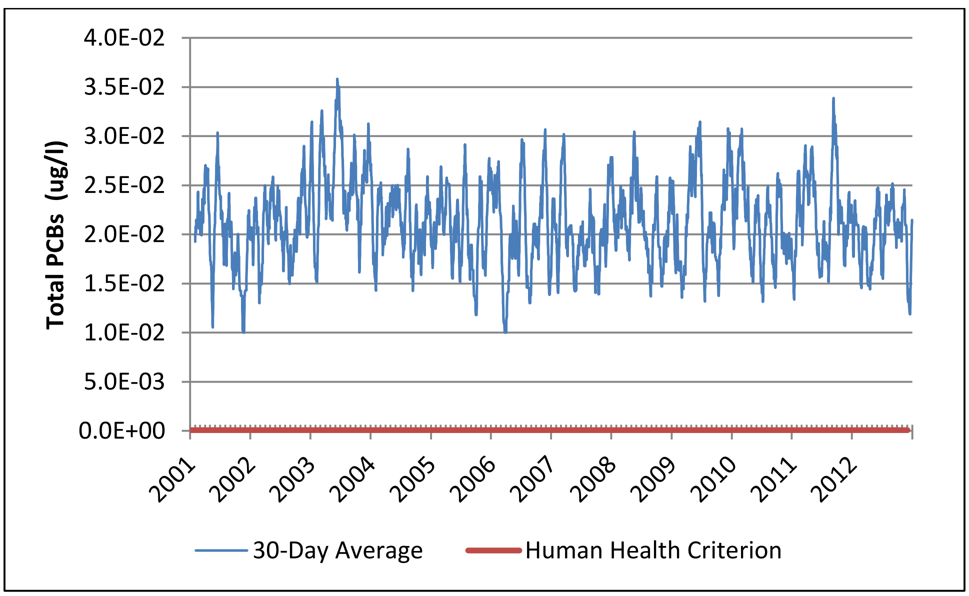

Figure 4.14: Simulated 30-Day Average PCB Concentrations (µg/l), Fenwick Branch, Baseline Conditions

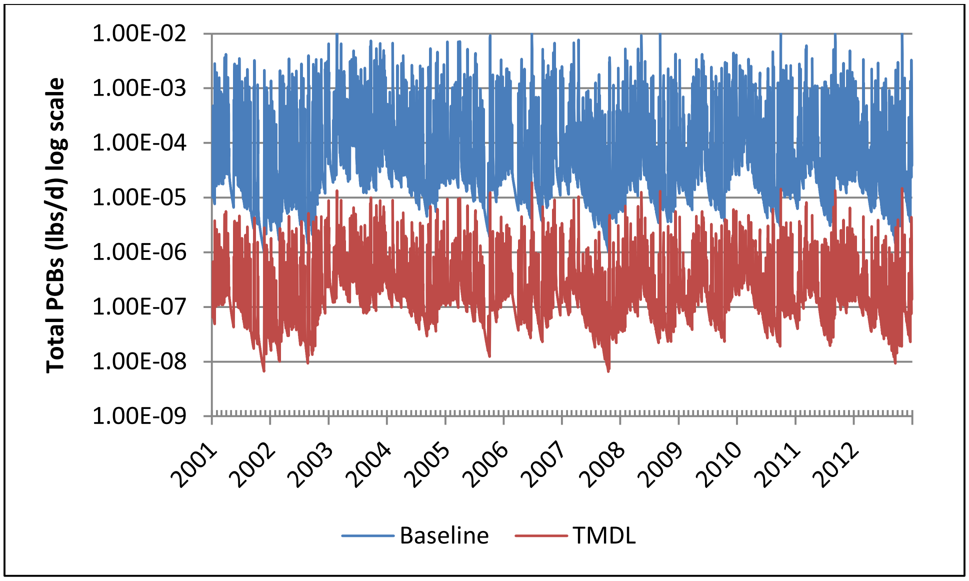

Figure 4.15: Simulated Daily PCB Loads (lbs/d), Fenwick Branch, Baseline Conditions and TMDL Scenario

4.4 Klingle Valley Creek

Klingle Valley Creek flows through a residential area and discharges into Rock Creek from the west near the Porter Street Bridge. Figure 4.16 shows the location of Klingle Valley Creek and its watershed[13]. The stream's reach parallels the south side of Klingle Road. A wooded buffer of a few hundred feet covers one side of the stream. The stream channel is about 30 feet wide. The creek itself is an approximately half a mile long stream and falls at a grade of about 5% from its headwaters to its confluence with Rock Creek (DDOH, 2004a).

The watershed comprises about 172 acres and is primarily residential. Table 4.13 gives the land use acreage in the Klingle Valley Creek watershed. The watershed is 36% impervious and 73% lies within the DC MS4.

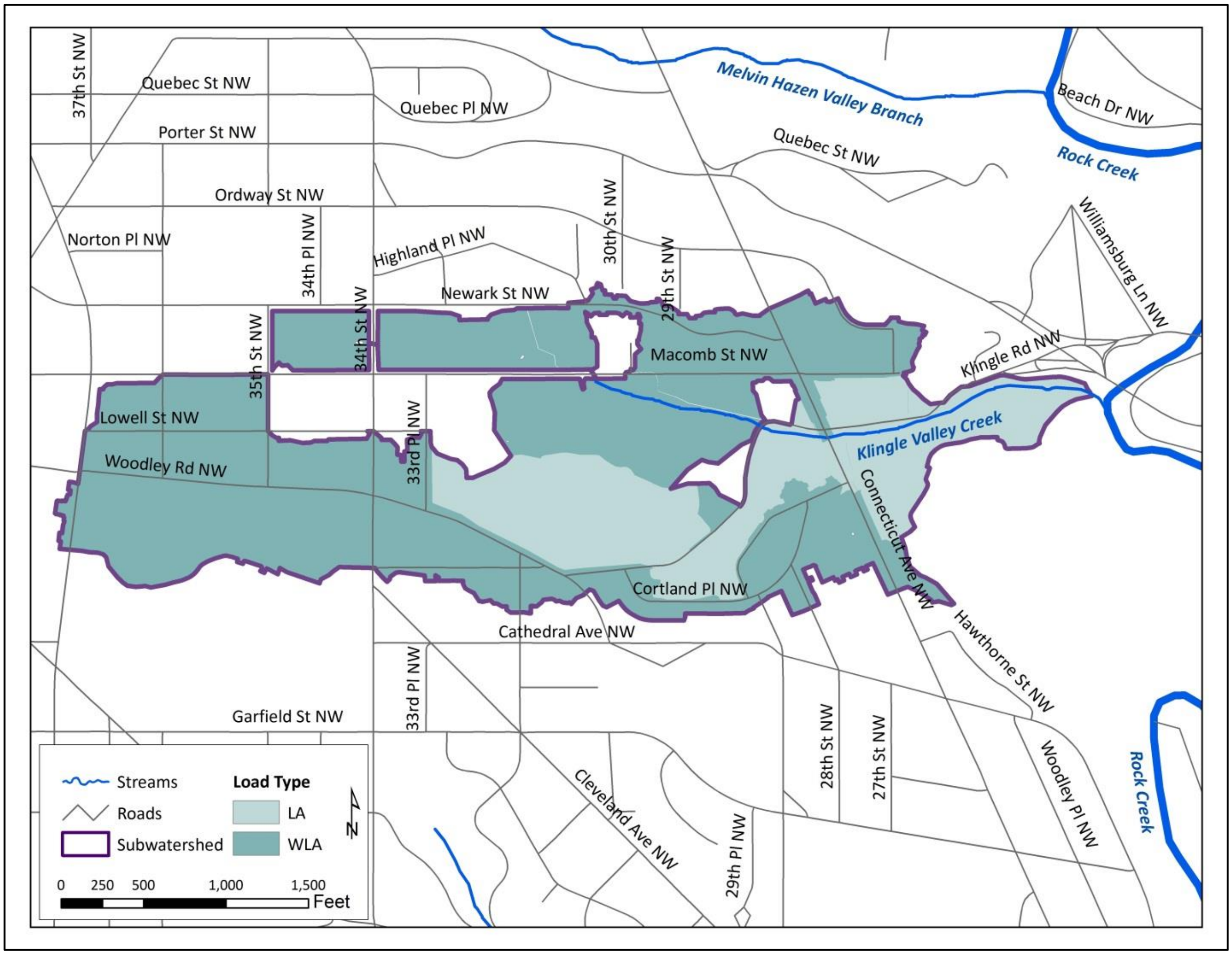

Figure 4.16: Klingle Valley Creek and its Watershed

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[13] Areas in white surrounded by the Klingle Valley Creek watershed discharge directly to Rock Creek through separate storm sewers.

Table 4.13: Klingle Valley Creek Land Use (acres)

Type	Impervious	Pervious	Forest	Total
DC MS4	55	57	14	125
DC Non-MS4	7	13	26	46
Maryland	-	-	-	-
Total	62	70	40	172

Figure 4.17 shows simulated daily average flow over the 2001-2012 year period. Simulated flows range from 0.01 cfs to 21.0 cfs. The average daily flow is 0.37 cfs and the median flow is 0.09 cfs.

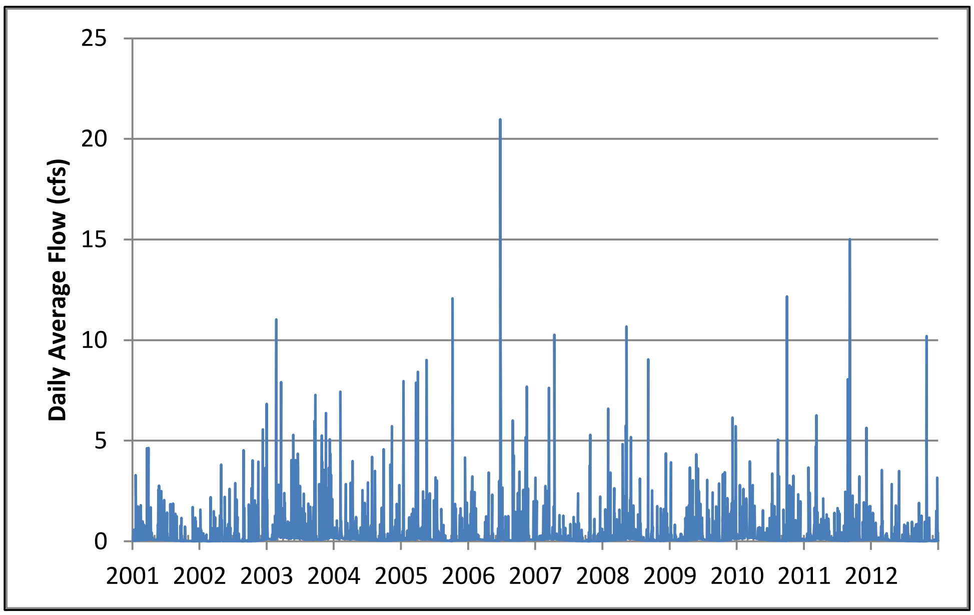


Figure 4.17: Simulated Average Daily Flow (cfs), Klingle Valley Creek

Table 4.14 presents the average annual baseline total PCB loads and TMDL allocations. Table 4.15 presents the daily average baseline loads and TMDL allocations, and Table 4.16 presents maximum daily baseline total PCB loads and TMDL allocations. Figure 4.18 shows simulated daily PCB concentrations under baseline conditions in 2005. Since the concentration of PCBs in storm flow is greater than the concentration in base flow, concentrations increase during storm events. Figure 4.19 contrasts the 30-day average total PCB concentration under baseline conditions and the current Class D human health criterion. Figure 4.20 presents simulated daily PCB loads under baseline conditions and under the TMDL.

Table 4.14: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Klingle Valley Creek

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.39E-02	3.12E-05	99.87%
	Total	2.39E-02	3.12E-05	99.87%
Load Allocation	Direct Drainage	5.26E-03	1.54E-05	99.71%
	Upstream Maryland	-	-	-
	Total	5.26E-03	1.54E-05	99.71%
Margin of Safety		-	Implicit	-
Total		2.92E-02	4.66E-05	99.84%

Table 4.15: PCB Average Daily Loads (lbs/d), Klingle Valley Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	6.55E-05	8.56E-08	99.87%
	Total	6.55E-05	8.56E-08	99.87%
Load Allocation	Direct Drainage	1.44E-05	4.22E-08	99.71%
	Upstream Maryland	-	-	-
	Total	1.44E-05	4.22E-08	99.71%
Margin of Safety		-	Implicit	-
Total		7.99E-05	1.28E-07	99.84%

Table 4.16: PCB Maximum Daily Loads (lbs/d), Klingle Valley Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	4.25E-03	5.56E-06	99.87%
	Total	4.25E-03	5.56E-06	99.87%
Load Allocation	Direct Drainage	8.15E-04	1.67E-06	99.80%
	Upstream Maryland	-	-	-
	Total	8.15E-04	1.67E-06	99.80%
Margin of Safety		-	Implicit	-
Total		5.07E-03	7.23E-06	99.86%

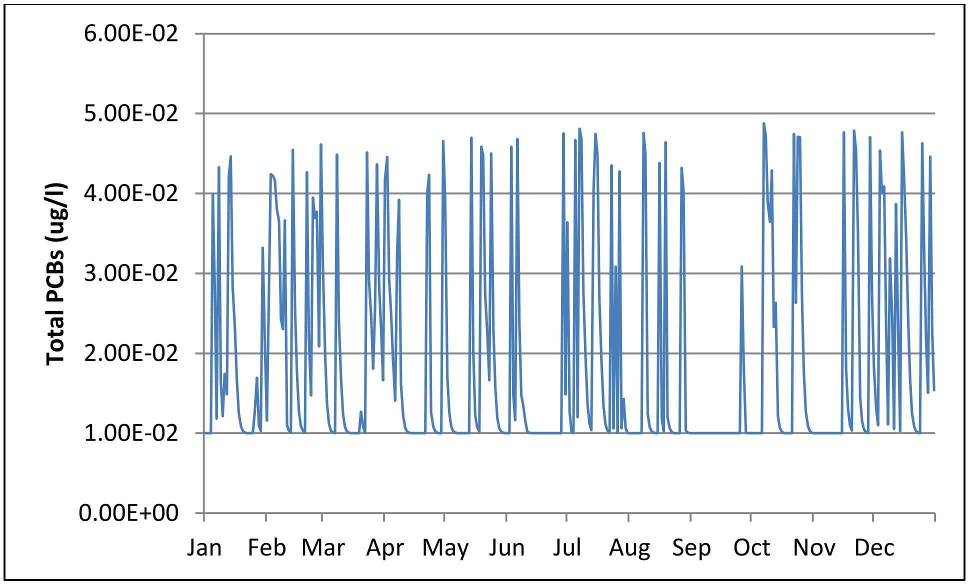


Figure 4.18: Simulated Daily PCB Concentrations (µg/l), Klingle Valley Creek, Baseline Conditions, 2005

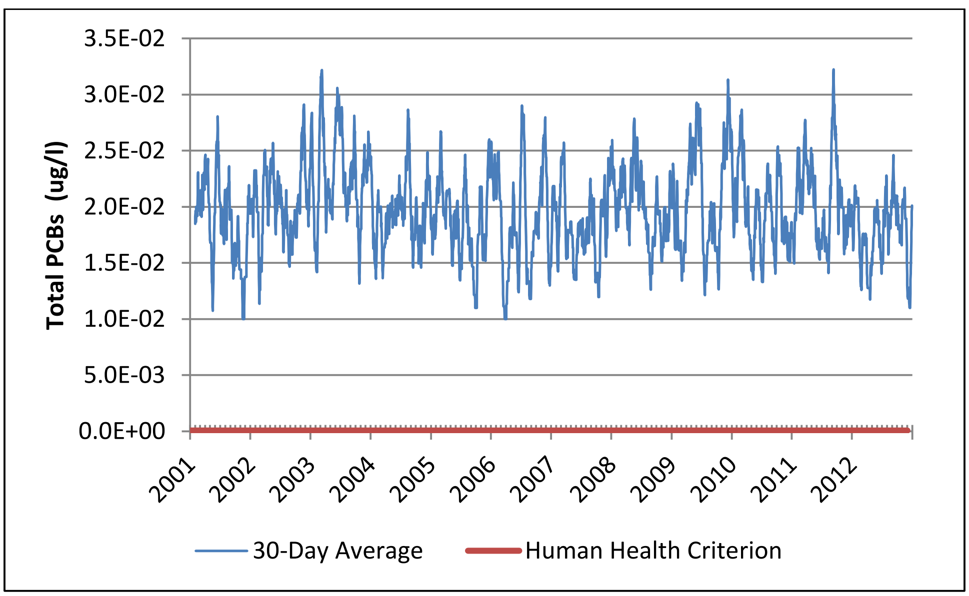


Figure 4.19: Simulated 30-Day Average PCB Concentrations (µg/l), Klingle Valley Creek, Baseline Conditions

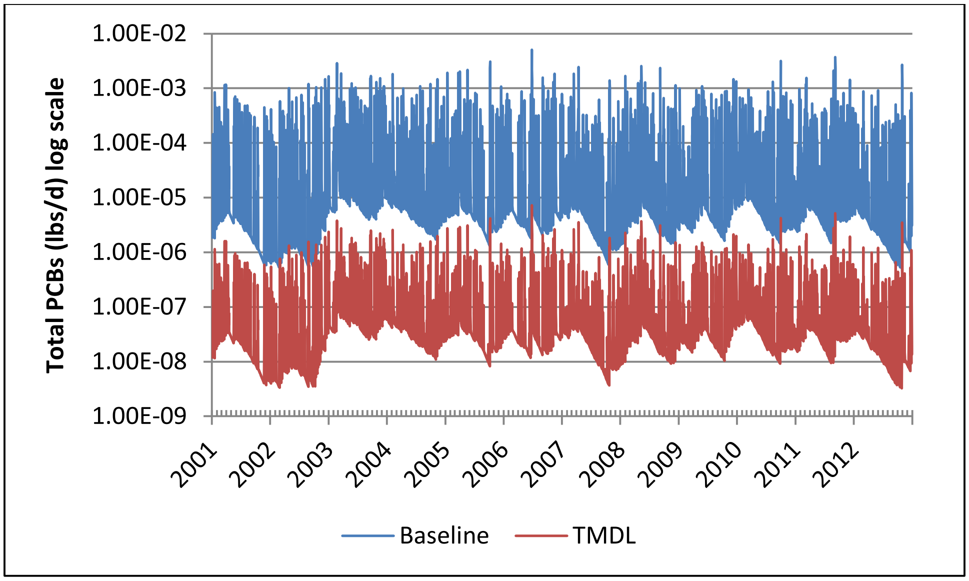


Figure 4.20: Simulated Daily PCB Loads (lbs/d), Klingle Valley Creek, Baseline Conditions and TMDL Scenario

4.5 Luzon Branch

Luzon Branch is an eastern tributary of Rock Creek. It travels roughly half a mile southwest and empties into Rock Creek at Joyce Road. Figure 4.21 shows the location of Luzon Branch and its watershed. Luzon Branch is approximately 26 feet wide. The stream is buffered by 100-1000 feet of parkland (DDOH, 2004a).

The Luzon Branch watershed measures about 643 acres. About 90 percent of the watershed is residential and light commercial, and the rest is parkland. Table 4.17 gives the land use acreage in the Luzon Branch watershed. The watershed is 47% impervious and 92% lies within the DC MS4.

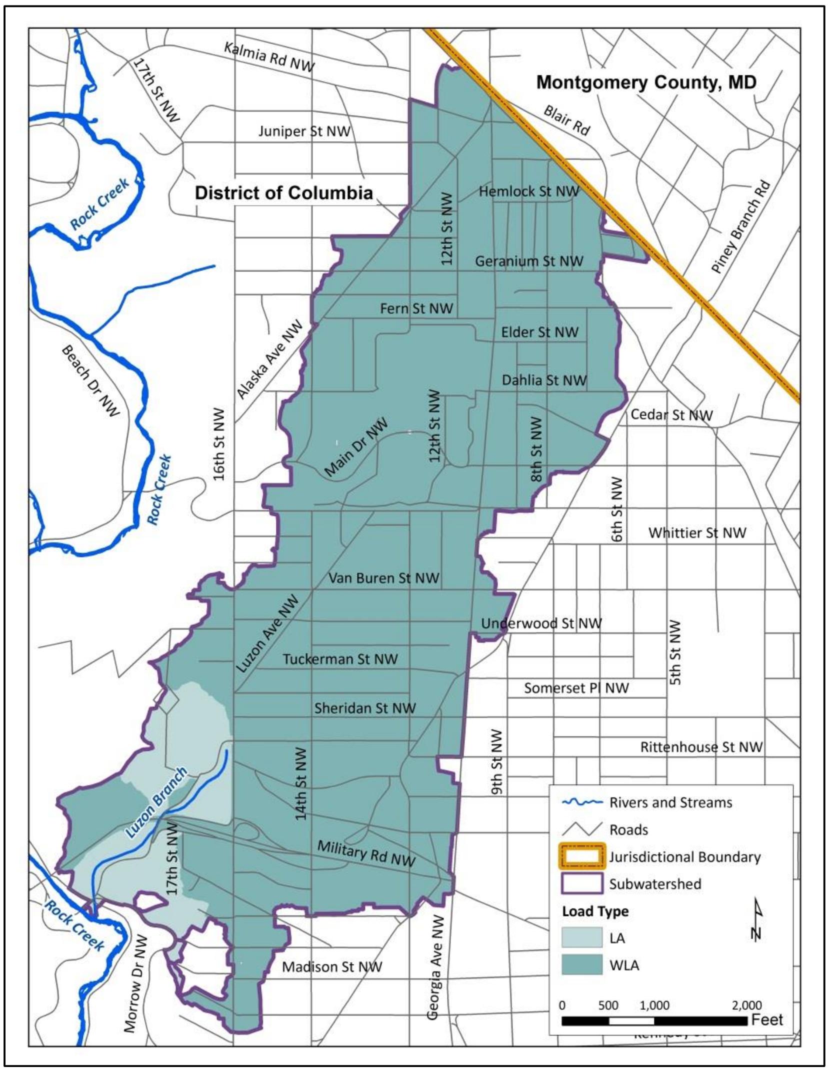


Figure 4.21: Luzon Branch and its Watershed

Table 4.17: Luzon Branch Land Use (acres)

Type	Impervious	Pervious	Forest	Total
DC MS4	300	277	13	590
DC Non-MS4	5	22	25	53
Maryland	-	-	-	-
Total	306	300	38	643

Figure 4.22 shows simulated daily average flow over the 2001-2012 year period. Simulated flows range from 0.03 cfs to 90.6 cfs. The average daily flow is 1.6 cfs and the median flow is 0.25 cfs.

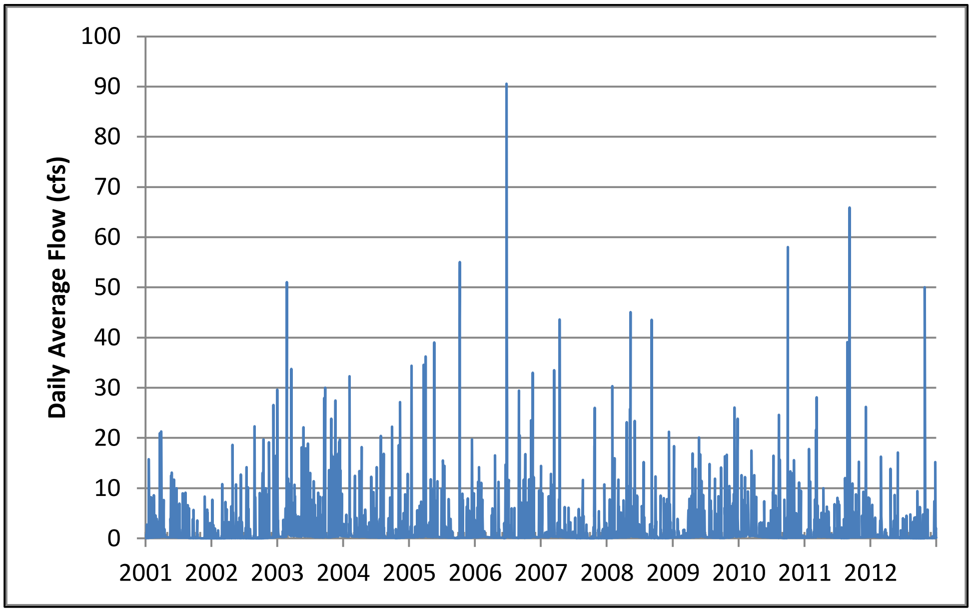


Figure 4.22: Simulated Average Daily Flow (cfs), Luzon Branch

Table 4.18 presents the average annual baseline total PCB loads and TMDL allocations. Table 4.19 presents the daily average baseline loads and TMDL allocations, and Table 4.20 presents maximum daily baseline total PCB loads and TMDL allocations. Figure 4.23 shows simulated daily PCB concentrations under baseline conditions in 2005. Since the concentration of PCBs in storm flow is greater than the concentration in base flow, concentrations increase during storm events. Figure 4.24 contrasts the 30-day average total PCB concentration under baseline conditions and the current Class D human health criterion. Figure 4.25 presents simulated daily PCB loads under baseline conditions and under the TMDL.

Table 4.18: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Luzon Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.29E-01	1.69E-04	99.87%
	Total	1.29E-01	1.69E-04	99.87%
Load Allocation	Direct Drainage	7.51E-03	3.05E-05	99.59%
	Upstream Maryland	-	-	
	Total	7.51E-03	3.05E-05	99.59%
Margin of Safety		-	Implicit	-
Total		1.37E-01	1.99E-04	99.85%

Table 4.19: PCB Average Daily Loads (lbs/d), Luzon Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.53E-04	4.62E-07	99.87%
	Total	3.53E-04	4.62E-07	99.87%
Load Allocation	Direct Drainage	2.06E-05	8.36E-08	99.59%
	Upstream Maryland	-	-	-
	Total	2.06E-05	8.36E-08	99.59%
Margin of Safety		-	Implicit	-
Total		3.74E-04	5.45E-07	99.85%

Table 4.20: PCB Maximum Daily Loads (lbs/d), Luzon Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.25E-02	2.94E-05	99.87%
	Total	2.25E-02	2.94E-05	99.87%
Load Allocation	Direct Drainage	9.35E-04	1.82E-06	99.81%
	Upstream Maryland	-	-	-
	Total	9.35E-04	1.82E-06	99.81%
Margin of Safety		-	Implicit	-
Total		2.34E-02	3.12E-05	99.87%

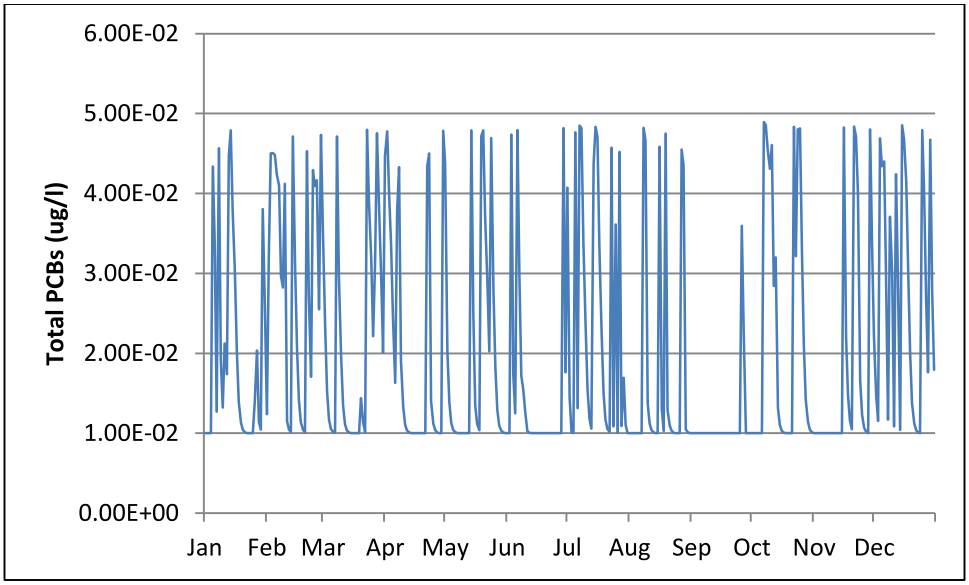


Figure 4.23: Simulated Daily PCB Concentrations (µg/l), Luzon Branch, Baseline Conditions, 2005

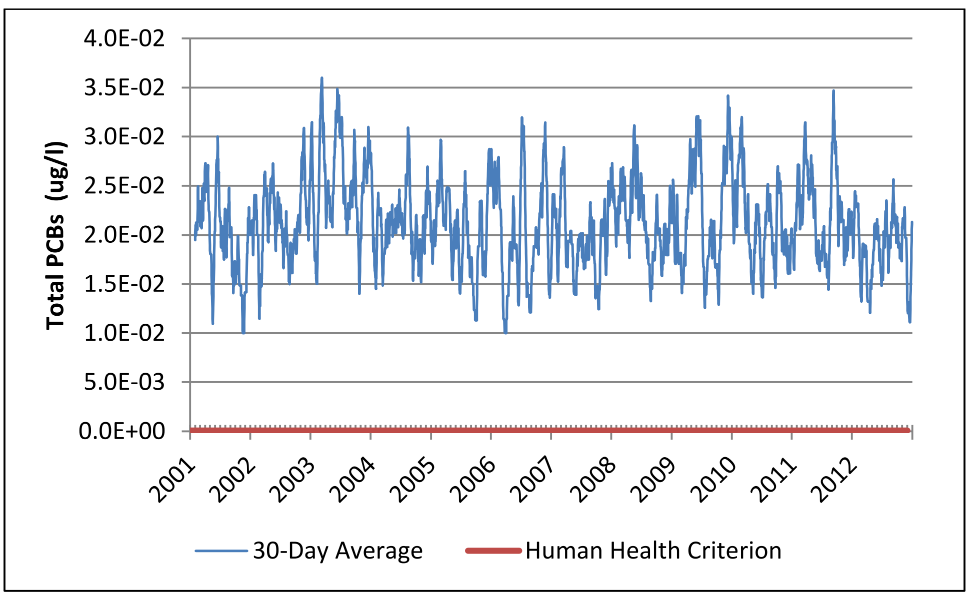


Figure 4.24: Simulated 30-Day Average PCB Concentrations (µg/l), Luzon Branch, Baseline Conditions

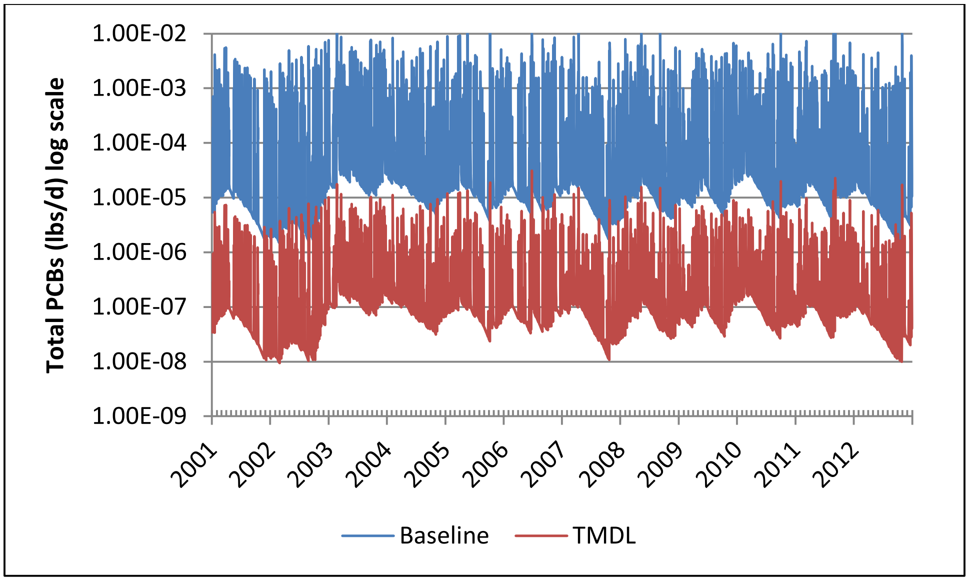
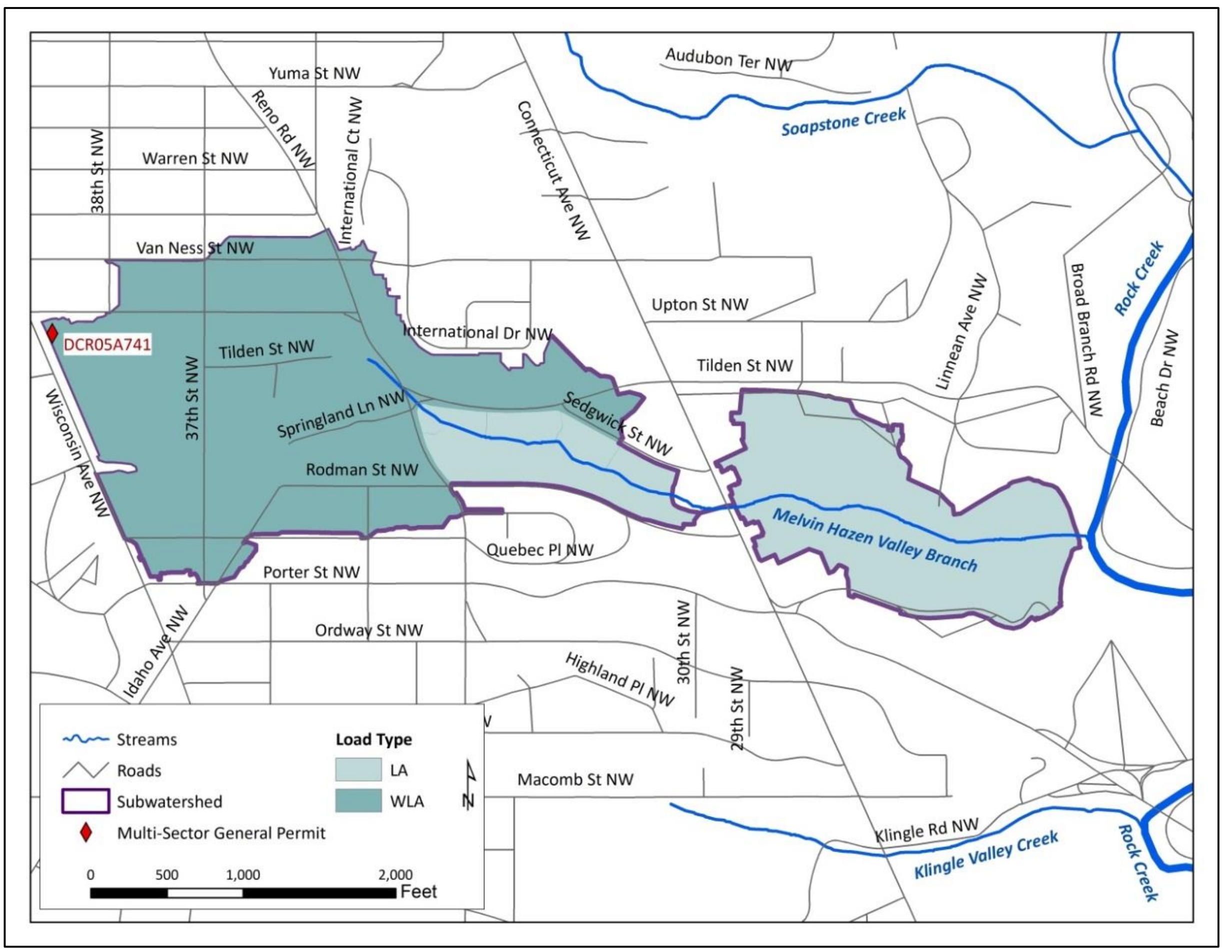


Figure 4.25: Simulated Daily PCB Loads (lbs/d), Luzon Branch, Baseline Conditions and TMDL Scenario

4.6 Melvin Hazen Valley Branch

Melvin Hazen Valley Branch is a second-order tributary of Rock Creek. It originates near 34th street and Tilden Street, NW. Figure 4.26 shows the location of Melvin Hazen Valley Branch and its watershed. Melvin Hazen Valley Branch stretches approximately 4,500 feet to its mouth at Rock Creek, and buffered on both sides by several hundred feet of forested parkland. The stream is carried in a pipe under Connecticut Avenue[14]. The stream is about 11 feet wide (DDOH, 2004a).

The Melvin Hazen Valley Branch watershed covers 174 acres, with more than two-thirds of the watershed is residential and commercial. The lower segment of the watershed is parkland. Table 4.21 gives the land use acreage in the Melvin Hazen Valley Branch watershed. The watershed is 30% impervious and 63% lies within the DC MS4. There is one MSGP in the watershed, the U. S. Post Office facility in Friendship Heights (DCR05A471), as shown in Figure 4.26. This permit is aggregated under the MS4 WLA.



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[14] Drainage along Connecticut Avenue discharges directly to Rock Creek through separate storm sewers.

Figure 4.26: Melvin Hazen Valley Branch and its Watershed

Table 4.21: Melvin Hazen Valley Branch Land Use (acres)

Type	Impervious	Pervious	Forest	Total
DC MS4	43	60	6	109
DC Non-MS4	9	9	47	65
Maryland	-	-	-	-
Total	52	69	53	174

Figure 4.27 shows simulated daily average flow over the 2001-2012 year period. Simulated flows range from 0.01 cfs to 19.7 cfs. The average daily flow is 0.35 cfs and the median flow is 0.10 cfs.

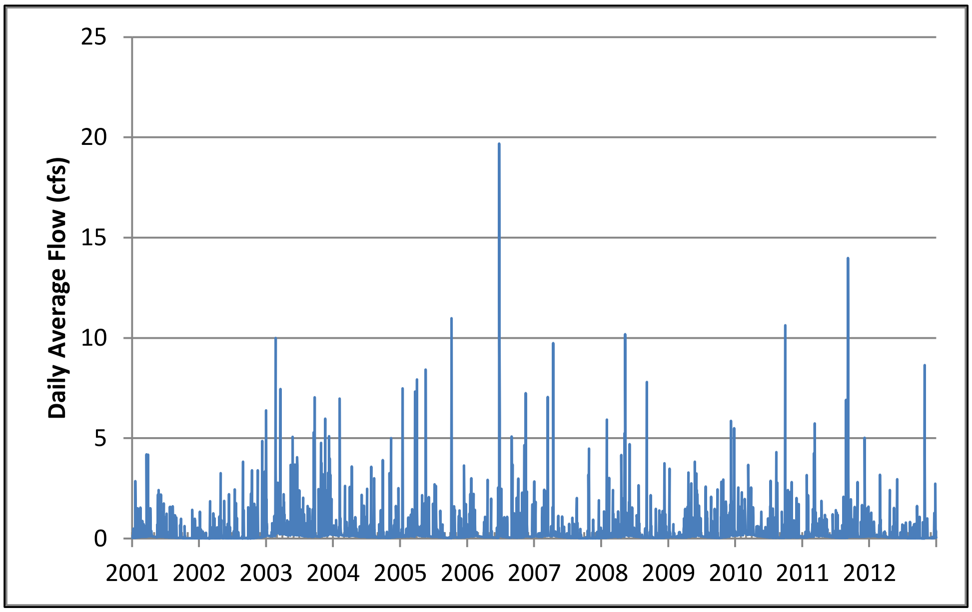

Figure 4.27: Simulated Average Daily Flow (cfs), Melvin Hazen Valley Branch

Table 4.22 presents the average annual baseline total PCB loads and TMDL allocations. Table 4.23 presents the daily average baseline loads and TMDL allocations, and Table 4.24 presents maximum daily baseline total PCB loads and TMDL allocations. Baseline loads and allocations for multi-sector general permit DCR05A741 are included in the DC Stormwater baseline loads and allocations. Figure 4.28 shows simulated daily PCB concentrations under baseline conditions in 2005. Since the concentration of PCBs in storm flow is greater than the concentration in base flow, concentrations increase during storm events. Figure 4.29 contrasts the 30-day average total PCB concentration under baseline conditions and the current Class D human health criterion. Figure 4.30 presents simulated daily PCB loads under baseline conditions and under the TMDL.

Table 4.22: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Melvin Hazen Valley Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.99E-02	2.60E-05	99.87%
	Total	1.99E-02	2.60E-05	99.87%
Load Allocation	Direct Drainage	5.99E-03	1.79E-05	99.70%
	Upstream Maryland	-	-	-
	Total	5.99E-03	1.79E-05	99.70%
Margin of Safety		-	Implicit	-
Total		2.59E-02	4.39E-05	99.83%

Table 4.23: PCB Average Daily Loads (lbs/d), Melvin Hazen Valley Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.45E-05	7.11E-08	99.87%
	Total	5.45E-05	7.11E-08	99.87%
Load Allocation	Direct Drainage	1.64E-05	4.90E-08	99.70%
	Upstream Maryland	-	-	-
	Total	1.64E-05	4.90E-08	99.70%
Margin of Safety		-	Implicit	-
Total		7.09E-05	1.20E-07	99.83%

Table 4.24: PCB Maximum Daily Loads (lbs/d), Melvin Hazen Valley Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.72E-03	4.85E-06	99.87%
	Total	3.72E-03	4.85E-06	99.87%
Load Allocation	Direct Drainage	8.59E-04	1.93E-06	99.78%
	Upstream Maryland	-	-	-
	Total	8.59E-04	1.93E-06	99.78%
Margin of Safety		-	Implicit	-
Total		4.57E-03	6.78E-06	99.85%

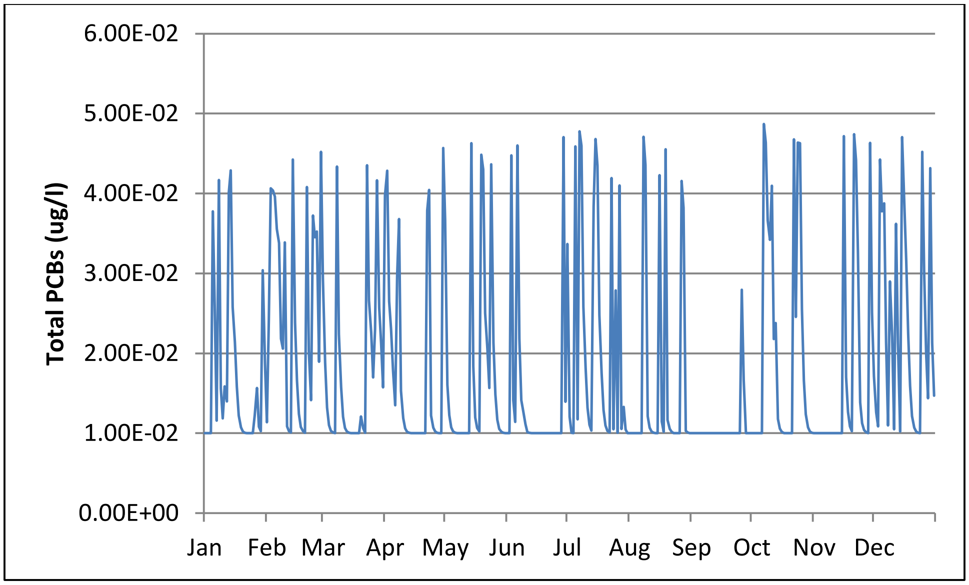

Figure 4.28: Simulated Daily PCB Concentrations (µg/l), Melvin Hazen Valley Branch, Baseline Conditions, 2005

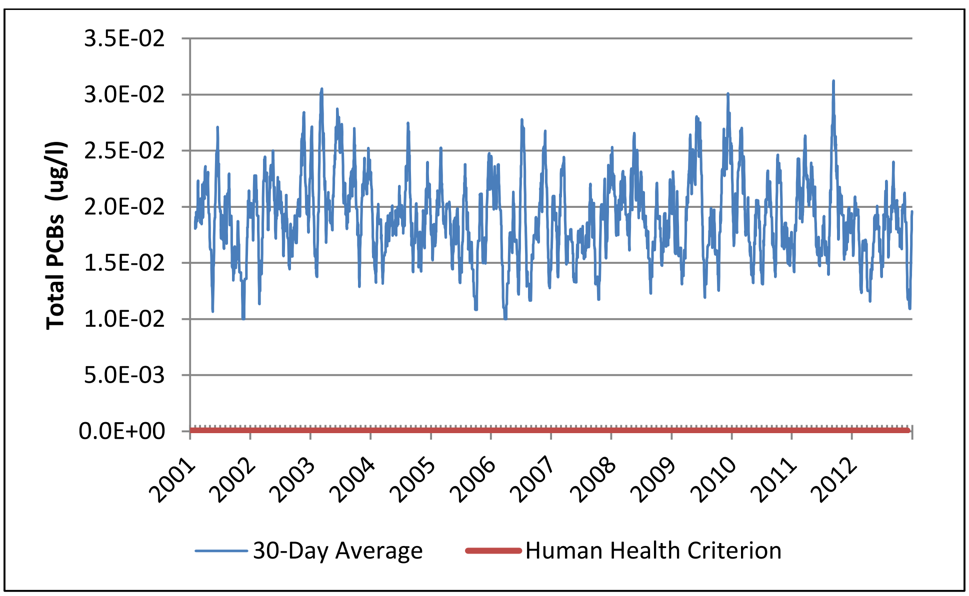

Figure 4.29: Simulated 30-Day Average PCB Concentrations (µg/l), Melvin Hazen Valley Branch, Baseline Conditions

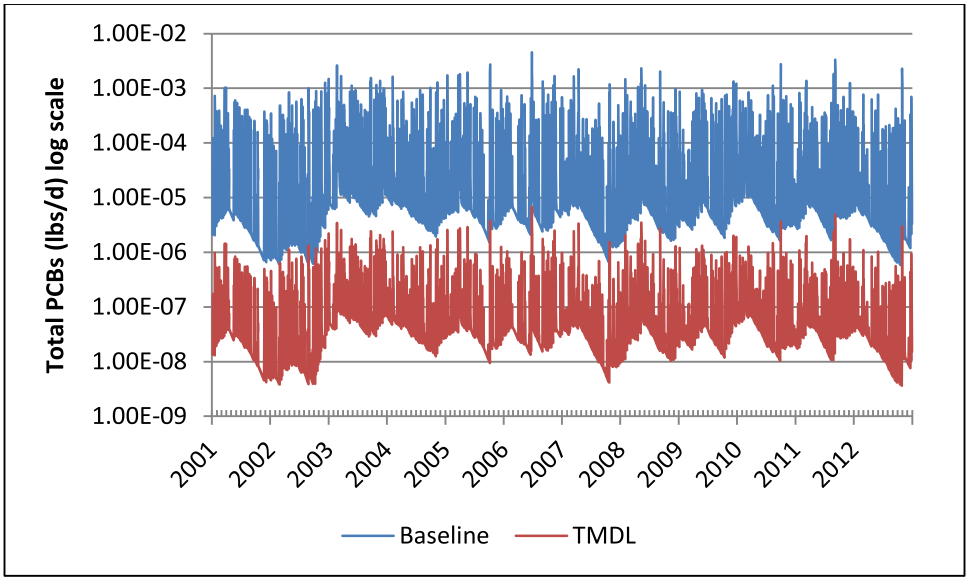

Figure 4.30: Simulated Daily PCB Loads (lbs/d), Melvin Hazen Valley Branch, Baseline Conditions and TMDL Scenario

4.7 Normanstone Creek

Normanstone Creek is a first order western tributary of Rock Creek and originates from a storm drain near Garfield Avenue and 33rd Street, NW. The stream travels parallel to Normanstone Parkway three quarters of a mile southeast to its confluence with Rock Creek, about 1,000 feet northeast of the Massachusetts Avenue bridge. Figure 4.31 shows the location of Normanstone Creek and its watershed[15]. Normanstone Creek is approximately 12 feet wide. Both sides of the stream are buffered by 100-1000 feet of forested parkland. The watershed includes most of the grounds of the National Cathedral, part of U.S. Naval Observatory, and parts of Cleveland and Woodley Park (DDOH, 2004a).

Table 4.25 gives the land use acreage in the Normanstone Creek watershed. The watershed encompasses 217 acres. The watershed is 35% impervious and 76% lies within the DC MS4. Most of the acreage is residential and light commercial (retail) with forested parkland along the stream reach.

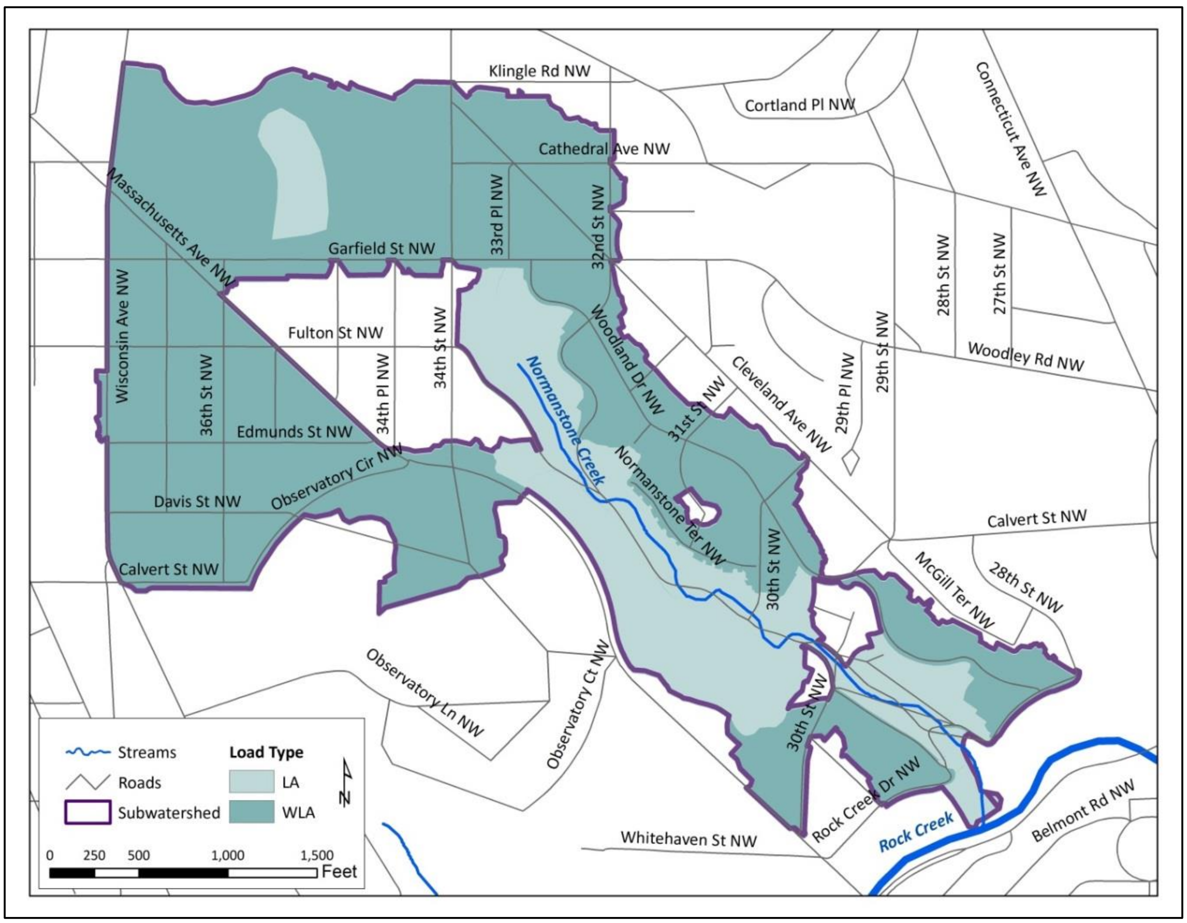

Figure 4.31: Normanstone Creek and its Watershed

15 Areas in white surrounded by the Normanstone Creek watershed discharge directly to Rock Creek through separate storm sewers.

Table 4.25: Normanstone Creek Land Use (acres)

Type	Impervious	Pervious	Forest	Total
DC MS4	70	88	8	166
DC Non-MS4	6	12	34	51
Maryland	-	-	-	-
Total	76	100	41	217

Figure 4.32 shows simulated daily average flow over the 2001-2012 year period. Simulated flows range from 0.01 cfs to 26.5 cfs. The average daily flow is 0.46 cfs and the median flow is 0.11 cfs.

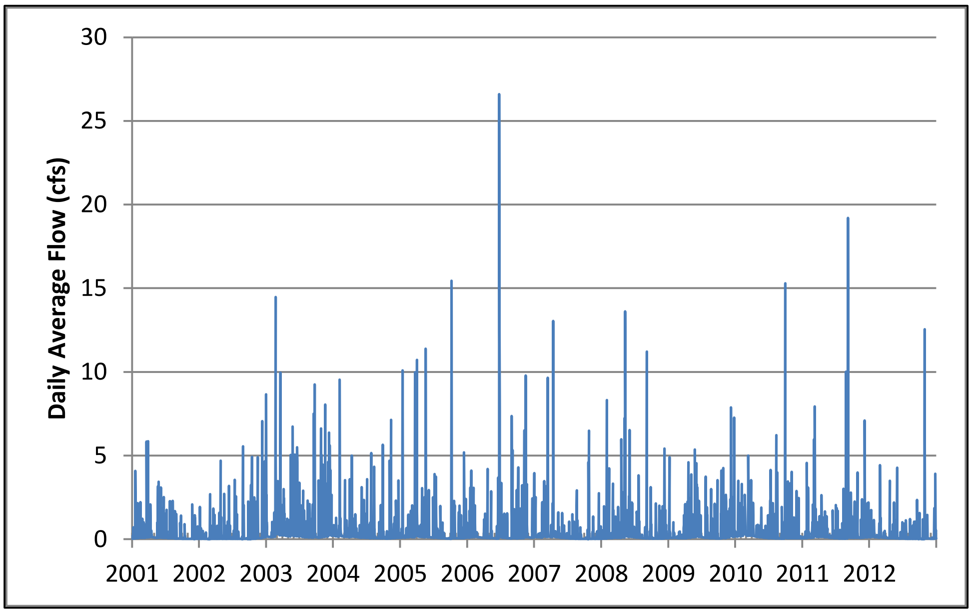

Figure 4.32: Simulated Average Daily Flow (cfs), Normanstone Creek

Table 4.26 presents the average annual baseline total PCB loads and TMDL allocations. Table 4.27 presents the daily average baseline loads and TMDL allocations, and Table 4.28 presents maximum daily baseline total PCB loads and TMDL allocations. Figure 4.33 shows simulated daily PCB concentrations under baseline conditions in 2005. Since the concentration of PCBs in storm flow is greater than the concentration in base flow, concentrations increase during storm events. Figure 4.34 contrasts the 30-day average total PCB concentration under baseline conditions and the current Class D human health criterion. Figure 4.35 presents simulated daily PCB loads under baseline conditions and under the TMDL.

Table 4.26: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Normanstone Creek

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	3.17E-02	4.14E-05	99.87%
	Total	3.17E-02	4.14E-05	99.87%
Load Allocation	Direct Drainage	5.03E-03	1.69E-05	99.66%
	Upstream Maryland	-	-	-
	Total	5.03E-03	1.69E-05	99.66%
Margin of Safety		-	Implicit	-
Total		3.67E-02	5.83E-05	99.84%

Table 4.27: PCB Average Daily Loads (lbs/d), Normanstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	8.68E-05	1.13E-07	99.87%
	Total	8.68E-05	1.13E-07	99.87%
Load Allocation	Direct Drainage	1.38E-05	4.62E-08	99.66%
	Upstream Maryland	-	-	-
	Total	1.38E-05	4.62E-08	99.66%
Margin of Safety		-	Implicit	-
Total		1.01E-04	1.60E-07	99.84%

Table 4.28: PCB Maximum Daily Loads (lbs/d), Normanstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	5.81E-03	7.59E-06	99.87%
	Total	5.81E-03	7.59E-06	99.87%
Load Allocation	Direct Drainage	7.23E-04	1.57E-06	99.78%
	Upstream Maryland	-	-	-
	Total	7.23E-04	1.57E-06	99.78%
Margin of Safety		-	Implicit	-
Total		6.54E-03	9.16E-06	99.86%

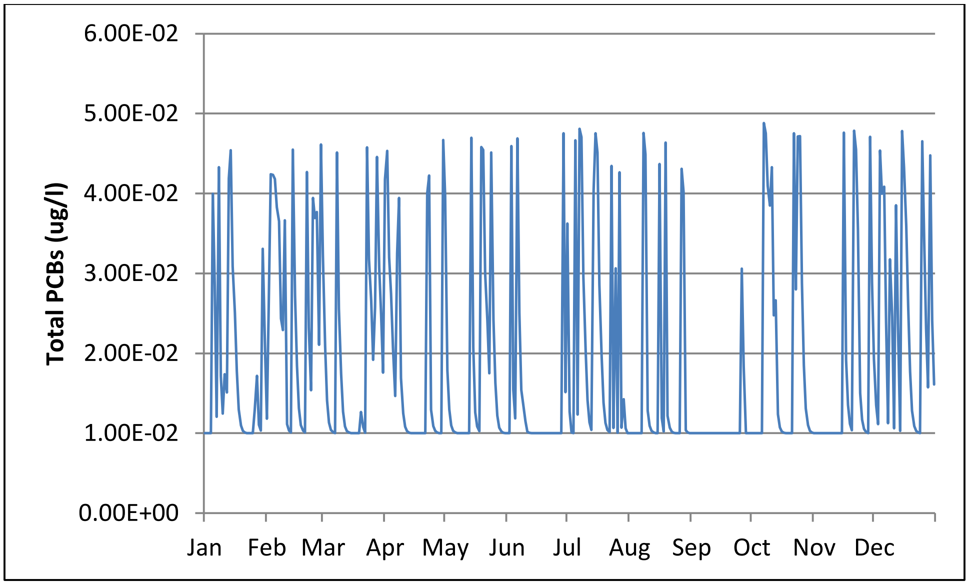

Figure 4.33: Simulated Daily PCB Concentrations (µg/l), Normanstone Creek, Baseline Conditions, 2005

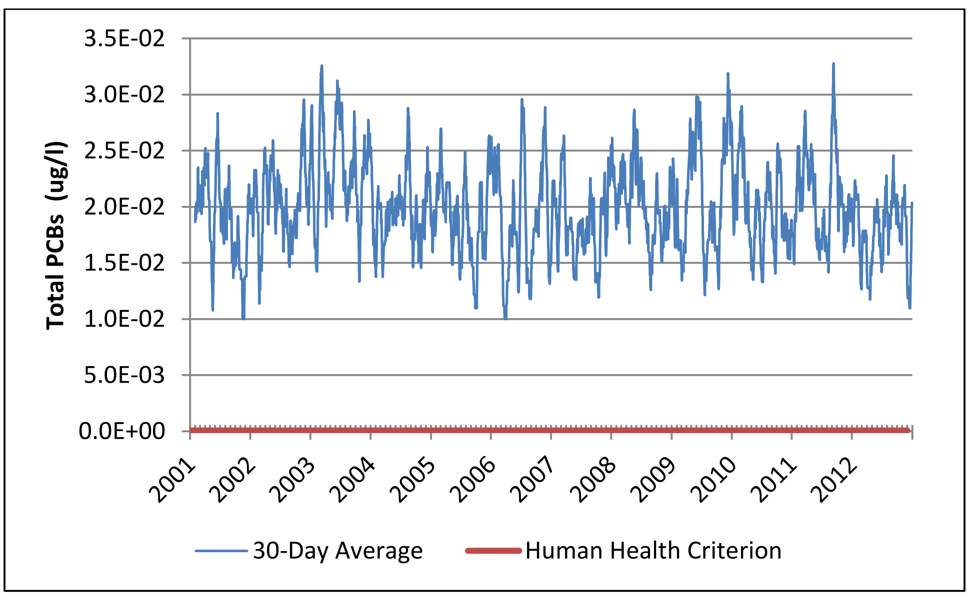

Figure 4.34: Simulated 30-Day Average PCB Concentrations (µg/l), Normanstone Creek, Baseline Conditions

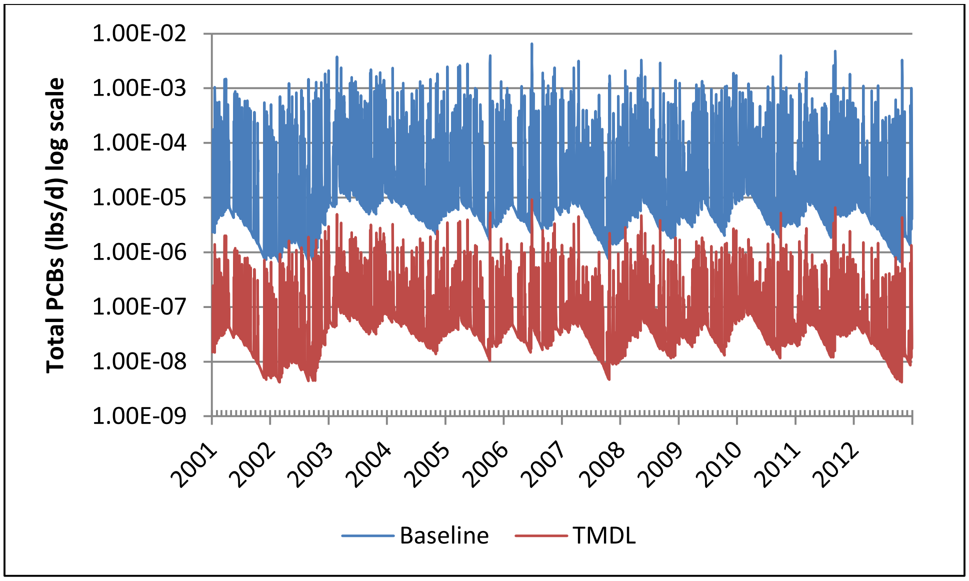

Figure 4.35: Simulated Daily PCB Loads (lbs/d), Normanstone Creek, Baseline Conditions and TMDL Scenario

4.8 Pinehurst Branch

Pinehurst Branch originates at the DC / MD state line in Chevy Chase Manor, Maryland. Figure 4.36 shows the location of Pinehurst Branch and its watershed. Pinehurst travels about 1.3 miles east-southeast to its confluence with Rock Creek. The average gradient of the stream is approximately 2 percent over its entire length (DDOH, 2004a).

Table 4.29 gives the land use acreage in the Pinehurst Branch watershed. Total watershed size is 664 acres. About a third of the watershed is in MD. The DC portion of the watershed is 23% impervious and 55% lies within the DC MS4. Most of the land use is low-medium density residential and commercial, and the remaining area is parklands (DDOH, 2004a).

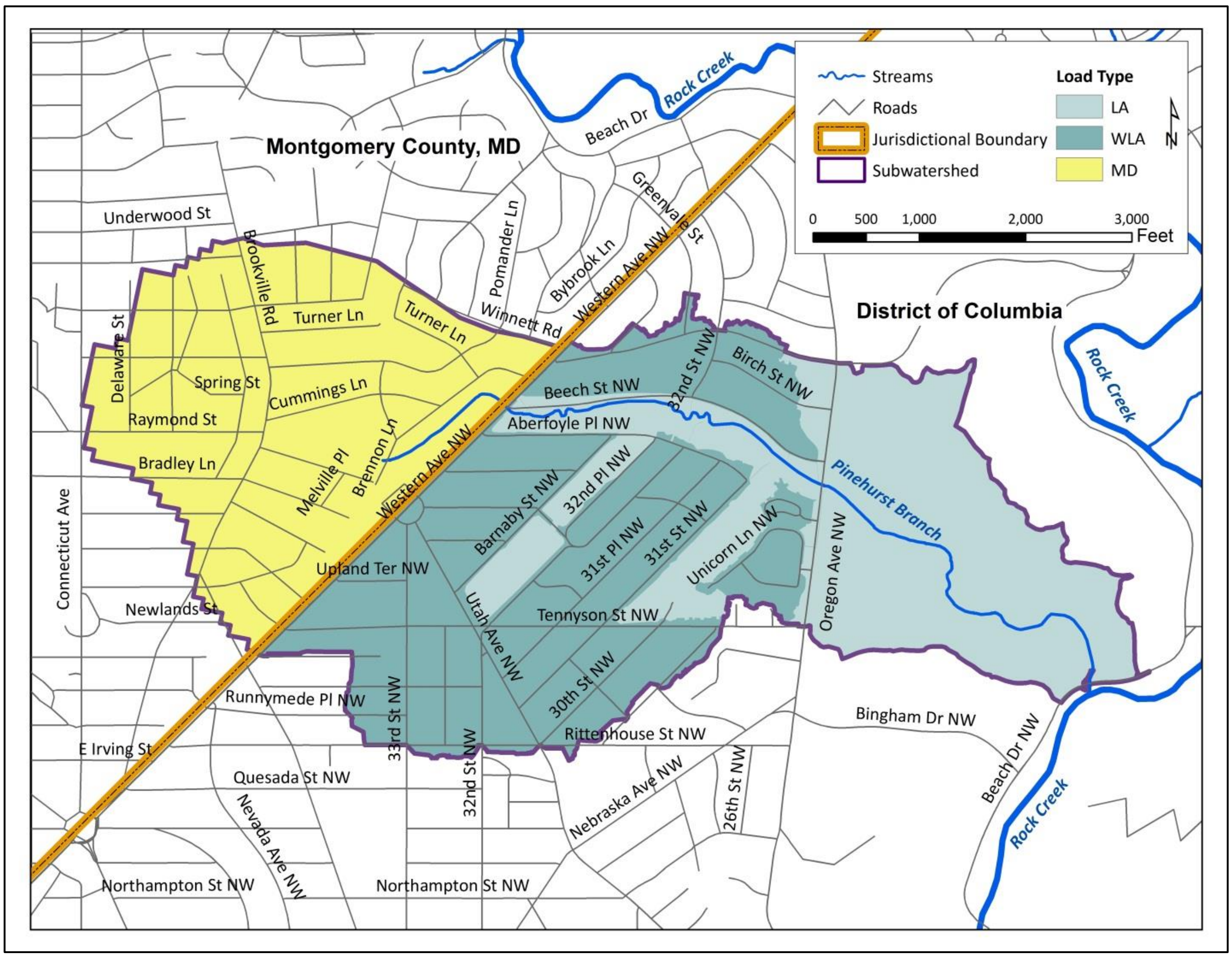

Figure 4.36: Pinehurst Branch and its Watershed

Table 4.29: Pinehurst Branch Land Use (acres)

Type	Impervious	Pervious	Forest	Total
DC MS4	89	151	6	246
DC Non-MS4	12	28	160	201
Maryland	59	160	0	218
Total	160	339	166	664

Figure 4.37 shows simulated daily average flow over the 2001-2012 year period. Simulated flows range from 0.04 cfs to 58.4 cfs. The average daily flow is 1.25 cfs and the median flow is 0.44 cfs.

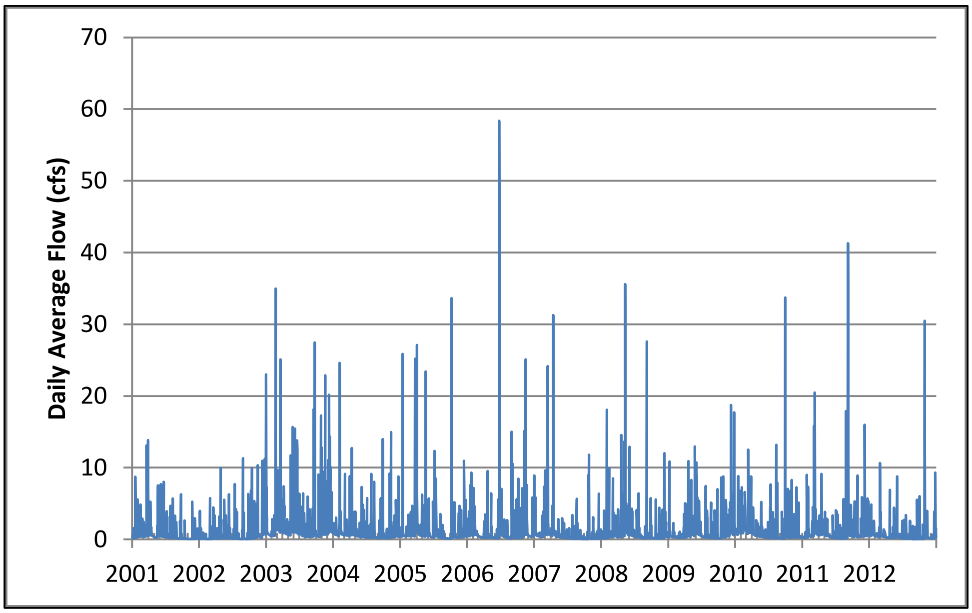

Figure 4.37: Simulated Average Daily Flow (cfs), Pinehurst Branch

Table 4.30 presents the average annual baseline total PCB loads and TMDL allocations. Table 4.31 presents the daily average baseline loads and TMDL allocations, and Table 4.32 presents maximum daily baseline total PCB loads and TMDL allocations. Figure 4.38 shows simulated daily PCB concentrations under baseline conditions in 2005. Since the concentration of PCBs in storm flow is greater than the concentration in base flow, concentrations increase during storm events. Figure 4.39 contrasts the 30-day average total PCB concentration under baseline conditions and the current Class D human health criterion. Figure 4.40 presents simulated daily PCB loads under baseline conditions and under the TMDL.

Table 4.30: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Pinehurst Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	4.31E-02	5.62E-05	99.87%
	Total	4.31E-02	5.62E-05	99.87%
Load Allocation	Direct Drainage	1.23E-02	4.55E-05	99.63%
	Upstream Maryland	3.28E-02	5.58E-05	99.83%
	Total	4.51E-02	1.01E-04	99.78%
Margin of Safety		-	Implicit	-
Total		8.82E-02	1.58E-04	99.82%

Table 4.31: PCB Average Daily Loads (lbs/d), Pinehurst Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.18E-04	1.54E-07	99.87%
	Total	1.18E-04	1.54E-07	99.87%
Load Allocation	Direct Drainage	3.37E-05	1.25E-07	99.63%
	Upstream Maryland	8.98E-05	1.53E-07	99.83%
	Total	1.24E-04	2.78E-07	99.78%
Margin of Safety		-	Implicit	-
Total		2.42E-04	4.32E-07	99.82%

Table 4.32: PCB Maximum Daily Loads (lbs/d), Pinehurst Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	8.35E-03	1.09E-05	99.87%
	Total	8.35E-03	1.09E-05	99.87%
Load Allocation	Direct Drainage	1.83E-03	4.89E-06	99.73%
	Upstream Maryland	3.54E-03	4.64E-06	99.87%
	Total	5.37E-03	9.54E-06	99.82%
Margin of Safety		-	Implicit	-
Total		1.37E-02	2.04E-05	99.85%

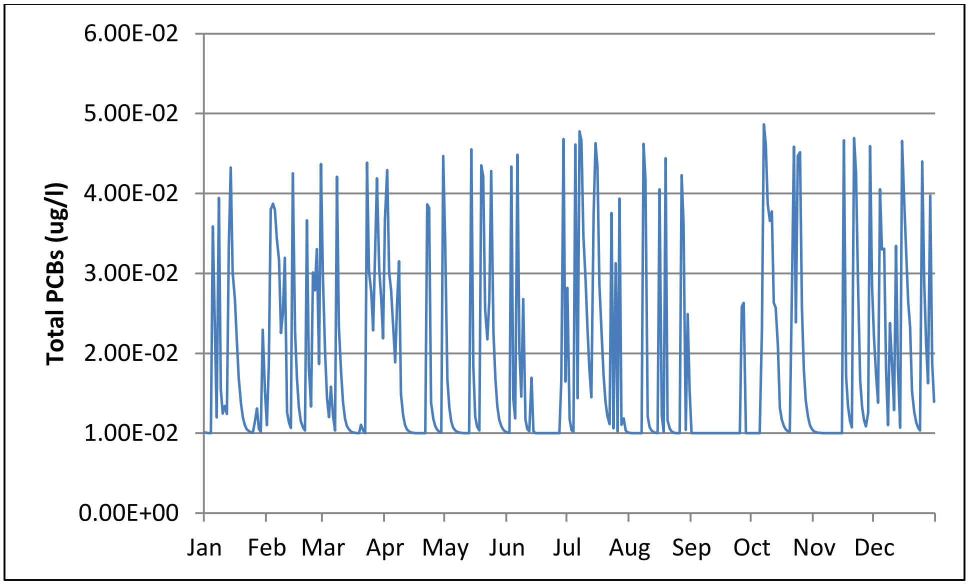

Figure 4.38: Simulated Daily PCB Concentrations (µg/l), Pinehurst Branch, Baseline Conditions, 2005

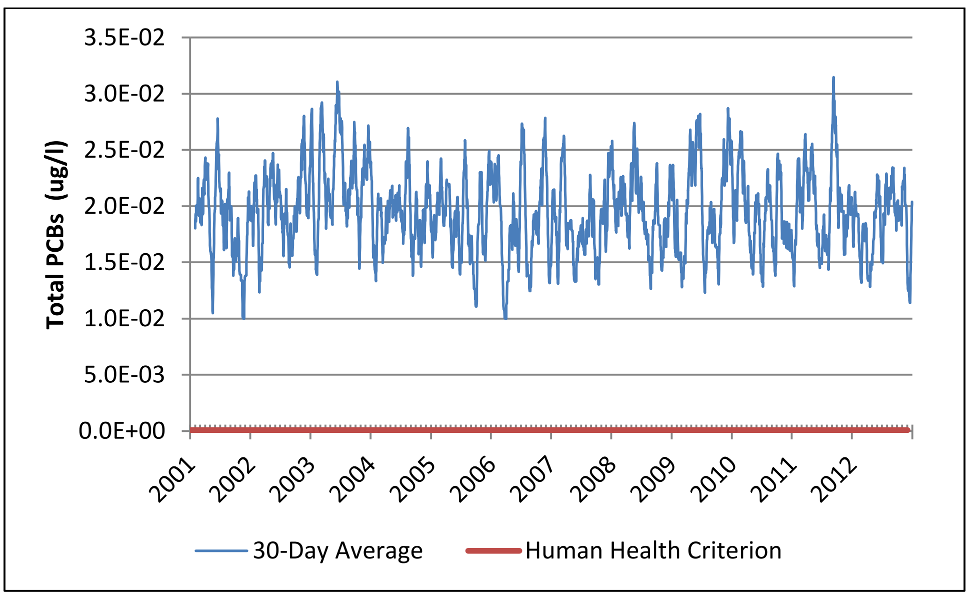

Figure 4.39: Simulated 30-Day Average PCB Concentrations (µg/l), Pinehurst Branch, Baseline Conditions

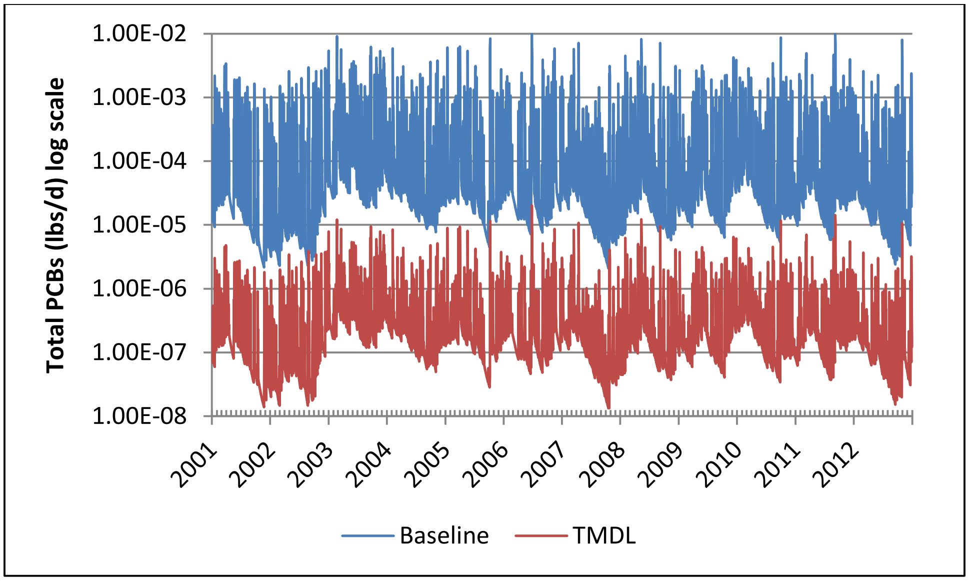

Figure 4.40: Simulated Daily PCB Loads (lbs/d), Pinehurst Branch, Baseline Conditions and TMDL Scenario

4.9 Piney Branch

Piney Branch runs approximately three-quarters of a mile through a strip of forested parkland about 1,000 yards wide before it enters Rock Creek from the east above the National Zoo. Piney Branch is approximately 12 feet wide. The watershed comprises about 2,500 acres, but most of the drainage area lies within the DC CSS (DDOH, 2004a). Figure 4.41 shows the Piney Branch watershed, including the CSS area discharging to the CSO outfalls on Piney Branch. Piney Branch is the only small tributary with CSO outfalls.

The CSS portion of the watershed contributes flow and pesticide loads only when CSO events occur; otherwise, flows from the CSS portion of the watershed are transported to the Blue Plains Advanced Wastewater Treatment Plant. As discussed in Section 2.3.1, CSO events are estimated to happen 28 times a year under current conditions, with a total annual volume of 280 MG. Under the District's LTCP, however, CSO events are expected to occur only twice a year, on average, with an average annual volume of 6.3 MG. When CSO events are not occurring, the flows and load from Piney Branch stem from the small portion of the watershed outside the CSS, which is only 100 acres.

Table 4.33 gives the land use acreage in the Piney Branch watershed. Figure 4.42 shows the location of Piney Branch and the watershed excluding the CSS area discharging the stream. Outside of the CSS, the watershed is 20% impervious and 45% lies within the DC MS4. The surface stream portion of the watershed is surrounded by predominantly forested parkland. The rest of the watershed is primarily urban residential and some light commercial (DDOH, 2004a).

Table 4.33: Piney Branch Land Use (acres)

Type	Impervious	Pervious	Forest	Total
DC MS4	18	18	9	45
DC Non-MS4	2	7	46	55
Maryland	-	-	-	-
Total Outside DC CSS	20	25	55	100
DC CSS				2,406
Total				2,506

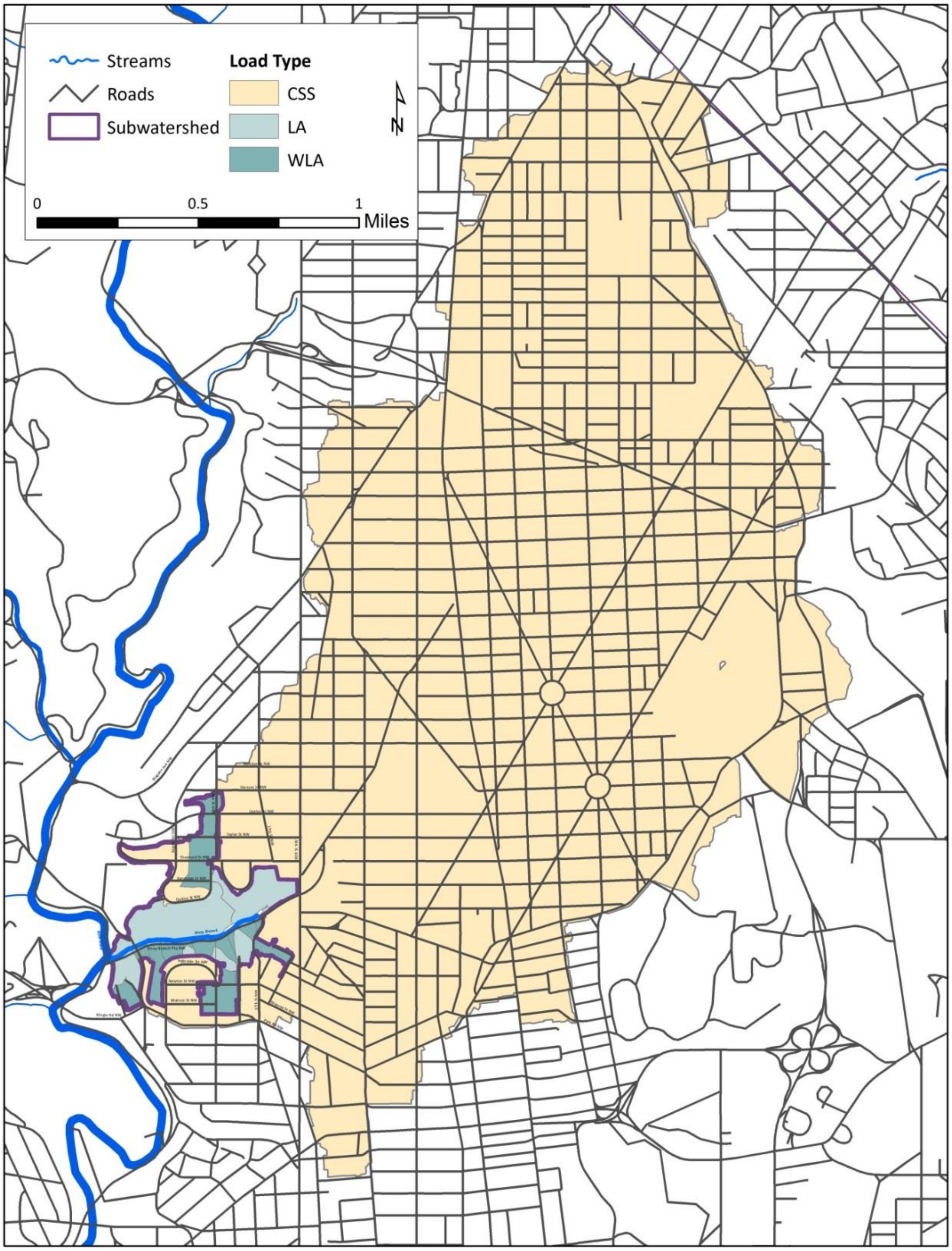

Figure 4.41: Piney Branch and its Watershed

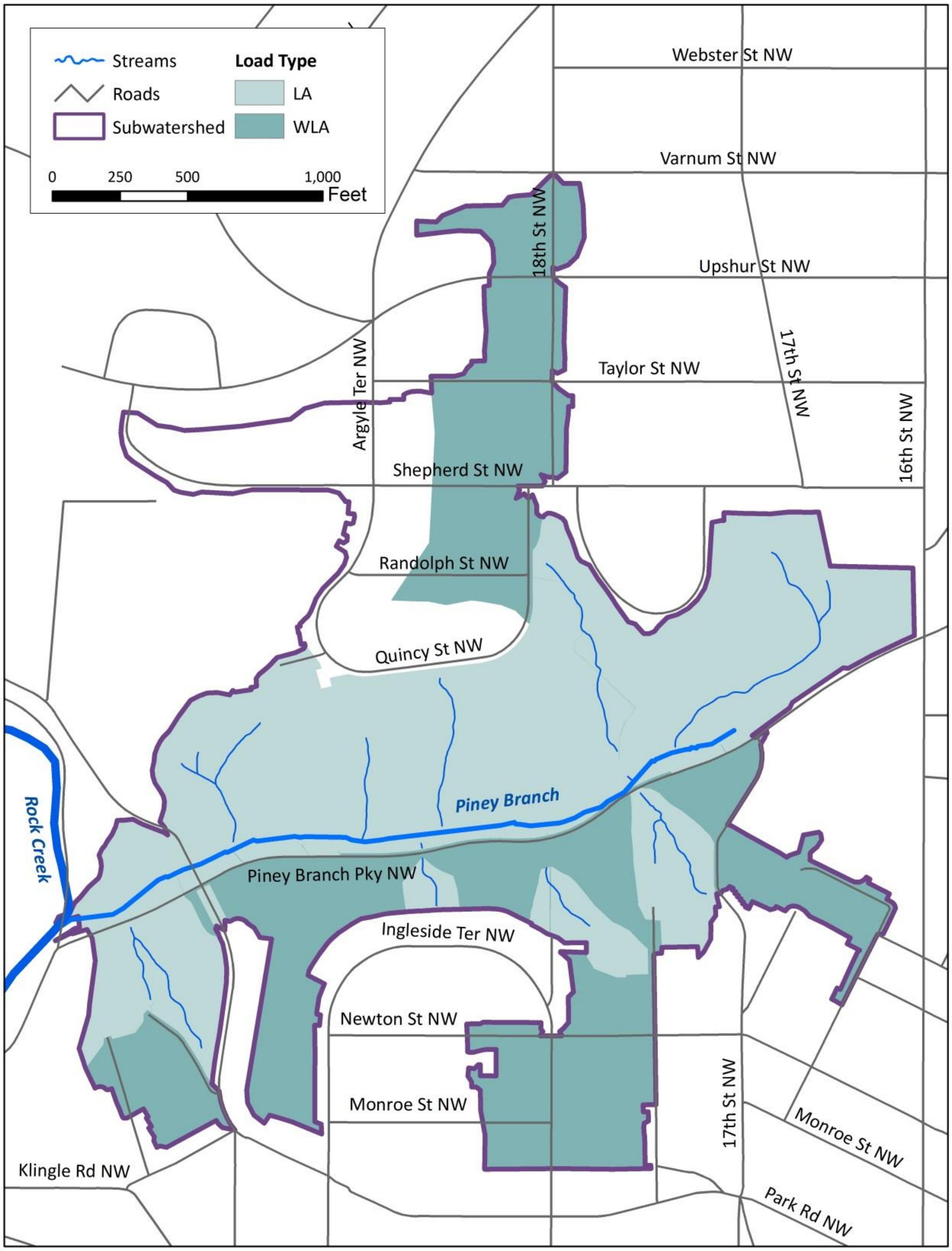

Figure 4.42: Piney Branch and its Watershed, Excluding CSS Area

Figure 4.43 shows simulated daily average flow over the 2001-2012 year period, including baseline CSO discharges. Simulated flows range from 0.01 cfs to 17.7 cfs. The average daily flow is 0.23 cfs and the median flow is 0.07 cfs. CSO flows account for about half of the flow under baseline conditions, but will only account for 4% of the flow under the LTCP.

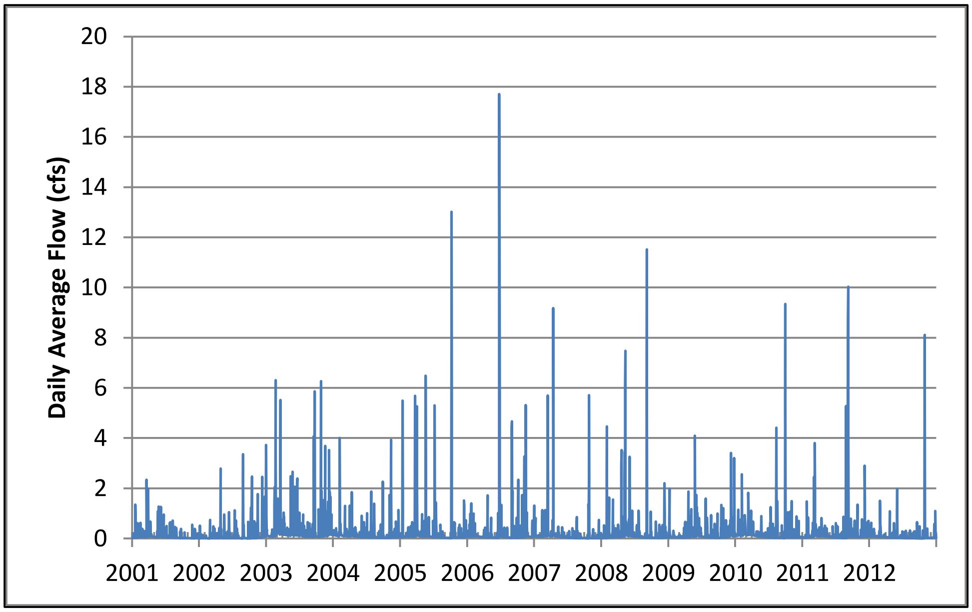

Figure 4.43: Simulated Average Daily Flow (cfs), Piney Branch

Table 4.34 presents the average annual baseline total PCB loads and TMDL allocations. Table 4.35 presents the daily average baseline loads and TMDL allocations, and Table 4.36 presents maximum daily baseline total PCB loads and TMDL allocations. Figure 4.44 shows simulated daily PCB concentrations under baseline conditions in 2005. Since the concentration of PCBs in storm flow is greater than the concentration in base flow, concentrations increase during storm events. Figure 4.45 contrasts the 30-day average total PCB concentration under baseline conditions and the current Class D human health criterion. Figure 4.46 presents simulated daily PCB loads under baseline conditions and under the TMDL.

Table 4.34: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Piney Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	7.72E-03	1.01E-05	99.87%
	DC Combined Sewer System	4.01E-02	8.37E-07	99.998%
	Total	4.78E-02	1.09E-05	99.98%
Load Allocation	Direct Drainage	2.84E-03	1.16E-05	99.59%
	Upstream Maryland	-	-	-
	Total	2.84E-03	1.16E-05	99.59%
Margin of Safety		-	Implicit	-
Total		5.07E-02	2.25E-05	99.96%

Table 4.35: PCB Average Daily Loads (lbs/d), Piney Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.12E-05	2.76E-08	99.87%
	DC Combined Sewer System	1.10E-04	2.29E-09	99.998%
	Total	1.31E-04	2.99E-08	99.98%
Load Allocation	Direct Drainage	7.78E-06	3.17E-08	99.59%
	Upstream Maryland	-	-	-
	Total	7.78E-06	3.17E-08	99.59%
Margin of Safety		-	Implicit	-
Total		1.39E-04	6.17E-08	99.96%

Table 4.36: PCB Maximum Daily Loads (lbs/d), Piney Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.37E-03	1.79E-06	99.87%
	DC Combined Sewer System	1.57E-02	2.09E-06	99.99%
	Total	1.71E-02	3.89E-06	99.98%
Load Allocation	Direct Drainage	4.42E-04	1.40E-06	99.68%
	Upstream Maryland	-	-	-
	Total	4.42E-04	1.40E-06	99.68%
Margin of Safety		-	Implicit	-
Total		1.75E-02	5.29E-06	99.97%

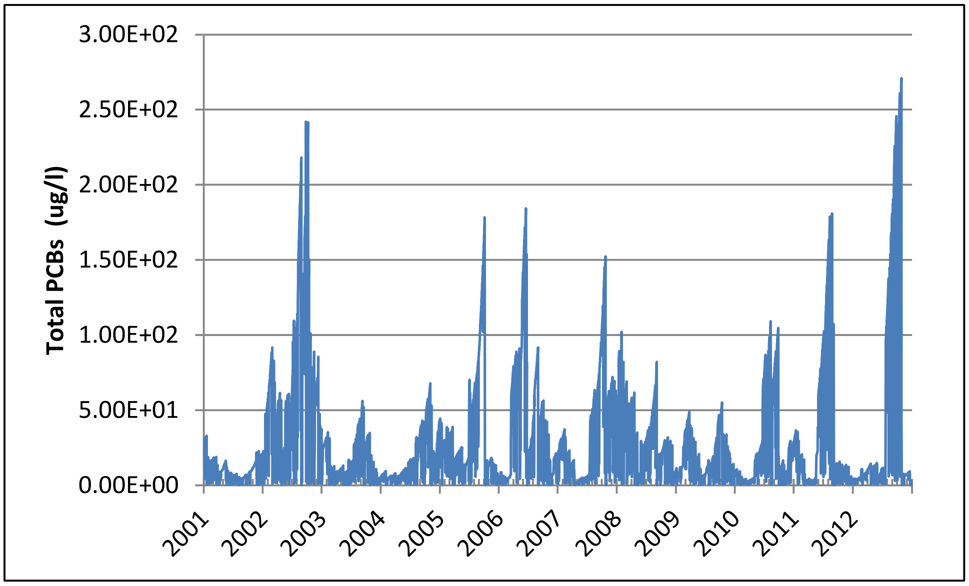

Figure 4.44: Simulated Daily PCB Concentrations (µg/l), Piney Branch, Baseline Conditions, 2005

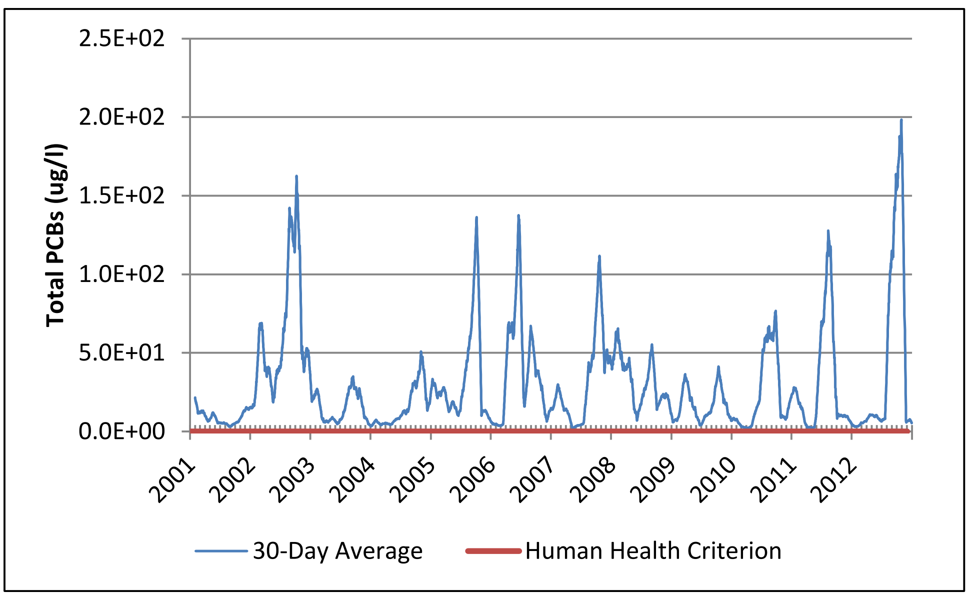

Figure 4.45: Simulated 30-Day Average PCB Concentrations (µg/l), Piney Branch, Baseline Conditions

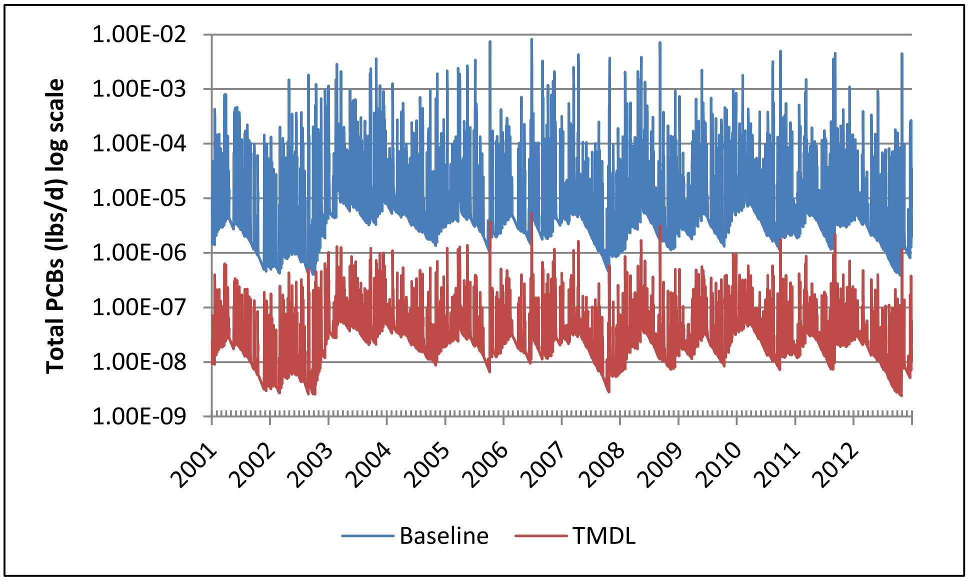

Figure 4.46: Simulated Daily PCB Loads (lbs/d), Piney Branch, Baseline Conditions and TMDL Scenario

4.10 Portal Branch

Portal Branch is an eastern tributary of Rock Creek near the northern corner of DC, and joins Fenwick Branch about 120 feet north of the Fenwick Branch's confluence with Rock Creek. The surface portion of the stream is less than half a mile long and is completely contained in the District. Portal Branch stretches about 2,220 feet and has an average width of 10 feet (DDOH, 2004a).

Figure 4.47 shows the location of Portal Branch and its watershed. Table 4.37 gives the land use acreage in the watershed. The watershed measures 201 acres, of which 71 acres lie within the District. The watershed in the District is mainly low medium density residential and parklands. Impervious surfaces cover about a third of the DC portion of the watershed and 88% of the watershed is served by DC's separate storm sewer system. The stream is buffered by 100 feet or less of parkland (DDOH, 2004a). The portion in MD is located in the heart of downtown Silver Spring, a commercial and transportation hub in Montgomery County.

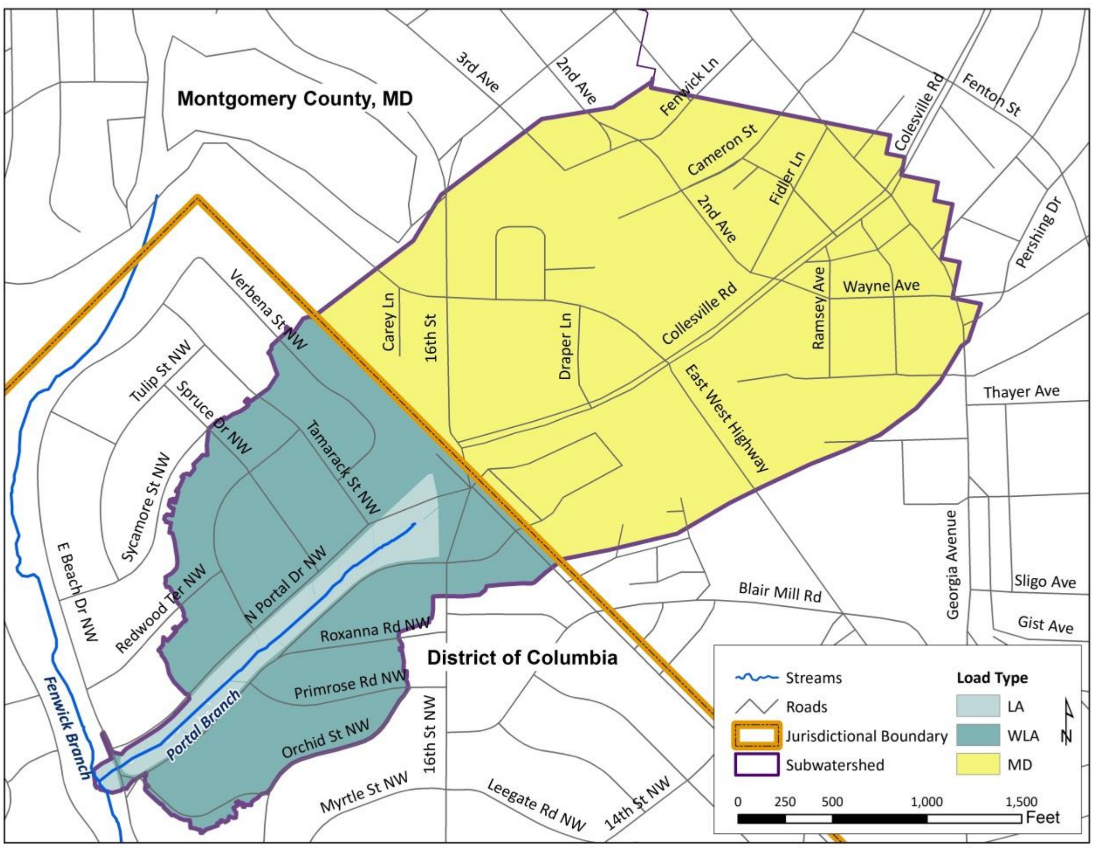

Figure 4.47: Portal Branch and its Watershed

Table 4.37: Portal Branch Land Use (acres)

Type	Impervious	Pervious	Forest	Total
DC MS4	22	37	2	62
DC Non-MS4	0	1	7	9
Maryland	80	50	0	130
Total	102	89	10	201

Figure 4.48 shows simulated daily average flow over the 2001-2012 year period. Simulated flows range from 0.01 cfs to 21.8 cfs. The average daily flow is 0.52 cfs and the median flow is 0.09 cfs.

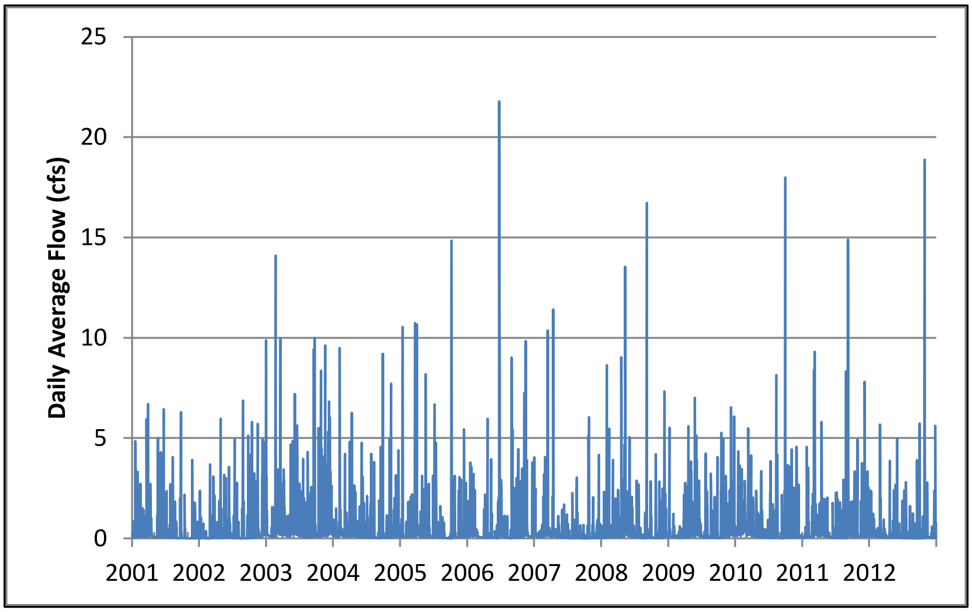

Figure 4.48: Simulated Average Daily Flow (cfs), Portal Branch

Table 4.38 presents the average annual baseline total PCB loads and TMDL allocations. Table 4.39 presents the daily average baseline loads and TMDL allocations, and Table 4.40 presents maximum daily baseline total PCB loads and TMDL allocations. Figure 4.49 shows simulated daily PCB concentrations under baseline conditions in 2005. Since the concentration of PCBs in storm flow is greater than the concentration in base flow, concentrations increase during storm events. Figure 4.50 contrasts the 30-day average total PCB concentration under baseline conditions and the current Class D human health criterion. Figure 4.51 presents simulated daily PCB loads under baseline conditions and under the TMDL.

Table 4.38: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Portal Branch

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.08E-02	1.41E-05	99.87%
	Total	1.08E-02	1.41E-05	99.87%
Load Allocation	Direct Drainage	7.39E-04	4.20E-06	99.43%
	Upstream Maryland	3.25E-02	4.65E-05	99.86%
	Total	3.32E-02	5.07E-05	99.85%
Margin of Safety		-	Implicit	-
Total		4.41E-02	6.48E-05	99.85%

Table 4.39: PCB Average Daily Loads (lbs/d), Portal Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.96E-05	3.87E-08	99.87%
	Total	2.96E-05	3.87E-08	99.87%
Load Allocation	Direct Drainage	2.02E-06	1.15E-08	99.43%
	Upstream Maryland	8.91E-05	1.27E-07	99.86%
	Total	9.11E-05	1.39E-07	99.85%
Margin of Safety		-	Implicit	-
Total		1.21E-04	1.78E-07	99.85%

Table 4.40: PCB Maximum Daily Loads (lbs/d), Portal Branch

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.09E-03	2.73E-06	99.87%
	Total	2.09E-03	2.73E-06	99.87%
Load Allocation	Direct Drainage	6.40E-05	2.31E-07	99.64%
	Upstream Maryland	3.99E-03	5.21E-06	99.87%
	Total	4.05E-03	5.44E-06	99.87%
Margin of Safety		-	Implicit	-
Total		6.14E-03	8.17E-06	99.87%

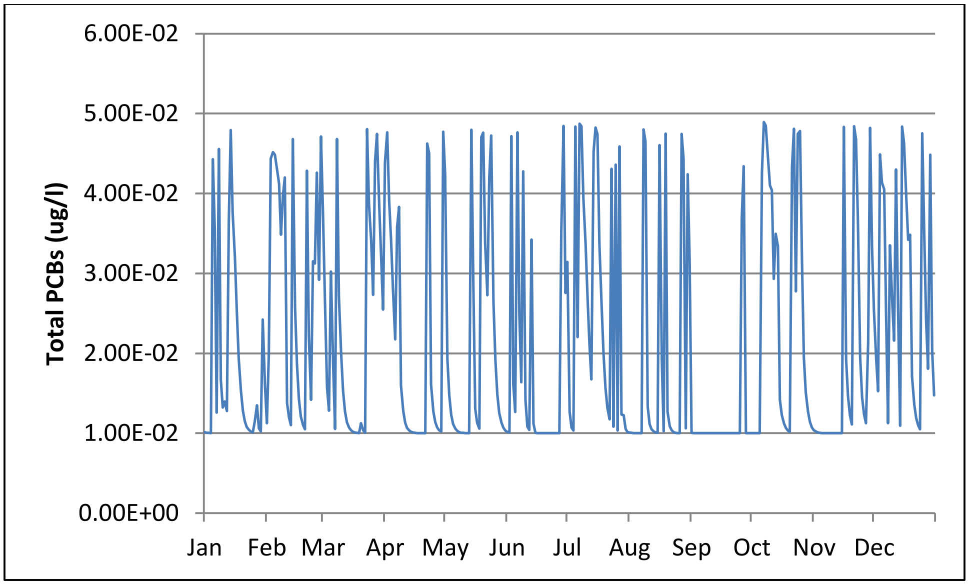

Figure 4.49: Simulated Daily PCB Concentrations (µg/l), Portal Branch, Baseline Conditions, 2005

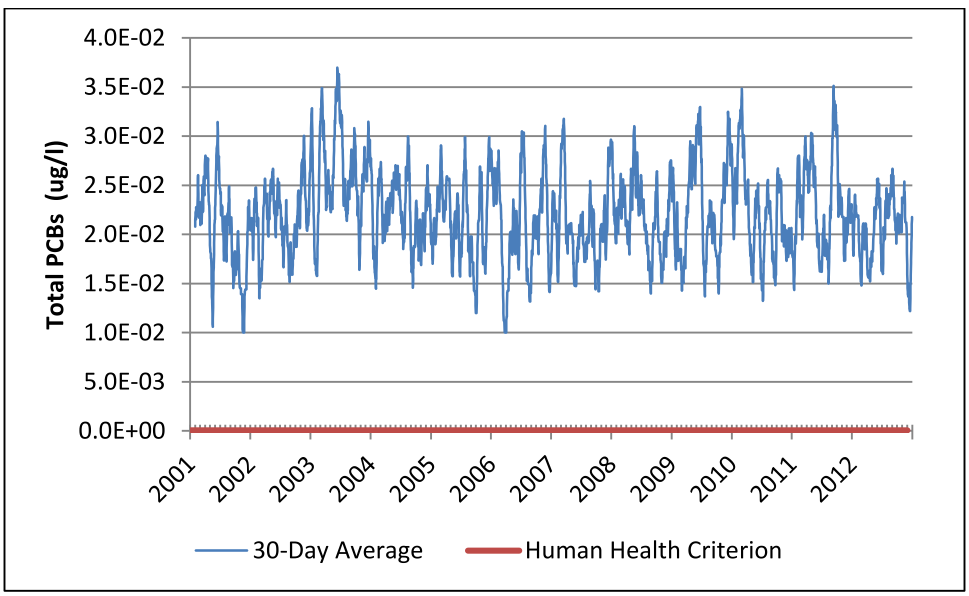

Figure 4.50: Simulated 30-Day Average PCB Concentrations (µg/l), Portal Branch, Baseline Conditions

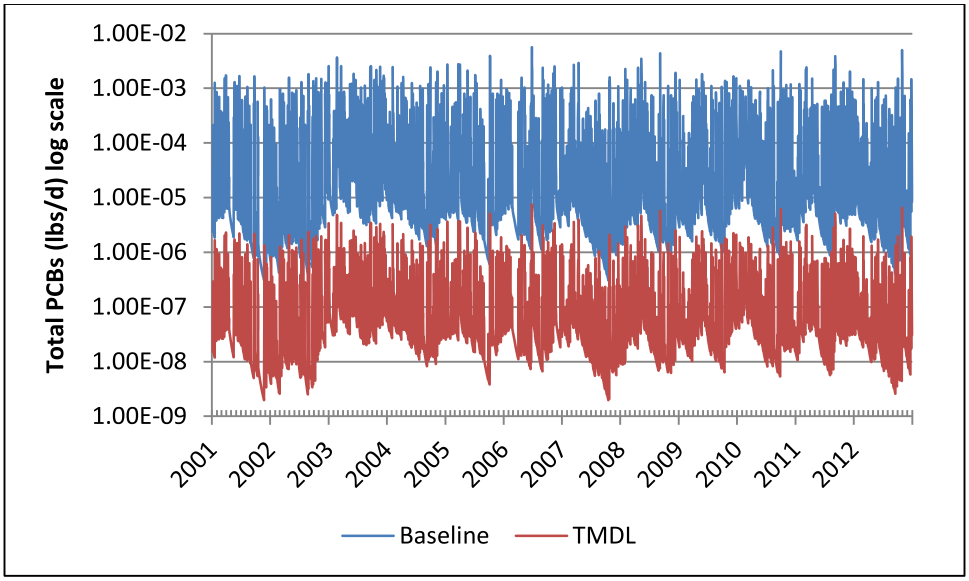

Figure 4.51: Simulated Daily PCB Loads (lbs/d), Portal Branch, Baseline Conditions and TMDL Scenario

4.11 Soapstone Creek

Soapstone Creek is a tributary of Broad Branch. Soapstone joins Broad Branch just before Broad Branch's confluence with Rock Creek. Soapstone Creek runs about 0.9 miles through a steep-sided heavily wooded valley about 500 yards wide. The average channel width is approximately 15 feet. Figure 4.52 shows the location of Soapstone Creek and its watershed (DDOH, 2004a).

Table 4.41 gives the land use acreage in the Soapstone Creek watershed. The watershed covers 514 acres and is mostly urban, with parkland and forest in the lower reaches of the creek. The northern quarter of the urban watershed is densely populated residential property. The southwestern quarter of the watershed is much less densely populated residential and commercial property (DDOH, 2004a). The watershed is 43% impervious and 80% lies within the DC MS4.

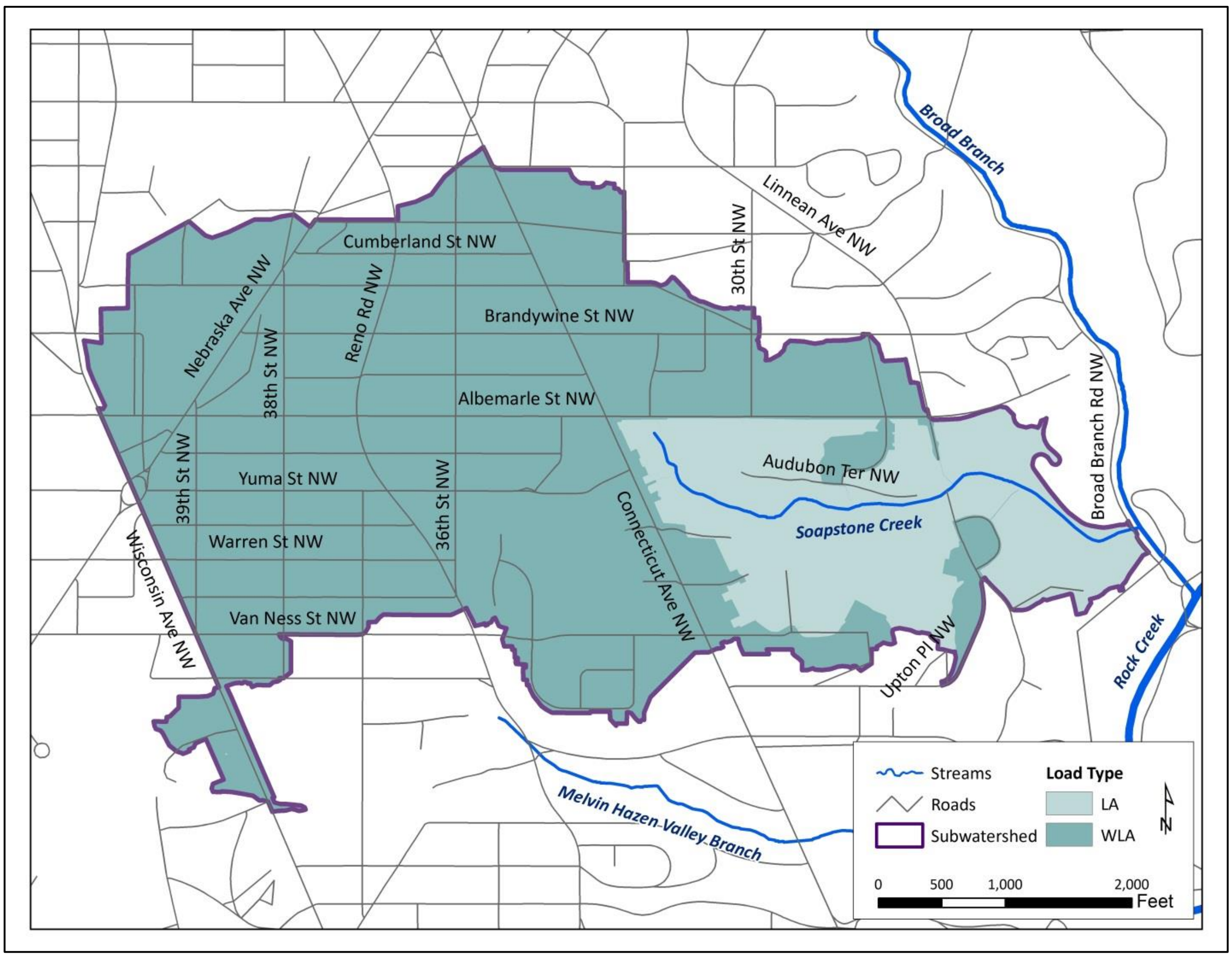

Figure 4.52: Soapstone Creek and its Watershed

Table 4.41: Soapstone Creek Land Use (acres)

Type	Impervious	Pervious	Forest	Total
DC MS4	202	202	7	411
DC Non-MS4	22	30	52	104
Maryland	-	-	-	-
Total	223	232	59	514

Figure 4.53 shows simulated daily average flow over the 2001-2012 year period. Simulated flows range from 0.02 cfs to 69.1 cfs. The average daily flow is 1.2 cfs and the median flow is 0.22 cfs.

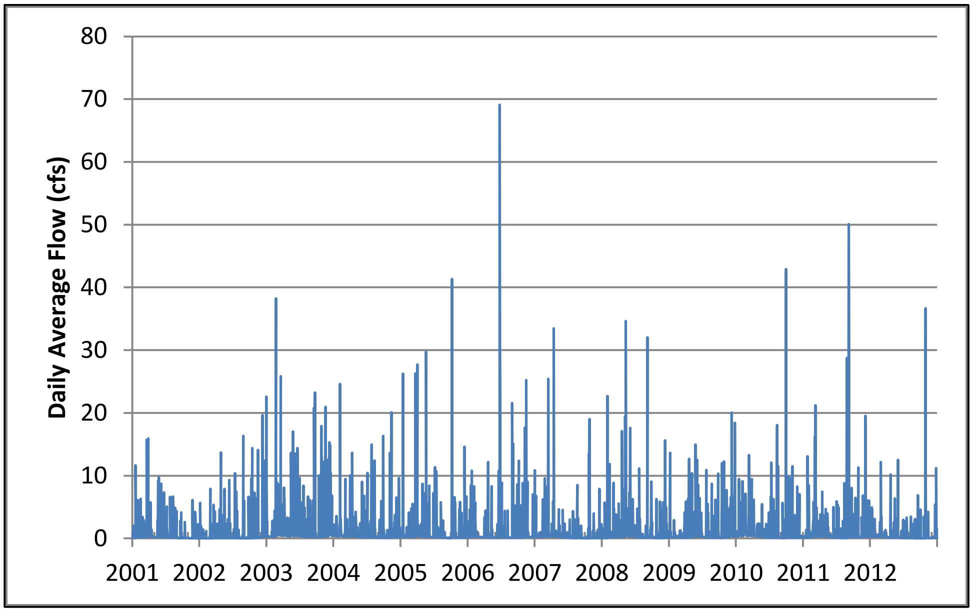

Figure 4.53: Simulated Average Daily Flow (cfs), Soapstone Creek

Table 4.42 presents the average annual baseline total PCB loads and TMDL allocations. Table 4.43 presents the daily average baseline loads and TMDL allocations, and Table 4.44 presents maximum daily baseline total PCB loads and TMDL allocations. Figure 4.54 shows simulated daily PCB concentrations under baseline conditions in 2005. Since the concentration of PCBs in storm flow is greater than the concentration in base flow, concentrations increase during storm events. Figure 4.55 contrasts the 30-day average total PCB concentration under baseline conditions and the current Class D human health criterion. Figure 4.56 presents simulated daily PCB loads under baseline conditions and under the TMDL.

Table 4.42: Average Annual PCB Baseline Loads and TMDL Allocations (lbs/yr), Soapstone Creek

Allocation Category	Source	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	8.78E-02	1.15E-04	99.87%
	Total	8.78E-02	1.15E-04	99.87%
Load Allocation	Direct Drainage	1.38E-02	3.76E-05	99.73%
	Upstream Maryland	-	-	-
	Total	1.38E-02	3.76E-05	99.73%
Margin of Safety		-	Implicit	-
Total		1.02E-01	1.52E-04	99.85%

Table 4.43: PCB Average Daily Loads (lbs/d), Soapstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	2.40E-04	3.14E-07	99.87%
	Total	2.40E-04	3.14E-07	99.87%
Load Allocation	Direct Drainage	3.78E-05	1.03E-07	99.73%
	Upstream Maryland	-	-	-
	Total	3.78E-05	1.03E-07	99.73%
Margin of Safety		-	Implicit	-
Total		2.78E-04	4.17E-07	99.85%

Table 4.44: PCB Maximum Daily Loads (lbs/d), Soapstone Creek

Allocation Category	Source	Baseline (lbs/d)	TMDL (lbs/d)	Percent Reduction
Wasteload Allocation	DC Regulated Stormwater	1.55E-02	2.02E-05	99.87%
	Total	1.55E-02	2.02E-05	99.87%
Load Allocation	Direct Drainage	2.04E-03	3.57E-06	99.82%
	Upstream Maryland	-	-	-
	Total	2.04E-03	3.57E-06	99.82%
Margin of Safety		-	Implicit	-
Total		1.75E-02	2.38E-05	99.86%

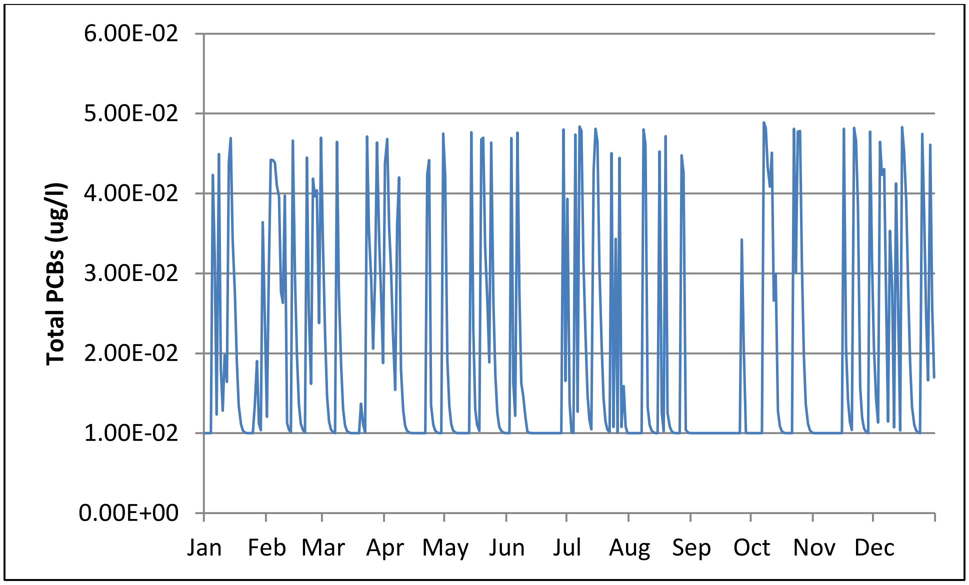

Figure 4.54: Simulated Daily PCB Concentrations (µg/l), Soapstone Creek, Baseline Conditions, 2005

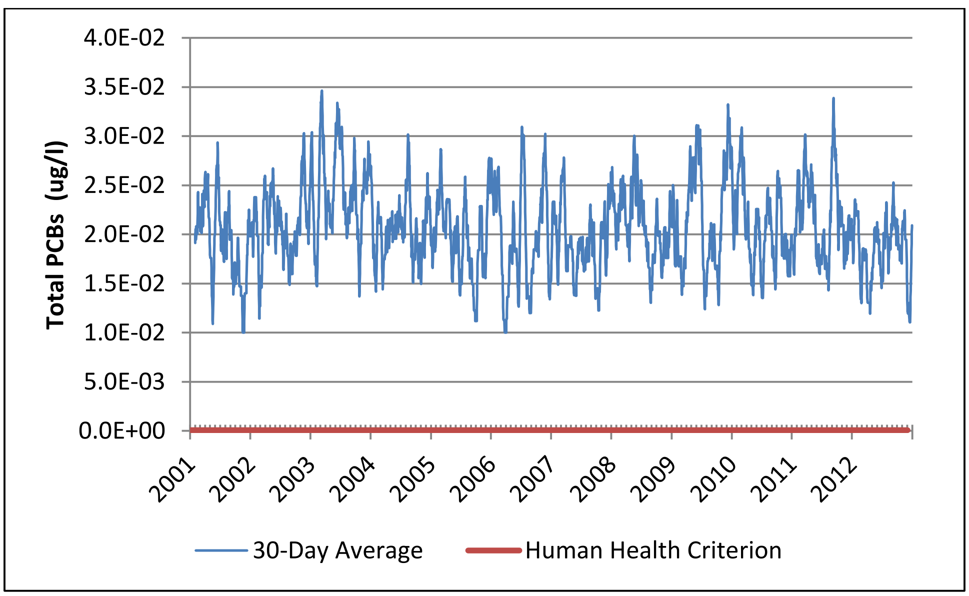

Figure 4.55: Simulated 30-Day Average PCB Concentrations (µg/l), Soapstone Creek, Baseline Conditions

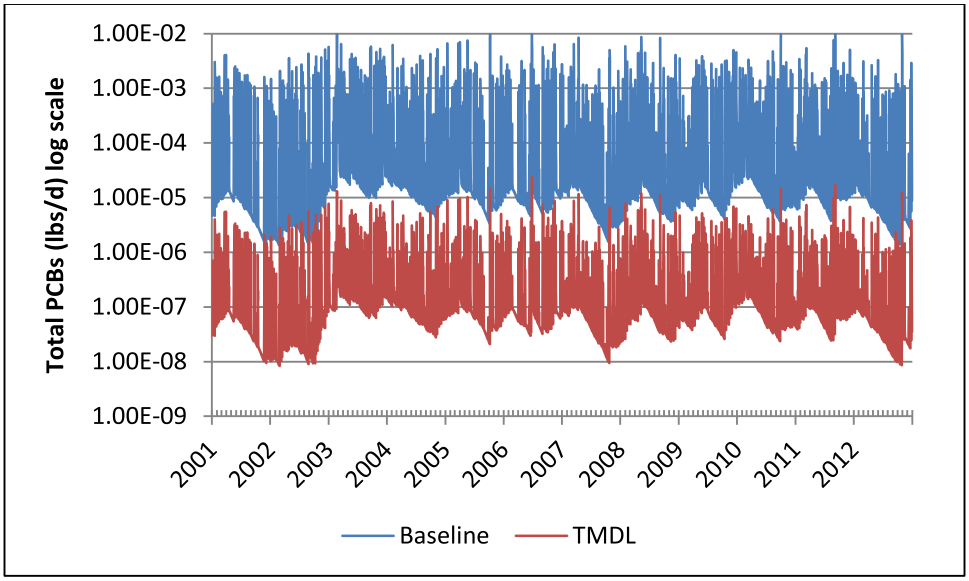

Figure 4.56: Simulated Daily PCB Loads (lbs/d), Soapstone Creek, Baseline Conditions and TMDL Scenario

5 Conclusion

A simple computer simulation model, the Small Tributary Pesticide Model (STPM), has been used to revise eleven PCB TMDLs for small tributaries in DC's portion of the Rock Creek watershed. STPM incorporates data that was not available at the time the original TMDLs were developed, including

- Improved delineation of DC MS4 areas;
- Simulated hydrology from a more recent model with broader peer review and acceptance within the Chesapeake Bay Program; and
- Instream PCB monitoring data and monitoring data collected in non-tidal waters for the tidal Potomac/Anacostia PCB TMDL.

The PCB TMDLs were established based on all sources meeting the District's chronic aquatic life criterion for PCBs as well as the water quality criteria for the protection of human health related to fish and shellfish consumption. The revised TMDLs are expressed as average annual loads, daily average loads, and maximum daily loads, satisfying the requirements of *Friends of the Earth vs. the Environmental Protection Agency, 446 F.3d 140, 144.*

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